THE 21ST ASIA-OCEANIA CONGRESS OF MEDICAL PHYSICS

"Science for Radiation Medicine"

10-12 DECEMBER 2021

VENUE

UNITED INTERNATIONAL UNIVERSITY (UIU)
DHAKA, BANGLADESH

Organizers

Co-Organizers

UNITED INTERNATIONAL UNIVERSITY

50th ANNIVERSARY 1971-2021 BANGLADESH

Endorsed by

Sponsors

CONFERENCE VENUE

ECLIPSE 16

Machine Learning + Human Intelligence = Machine Intelligence

ECLIPSE 16 | When considering treatment planning systems, it's important to be able to quickly create optimal, concise patient treatment plans. RapidPlan™ combined with MCO harnesses the power of machine learning combined with human intelligence to provide high quality individual plans with an efficient workflow. Collaborating with your peers using RT Peer Review allows you to further refine your patient treatment strategy. Eclipse™ RT Peer Review, RapidPlan and MCO give you the tools to confidently create the optimal plans quickly and with more certainty.

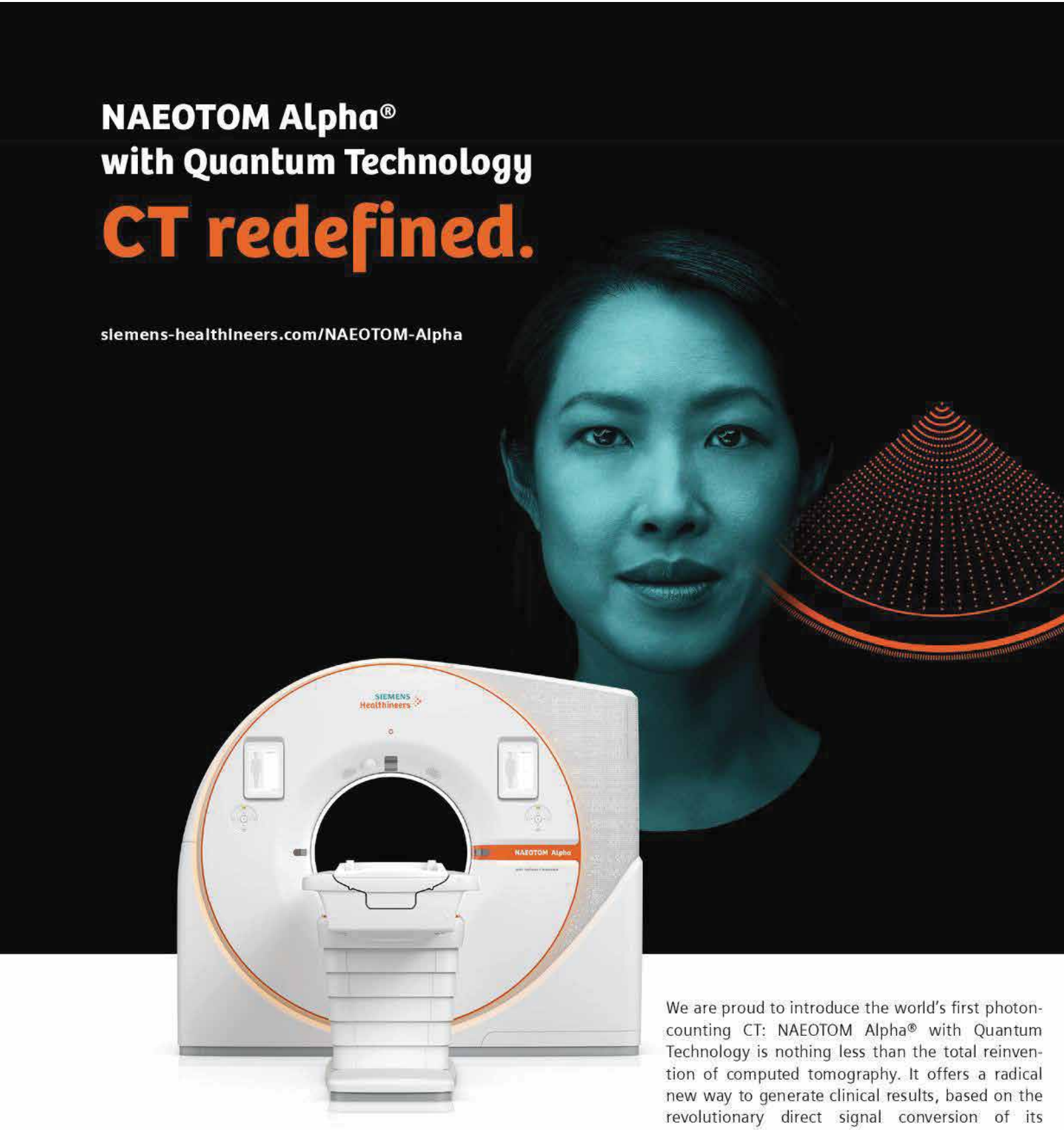
To learn more, visit us at Varian.com/Eclipse

Radiation may cause side effects and may not be appropriate for all cancers.

varian
A Siemens Healthineers Company

NAEOTOM Alpha®
with Quantum Technology
CT redefined.

siemens-healthineers.com/NAEOTOM-Alpha



We are proud to introduce the world's first photon-counting CT: NAEOTOM Alpha® with Quantum Technology is nothing less than the total reinvention of computed tomography. It offers a radical new way to generate clinical results, based on the revolutionary direct signal conversion of its QuantaMax detector.

NAEOTOM Alpha
CT redefined.

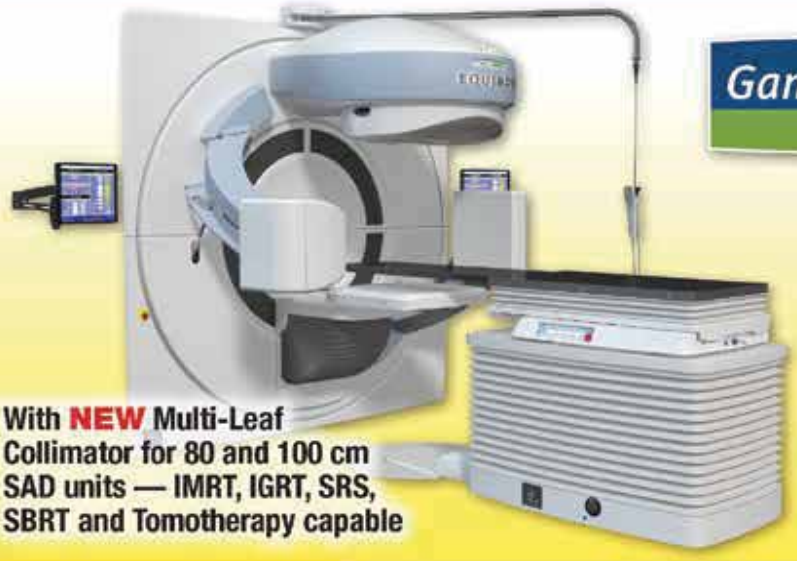
SIEMENS Healthineers

Siemens Healthcare Ltd
8, Laila Tower (6th Floor), Gulshan 1, Dhaka 1212, Bangladesh

Best™ medical international

TEAMBEST GLOBAL®
One World • One Source • The Best!
healthcare for everyone
TeamBest
Your True Partner
www.teambest.com

Best™ Integrated Radiotherapy Solutions



GammaBeam™ saving lives

With **NEW** Multi-Leaf Collimator for 80 and 100 cm SAD units — IMRT, IGRT, SRS, SBRT and Tomotherapy capable

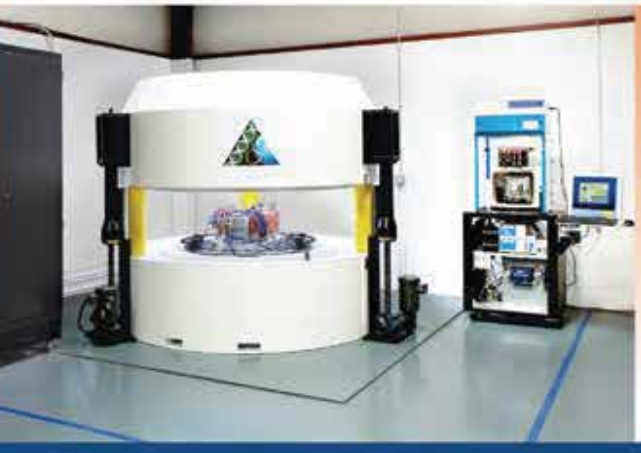
Best GammaBeam™ 100/300 Equinox Teletherapy System with IMRT & IGRT

Best GammaBeam™ 100/300 Equinox provides freedom in treatment planning and can interface with all major record/verify systems to allow for rapid treatment parameter loading, treatment set-up verification and recording of delivery.

Best HDR Remote Afterloader

Best Treatment Planning System for LDR, HDR Brachytherapy, SRS, SBRT, Tomotherapy & Teletherapy with IMRT/IGRT

Best Sonalis™ Ultrasound Imaging System



NEW! Best Sub-Compact Model 200 Self-Shielded Cyclotron with Optional Second Chemistry Module (Patent Pending)

- Low energy compact system — can be placed next to PET/CT
- Integrated self-shielded cyclotron and chemistry module
- Easy to operate push-button graphic interface
- Capable of producing: ^{18}FDG, Na^{18}F, ^{18}F-MISO, ^{18}FLT, ^{18}F-Choline, ^{18}F-DOPA, ^{18}F-PSMA, ^{11}C, ^{13}N, ^{68}Ga and more!
- Ideal for Nuclear Cardiology and other Medical Applications

TeamBest ASIA Private Limited email: asia@teambest.com
2/299A Plot No. 36, 5th Cross Street • V.G.P. Prabhu Nagar, Perumbakkam • Chennai – 600100 India
www.teambestasia.in www.theratronics.com www.teambest.com

AFRICA | ASIA | EUROPE | LATIN AMERICA | MIDDLE EAST | NORTH AMERICA

* Certain products shown are not available for sale currently.

LABAID
CANCER HOSPITAL
AND SUPER SPECIALITY CENTRE
Winning Cancer

ক্যান্সার চিকিৎসায় আর বিদেশ নয়
নিজ দেশে ঘরের পাশে
সর্বাধুনিক সুচিকিৎসায়

ল্যাবএইড ক্যান্সার হাসপাতাল এন্ড সুপার স্পেশালিটি সেন্টার

সেবাসমূহ-

- দেশবরেণ্য ক্যান্সার, সার্জারি, মেডিসিন, গাইনি, ইউরোলজি ও হেমাটোলজি বিশেষজ্ঞ চিকিৎসকগণ
- সর্বাধুনিক রেডিওথেরাপি মেশিনদ্বারা চিকিৎসা প্রদান
- আধুনিক কেমোথেরাপি ডে-কেয়ার সেন্টার
- সর্বাধুনিক প্রযুক্তি সম্পন্ন ল্যাবরেটরিতে প্যাথলজি টেষ্ট
- অভিজ্ঞ ডাক্তার, ফিজিসিস্ট, টেকনেশিয়ান ও নার্সের তত্ত্বাবধানে চিকিৎসাসেবা প্রদান
- ফার্মেসীতে সকল প্রকার দেশী বিদেশী ঔষধ সরবরাহ
- সকল প্রকার রেডিওলজি টেষ্টের সুবিধা
- সকল প্রকার গ্যাস্ট্রোএন্টারোলজি, ইন্টারভেনশনাল রেডিওলজি এবং বায়োপসি প্রসিডিউরসমূহ

হটলাইন
১০৬৬৪

ব্র্যাকিথেরাপির শুভ উদ্বোধন

বিশ্বমানের ক্যান্সার চিকিৎসার অংশ হিসেবে ল্যাবএইড ক্যান্সার হাসপাতাল এন্ড সুপার স্পেশালিটি সেন্টারে যুক্ত হয়েছে ব্র্যাকিথেরাপি চিকিৎসাসেবা

১ অত্যন্ত আধুনিক Ir-192 বা দীর্ঘমেয়াদী Co-60 রেডিয়েশন ব্যবহার

২ নিরাপদ, নিরবচ্ছিন্ন কার্যপ্রবাহ ও কম খরচে চিকিৎসা সুবিধা

৩ তুলনাতীত নিশ্চয়তায় QAssist প্রযুক্তি

৪ রিয়েল-টাইম ডোজ মনিটরিংয়ের জন্য ইন্টিগ্রেটেড ইন-ভিভো ডসিমেট্রি

৫ রোগীর নিরাপত্তা নিশ্চয়তায় ইউনিক ফিচার

৬ ইউজার ফ্রেন্ডলি

ল্যাবএইড ক্যান্সার হাসপাতাল
এন্ড সুপার স্পেশালিটি সেন্টার
২৬ গ্রিন রোড, ধানমন্ডি, ঢাকা ১২০৫
ওয়েব : www.labaidcancer.com

/labaidcancerhospital
/company/labaid-cancer-hospital
/labaidcancerhospital
09666710001, 01766662222

SOUTH ASIA CENTRE FOR MEDICAL PHYSICS AND CANCER RESEARCH (SCMPCR)

A Global Player of Training for Cancer Treatment Personals

MOTTO:- QUALITY EDUCATION AND HEALTH SCIENCE FOR PATIENT BENEFIT

ACCREDITED TRAINING PROGRAM

International Organization for Medical Physics

European Board for Accreditation in Medical Physics

ABOUT US

SCMPCR prime objectives is creating awareness program for the mass people for different communicable and non-communicable diseases, especially for cancer patients under UNDP SDG-goal 3 (Good Health & Well-being). SCMPCR also takes keen interest in arranging and conducting training programs to develop skilled manpower under UNDP SDG-goal 4 (Quality Education). It realizes the need to educate specially, women regarding the screening and prevention of cancer treatment under UNDP SDG-goal 4.

WHAT WE OFFER?

1. Health education
2. Awareness and Screening Program
3. Promotion of Self-help Groups for Cancer Patients
4. Training and Research
5. Tele Radiology
6. Welfare home for cancer patients

SCMPCR

Alo-BT

Alo Bhubon Trust

C-17, Anandopur, Thana Stand, Savar, Dhaka 1340, Bangladesh

Phone: +8801679400784
Email: scmpcr17@gmail.com
Website: www.scmpcr.org

AOCMP-2021

CONTENTS

Arch. Yeafesh Osman
Minister
Ministry of Science and Technology
Govt. of the People's Republic of Bangladesh

Message

It is my pleasure to know that the "21st Asia-Oceania Congress of Medical Physics (AOCMP)", the yearly conference of Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) hosted by the Bangladesh Medical Physics Society (BMPS) is going to be held from December 10 to 12, 2021 in Dhaka, Bangladesh. The co-organizers are South Asia Centre for Medical Physics and Cancer Research (SCMPCR), United International University (UIU), Bangladesh Atomic Energy Commission (BAEC) and National Institute of Cancer Research and Hospital (NICRH).The congress has been endorsed by the International Organization for Medical Physics (IOMP), European Federation of Organization for Medical Physics (EFOMP) and Middle East Federation of Organization for Medical Physics (MEFOMP).

Medical physicists work in health care and apply their knowledge of physics to the development and use of medical radiation treatments, devices, and technologies. Medical physicists often consult with their physician colleagues to offer advice and resources to solve problems that occur when using radiation therapy or nuclear medicine.

The Ministry of Science and Technology is constantly working to extend the peaceful use of nuclear technology-based medical treatment facilities throughout Bangladesh, which contributes considerably to the protection of people's health. Three PET-CTs have been installed at the National Institute of Nuclear Medicine and Allied Sciences (NINMAS) and Institute of Nuclear Medicine and Allied Sciences (INMAS), Dhaka, for modernization of nuclear medical services. The Institute of Food and Radiation Biology at the Atomic Energy Research Establishment (AERE), Savar, has had its laboratories upgraded in addition to its infrastructural development. The Atomic Energy Research Establishment (AERE), Savar, has built the Nuclear Medical Physics Institute to provide cancer therapy, as well as one LINAC equipment to educate trained medical Physicists and technologists in cancer treatment.

It is truly our great joy that the largest medical physics event in the Asia and Oceania region is hosted in Bangladesh on the occasion of Bangladesh's 50th anniversary. I'd like to extend a warm greeting to all attendees, both in person and online, and wish the 21st AOCMP to be a successful event.

Architect Yeafesh Osman

Room No-922, Floor No-9, Building No-6, Bangladesh Secretariat, Dhaka-1000, Bangladesh
Phone : +88 02 9511066, Fax : +88 02 9552323
E-mail : minister@most.gov.bd, Web : www.most.gov.bd

Md. Ali Noor
Secretary
Medical Education & Family Welfare Division
Ministry of Health and Family Welfare
Govt. of the People's Republic of Bangladesh

মোঃ আলী নূর
সচিব
স্বাস্থ্য শিক্ষা ও পরিবার কল্যাণ বিভাগ
স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

Message

It is my pleasure to know that the "21st Asia-Oceania Congress of Medical Physics (AOCMP)", the yearly conference of Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) hosted by the Bangladesh Medical Physics Society (BMPS) is going to be held from December 10 to 12, 2021 in Dhaka, Bangladesh. The co-organizers are South Asia Centre for Medical Physics and Cancer Research (SCMPCR), United International University (UIU), Bangladesh Atomic Energy Commission (BAEC) and National Institute of Cancer Research and Hospital (NICRH). The congress has been endorsed by the International Organization for Medical Physics (IOMP), European Federation of Organization for Medical Physics (EFOMP) and Middle East Federation of Organization for Medical Physics (MEFOMP).

Medical physicists work in health care and apply their knowledge of physics to the development and use of medical radiation treatments, devices, and technologies. They make sure the equipment is operating correctly and are often involved directly with a patient's diagnosis and treatment, as well as with radiation safety and product development. Medical physicists often consult with their physician colleagues to offer advice and resources to solve problems that occur when using radiation therapy or nuclear medicine.

Bangladesh is already at a better stage to use digital health technology across all sectors and provides scope for the general population to access the digital solutions to enable the advancement of socio-economic development. The medical physicists can greatly contribute to strengthening the digital health systems and welcome all healthcare professionals and development partners to work jointly on this initiative which will ultimately lead to better health for the people of Bangladesh.

Bangladesh suffers from both a shortage of and geographical misdistribution of human resources for health and there is a lack of qualified medical physicist in Bangladesh. I greatly appreciate the initiative of BMPS to disseminate scientific and technical information, fostering the educational and professional development of medical physics and promoting the highest quality medical services for patients.

I hope this conference, will allow attendees from home and abroad to discuss and gain knowledge as well as new research ideas in the field of cancer care, particularly in Medical Physics. I'd like to extend my thanks to organizer and a warm greeting to all attendees, both in person and online, and wish the 21st AOCMP a great success.

07.12.2021
Md. Ali Noor

Dr. Md. Sanowar Hossain
Chairman
Bangladesh Atomic Energy Commission (BAEC)

Message

Dear Esteemed Guests and Delegates,

Bangladesh Atomic Energy Commission (BAEC) is delighted to be one of the Co-organizers of the Asia-Oceania Congress of Medical Physics 2021 at Dhaka, Bangladesh. BAEC has always been working for the development of Medical Physics in Bangladesh. It has solely organised numerous trainings and workshops to train large number of relevant persons in the field of ionising radiation and nuclear medicine. BAEC also organised different scientific programmes as co-organizer before and will continue to do so. Bangladesh Medical Physics Society (BMPS) has also been working hard for developing the platform in Bangladesh.

It is well known to all that the present government is striving to solve the electricity crisis through Nuclear Power Plant in Rooppur implemented by BAEC. BAEC is working hard to implement this plan and generate significant amount of the clean energy from Nuclear Power by 2021. BAEC is also playing a major role for development of Medical physicists in the Nuclear medicine sector, Recently BAEC in 2018 established Institute of Nuclear Medical Physics (INMP) aiming to provide advanced training in order to develop qualified medical physicists (QMPs) and nuclear medical technologists. Cancer diagnosis and treatment in Bangladesh is highly expensive, thus INMP also had a target of providing quality service to the cancer patients using physics techniques at a very affordable cost.

BAEC has hosted several conferences previously with BMPS. This time BAEC would like to congratulate BMPS for taking the challenge to host the AFOMP conference in Bangladesh for the first time. Medical Physics is a very specialised subject and requires intensive clinical and academic training to be a qualified medical physicist. Organising such kind of scientific programmes will bring all the scientists and researchers from across the world, together to share their recent works and developments. This will certainly help the local scientists to develop themselves even further also it will provide the chance to show the world about our recent developments in the field of medical physics.

I would like to thank all the key personnel and all the organizers and the participants of this conference to make this event a great success.

Dr. Md. Sanowar Hossain

Dr. Kazi Anowarul Hoque
Former Additional Secretary,
Local Government Division
Ministry of Local Government, Rural Development
& Co operatives
Bangladesh Secretariat, Dhaka, Bangladesh.

Message

I am pleased to know that the "21st Asia-Oceania Congress of Medical Physics (AOCMP)", the yearly conference of Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) is going to be held from December 10 to 12, 2021 in Dhaka, Bangladesh. It is hosted by the Bangladesh Medical Physics Society (BMPS.

Medical physicists play a pivotal role diagnosis radiology, nuclear medicine, radiotherapy and radiation protection. They are also involved directly in preparation and quality control of the equipment used in the aforementioned disciplines.

Medical physicists often consult with their physician colleagues to offer advice and resources to solve problems that occur when using radiation therapy or nuclear medicine.

I would like to welcome all participants in person and online and wish the 21th AOCMP will be a great success.

Thank you.

Dr. Kazi Anowarul Hoque

Prof. Dr. M Iqbal Arslan
President
Swadhinata Chikitshak Parishad (SWACHIP)

Message

Dear Esteemed Delegates,

I am delighted to warmly thank the organizers, co-organisers and the participants of this important Conference forgiving me the privilege of welcoming and addressing you all. I am particularly happy to be present in this unique event and to exchange views and share experiences.

Cancer is one of the leading causes of death globally accounting for nearly 10 million deaths in 2020 and radiotherapy is currently essential in the management of cancer patients either alone or in combination with surgery or chemotherapy or both for cure and palliation. Approximately 60% of all cancer patients received radiotherapy each year as definitive, palliative or adjuvant to surgery or chemotherapy.

In radiation therapy, medical physicists work with physicians, optimise treatment plans, and conduct quality control and verification of the actual medical application working in concert with physicians, clinical radiological technologists, and radiotherapy quality control specialists.

I am very glad to know that the biggest medical physics conference of the Asia Oceania region is going to be held in Bangladesh on the occasion of Mujib Borsho and the 50th years Anniversary of Bangladesh. I congratulate all the distinguish speakers and the delegates for their commitment and active participation.

I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations that will lead to a better, healthier, merrier world.

I wish the conference great success

Thank you for your attention.

Prof. Dr. M Iqbal Arslan

Organizers

Professor Dr. Golam Abu Zakaria
*P*atron, Asia-Oceania Medical Physics Congress
(AOCMP-2021)
Chairman, South Asia Centre for Medical Physics
and Cancer Research (SCMPCR)

Message

The history of medical physics in Bangladesh began in the 1990s. Since then, the medical physics community has traveled widely. We have tried to establish this platform with hard work and dedication. During this journey, we have been able to develop a good number of medical physicists with education and training at international level. We have had good experience and qualifications in this area, but it is time to have even higher ambitions to make this platform more sustainable in the future. We have to work even harder by bringing all medical physicists under one roof. Medical physicists working in both clinical and academic sectors should continue stretching their scientific works together to develop this sector in Bangladesh at international level. I strongly believe both the already qualified and the upcoming young generation have the potential to fulfill the necessity of making a community of qualified medical physicists in Bangladesh and South Asia.

We have hosted many different national and international medical physics conferences in Bangladesh, but this time we are very excited to host the 2021 Asia-Oceania Medical Physics Congress (AOCMP-2021) in Dhaka. We are all aware of the current COVID-19 pandemic situation, for which we had to relocate the conference venue from Cox's Bazar to Dhaka. I hope that this international conference will give a strong impetus for the further development of medical physics in our region. The SCMPCR has been played an important role for skilled medical physicists manpower in the South Asia region.

All the organizers have worked hard to make this congress a great success. I would like to thank the chairman, president, secretary, all organizers and participants of this conference from Bangladesh and abroad. Last but not least, I would like to thank the United International University (UIU) authority for their strong support in making the conference successful.

I wish everyone the best of luck.

G. A. Zakaria

Professor Dr. Golam Abu Zakaria

Professor Dr. Chowdhury Mofizur Rahman
Vice Chancellor
United International University

UNITED INTERNATIONAL UNIVERSITY

Message

We are excited to host the 21st Asia-Oceania Congress of Medical Physics 2021 at our university, which is the region's largest medical physics conference.

According to the IAEA, Medical Physicists is a required manpower for effective and precise cancer treatment, as well as Clinical Engineering to deliver continuous medical and health services across the country. These are immensely challenging subjects that necessitate the adequate skills and special training in order to give high-quality cancer treatments and maintain clinical instruments at an international level.

We have recently launched Centre for Biomedical Science and Engineering (CBMSE) at United International University (UIU). We have plans to launch MSc in Medical Physics (MP) and a BSc in Biomedical Engineering (BME) under CBMSE in the soonest possible time. We hope to attract international faculty members and students and will take all necessary steps to train qualified medical physicists and Biomedical Engineers to meet Bangladesh's growing demand for such professionals.

Food adulteration, use of preservatives, contaminated water, use of insecticides and climate change effects give rise to cancerous diseases in an enormous scale. The advancement of Medical Physics as a tool for the treatment of cancerous diseases is a crying need of the time. The 21st Asia-Oceania Congress of medical Physics will be a perfect platform to discuss and exchange the recent developments of Medical Physics and related areas among the researchers, academicians and practitioners.

I would like to express my gratitude and sincerest thanks to the chairperson, president, secretary, conference organizers, and all the attendees from home and abroad for making this event a huge success.

Professor Dr. Chowdhury Mofizur Rahman

Prof. Arun Chougule
President AFOMP

Message

Dear colleagues
Greetings from a AFOMP President and EXCOM.
As you know that AF OMP was founded in 2000 and we have completed 21 years of active fruitful existence and moved from infancy to adulthood. In last 21 years with cooperation of all the NMO's and all of you AFOMP has established as a vibrant and extremely useful regional organisation of IOMP.
Asia Oceania region has over 50 countries and hosts over 60% of the world's population. Some countries are too small and do not have even a single medical physicist or the required number of medical physicists to form national medical physics organisation. Socioeconomically AFOMP region is remarkably diverse and no unifying council, therefor AFOMP has a big role to play for harmonization of medical physics education as well recognition of medical physics profession. At present AFOMP has 19 NMO's as members and 2 NMO's as associate member and re-presents over 11,000 medical physicists.
Since 2000 AFOMP is organizing Asia Oceania Congress of Medical Physics [AOCMP], annual meeting of AFOMP every year in different countries of AFOMP region. Despite of Covid 19 pandemic the 20 th AOCMP was held in Phuket in hybrid mode with great efforts of the organisers.
The 21st AOCMP is being organised in hybrid mode by Bangladesh Medical Physics Society (BMPS), at United International University (UIU), Dhaka, Bangladesh during 10 to 12 December 2021. The organisers of AOCMP2021 coincides with the 50th anniversary of Bangladesh's independence. The theme of the conference is "Science for radiation Medicine "Many activities, meetings, sessions, mini-symposiums, invited talks, proffered papers and the prestigious Prof Kiyonari Inamura memorial AFOMP oration one the main features of the conference. Organisers are planning IMPCB certification examination in collaboration with IMPCB for benefit of candidates in this part of the region. Every year AFOMP awards 8- 9 travel grants for young medical physicists from the lower- and middle-income countries from AFOMP region to facilitate them to attend the important annual meeting and present their work. To encourage young medical Physicist, the best oral and poster presentation awards are also planned as done every year.

The organisers are trying their level best to make this annual meeting of AFOMP very fruitful in terms of scientific, social, organisational, and cultural fronts. AOCMP's are great opportunities to meet old friends, colleagues, explore new friendships, renew, and start new collaborations, understand the culture of host country, enjoy the cuisine, culture, and visit new places. The meeting provide opportunity to attend the trade exhibitions and demonstration, to learn new technology, the

equipment's features, techniques, and sort of any issues with the product one is using or planning to acquire.

I am sure most of you will plan to attend this especially important meeting of AFOMPO in person provided the covid-19 guidelines permits and if not able to make in person you will certainly participate in virtual way. The Bangladesh facilitates visa on arrival, [refer to conditions if any]. I request you all to submit the abstracts for presentation and take part in this mega event actively.

Prof. Arun Chougule

Prof. Dr. Hasin Anupama Azhari
Organizing Chairperson, AOCMP-2021
Secretary General, AFOMP
Director, Centre for Biomedical Science and Engineering
(CBMSE), United International University (UIU)

Message

Dear Colleagues,

On behalf of the AOCMP-2021 organizing committee, I am honored and delighted to welcome you to the 21st Asia-Oceania Congress of Medical Physics (AOCMP), Dhaka, Bangladesh. Considering the restrictions of the pandemic, we have preferred this a hybrid congress that combine both in-person and virtual experiences.

The COVID-19 pandemic has impacted our community more than any other event in most of our lifetimes. All the societies and organizations globally are trying to navigate their way through this crisis, balancing the short-term need with a long-term strategy.

While we are all in the same storm, we must realize that we are in different boats, and therefore different solutions and strategies are necessary. Locally, nationally and around the world, this pandemic has affected us all in various ways, and we have vastly different means and capabilities in how to respond.

We have tried our best to give you a good congress environment to exchange views and share experiences with high level professors, colleagues and friends, representing many well-known Universities and Research Institutes together with members of relevant international organizations. Six keynote speeches from the IAEA, IOMP, AFOMP, EFOMP, MEFOMP, and DGMP, as well as 22 invited lectures from well-known professionals, have been enlightened our scientific program. There are also five Mini-Symposia with a series of panel discussions on various topics. Many excellent oral and poster sessions would have been presented by a broad group of physicists, researchers, students, and others.

We are delighted to inform you that the IMPCB exam will be held for the 2nd time on 13-14 December 2021 in Dhaka.

As a conference chair of AOCMP-2021, I know that the success of the conference depends ultimately on the many people who have worked with us in planning and organizing both the scientific program and supporting hybrid event management. In particular, we thank the AOCMP committee members for their wise advice and brilliant suggestion on organizing the technical program, and our sponsors who have helped us to keep down the costs of AOCMP-2021 for all participants. Recognition should go to the Local Organizing Committee members who have all worked extremely hard for the details of important aspects of the congress.

Most of all, I thank you, the participants, for enriching the conference by your presence. I hope you will enjoy the congress, renew old friendships, make new friends, get new ideas, and above all, have a good time.

Thanks and Regards

Prof. Dr. Hasin Anupama Azhari

M. Akhtaruzzaman, PhD
Organizing Secretary, AOCMP-2021
Secretary, BMPS

Message

Distinguish Guests and Esteemed Colleagues

I am delighted that the "21st Asia-Oceania Congress of Medical Physics (AOCMP)", the yearly conference of Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) hosted by the Bangladesh Medical Physics Society (BMPS) is going to be held from December 10 to 12, 2021 in Dhaka, Bangladesh. It is really a great pleasure that the largest medical physics event in the Asia-Oceania region is being hosted in Bangladesh on the occasion of 50th anniversary of Bangladesh. The co-organizers are South Asia Centre for Medical Physics and Cancer Research (SCMPCR), United International University (UIU), Bangladesh Atomic Energy Commission (BAEC) and National Institute of Cancer Research and Hospital (NICRH). The congress has been endorsed by the International Organization for Medical Physics (IOMP), European Federation of Organization for Medical Physics (EFOMP) and Middle East Federation of Organization for Medical Physics (MEFOMP).

Asia-Oceania Congress on Medical Physics (AOCMP) is organized annually in different countries in the Asia-Oceania region to provide a scientific platform to share, upgrade, and enhance medical physics knowledge worldwide. To host AOCMP 2021, the bidding process was held in Perth, Australia in 2019. Bangladesh and Japan were participated, and on behalf of Bangladesh, BMPS won the bid to host AOCMP 2021 congress.

Medical physicists work in health care and apply their knowledge of physics to the development and use of medical radiation treatments, devices, and technologies. They make sure the equipment is operating correctly and are often involved directly with a patient's diagnosis and treatment, as well as with radiation safety and product development. Medical physicists often consult with their physician colleagues to offer advice and resources to solve problems that occur when using radiation therapy or nuclear medicine.

Although still the COVID-19 pandemic is going on, we are able to receive a considerable number of exciting talks from the globe and therefore hold the AOCMP-2021 congress in hybrid mode. The organizer BMPS and co-organizers have worked hard to develop a rich and simulating scientific program, with time set aside for mingling with colleagues and celebrating our success. Scientific program has been arranged as following: Kiyonari Inamura Oration Lecture, 6 Keynote Lectures, 25 Invited Lectures, 6 Mini Symposia, 91 Oral and 64 e-poster presentations.

I would like to express my gratitude to all organizers, sponsors and participants for their valuable contributions and supports to make this event a grand success.

M. Akhtaruzzaman, PhD

Md. Anwarul Islam
President
Bangladesh Medical Physics Society (BMPS)

Message

On behalf of Bangladesh Medical Physics Society (BMPS), I would like to extend my warmest welcome to you to the "21st Asia-Oceania Congress of Medical Physics (AOCMP)", the official yearly congress of the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP). This is also a great honor for BMPS for being hosted this prestigious conference specially the 50th anniversary of Bangladesh's independence.

BMPS has experience to organize yearly national and by three yearly international seminar and conference from its establishment in 2009. This conference has been designed to provide an innovative and comprehensive overview of the latest advancement in different field of medical physics. We would like to extend our thanks to all of you who have worked very hard to make this conference a very special event. Many thanks to the different companies for their financial support, UIU authorities and staff for their generous support. We also offer special thanks to both print and electronic media for their presence and coverage.

I am quite sure that you will enjoy the conference and your interaction with the colleagues form many different countries will stimulate a creative exchange of ideas and will be personally rewarding.

I sincerely, wish a great success of the conference.

Md. Anwarul Islam

Co-Organisers

The International Medical Physics Certification Board

www.IMPCB.org

AOCMP 2021 Organizing Committee

Message from IMPCB

Thanks to the leaders of IOMP and AFOMP and the Organizers of AOCMP2021 for inviting IMPCB to present the Plenary Session on Medical Physicists Certification during the Congress, and to create an Examination Session immediately after the Congress.

As many AFOMP colleagues are working on forming or seeking accreditation for their own certification boards, several important questions deserve in depth exploration. The AOCMP incorporation of the Exam Session and the symposium in the program is very much welcome. IMPCB takes the opportunity and has resolved to use the forum to revisit the recommendations of the IAEA TCS-71, starting from the IOMP point of view when the IMPCB was formed. The method and model used by IMPCB in the past eleven years will be revisited in detail. The IMPCB leadership will be ready to answer questions during the symposium. The state of the art of diagnosis and treatments helped boost the demand of certified medical physicists. The solution to balance the demand is to improve the supply of highly qualified medical physicists. This should be done before the situation becomes critical. How to achieve this goal in the region and overcome the obstacles will be of interest to all participants of the Congress.

There are nineteen candidates approved to take the written examinations for individual certifications according to records available at press time. It took more than five months to review all the credential records for the over thirty applicants.

For the Plenary Session which will be on Day 2, IMPCB will feature six speakers who can speak with firsthand information. We highly appreciate your participation.

Sincerely,

Raymond K. Wu

Raymond K. Wu, PhD
Chief Executive Officer, IMPCB
Past Chairman, IOMP Professional Relations Committee
Professor in Radiation Oncology (Retired),
Eastern Virginia Medical School, USA

Professor (Dr.) Qazi Mushtaq Hussain
Director
National Institute of Cancer Research & Hospital

Message

National Istitute of Cancer Research & Hospital (NICRH) is delighted to be one of the Co-organizers of the Asia-Oceania Congress of Medical Physics 2021 atDhaka, Bangladesh. NICRH is the country's only tertiary level government hospital. It is the pioneer and largest institute of cancer reasearch and treatment in Bangladesh. Since its inception, NICRH has been guided by three core ideas: commitment, compassion and community.We have taken a comprehensive approach to tackle cancer in respect to prevention, diagnosis, treatment and survivorship. We have been working very hard to offer modern conformal radiotherapy treatments to the patients.

Incorporation of latest technology equipments like Linear Accelerator with associated instruments in radiation oncology department made a significant shift of the treatment approach towards more curative intent. In order to reach to a level of a comprehensive cancer center improvements in all other disciplines are also made with equal importance. With a fleet of highly qualified, eminent and visionary faculty members, this institute has been offering service to cancer patients.Trainings, workshops and scientific conferences are the modalities to improve our knowledge and compare ourselves to the world.

Bangladesh Medical Physics Society (BMPS) has also been working hard for developing the medical physics in Bangladesh. BMPS has taken a great leap and shown its excellence by organizing the AFOMP conference in Bangladesh during this pandemic situation. Medical Physics requires specialization in both clinical and academic perspective. I believe organising such scientific programes regularly will bring out the best from our youngsters to lead the nation with qualified persons from now on to the future.

I would like to thank all the organizers and the participants from home and aborad to make this conference a great success. I wish all best of luck.

Professor (Dr.) Qazi Mushtaq Hussain

Endorsers

Madan M. Rehani
President, IOMP

Message

Dear Colleagues,

I am delighted to note that the 21st Asia-Oceania Congress of Medical Physics (AOCMP) is being organized at United International University (UIU), Dhaka, Bangladesh on 10-12 December 2021. Asian region has a tradition of organizing AOCMP regularly and 21st conference itself is a sign of the long history of this conference that is organized under the aegis of the Asian Federation of Organizations of Medical Physics (AFOMP).

No other region of the world has been organizing regional medical physics conferences for that long. Congratulations to AFOMP for continued regular actions and we in IOMP are happy that AFOMP has been able to maintain this activity. Congresses provide effective means for continuing education. I note that AOCMP has invariably maintained reasonable balance between regional talents and external experts. I am sure this conference also will provide scientific feasts for all participants. The problems created by pandemic are insurmountable and we all are helpless in making the usual in-person happen with large attendance. Despite that, I believe the organizers will use best mechanism to have an effective conference.

I wish the congress great success.

Best wishes

Madan M. Rehani

Paddy Gilligan
President of EFOMP

Message

Dear Asia-Oceania Federation of Organizations for Medical Physics Colleagues and Friends,

The European Federation of Organisations for Medical Physics are pleased to endorse the 21st Asia Oceanic congress of Medical Physics (AOCMP). In many countries the age of 21 represents a coming of age and a sign of well-established maturity and wisdom. We feel that the same is true for your congress. Congratulations on an excellent congress program. EFOMP are proud of the contribution of our national member organisation particularly the DGMP in the congress and its links with the Bangladesh Medical Physics Society (BMPS).

It is heartening to know that despite large geographical distances separating us Medical Physics has the same objectives to improve the patient and staff experience through safe use of effective treatment and diagnostics. The balance of delivering new technologies in their optimum manner is well reflected in this exciting congress. In the pandemic and hopefully soon post pandemic era medical physicists will play a key role to in access to optimized diagnostic and therapeutic options.

The desire to advance standards in education and training for medical physics is very evident and something that resonates very strongly with EFOMP. Although distance and COVID concerns have limited our face-to-face interactions we have reaped some dividends from the improvements in online learning and technology.

So, on behalf of EFOMP we would like to congratulate you on an excellent program and wish you the very best success for AOCMP 21.

With Best Wishes,

Paddy Gilligan

Dr. Huda M. Al-Naemi
President of MEFOMP

MEFOMP

Message

Dr. Hassan Kharita
General Secretary of MEFOMP

The Middle East Federation of Organizations of Medical Physics (MEFOMP) is happy to announce that the "21st Asia-Oceania Congress of Medical Physics (AOCMP) in 2021" have fulfilled its endorsement criteria. It is our pleasure to endorse this extremely important conference and to encourage all medical physicists and health professionals to participate and attend this event.

This great conference is promoting the latest advancements and innovations in all areas of medical physics and offering a unique opportunity to meet virtually or personally distinguished speakers in this field. This conference is also offering a series f diverse continuing education lectures in medical physics.

MEFOMP honored to be part of this event and to offer a Mini Symposium in one of the parallel sessions. It is our hope to continue and strengthen this collaboration with AFOMP in future for very successful conferences. I wish AOCMP-2021 all the success and hope that all participants will find this

conference beneficial and useful to their professional development.

Best wishes

Dr. Huda M. Al-Naemi

Dr. Hassan Kharita

AOCMP-2021 Committees

Patron

Prof. Dr. Golam Abu Zakaria

Prof. Dr. Chowdhury Mofizur Rahman

Chairperson

Prof. Dr. Hasin Anupama Azhari

Co-Chairperson

Dr. Md. Jahangir Alam

Mr. Md. Anwarul Islam

Secretary

Dr. Md. Akhtaruzzaman

Joint-Secretary

Mr. Jobairul Islam

Treasurer

Mr. Safayet Zaman

Ms. Sadia Afrin Sarah

Members (National)

Mr. Md. Nazmul Islam (AHL)

Dr. Rajada Khatun (BAEC)

Mr. Harun-Or Rashid (BSMMU)

Dr. M. Anwarul Islam (CMH)

Mr. Md. Khairul Islam (CMH)

Mr. Polash Chandra Sarker (CMCH)

Mr. SM Enamul Kabir (DHL)

Dr. Murugan Appasamy (EHD)

Mr. Md. Atiquzzaman (EMCH)

Ms. Zinat Rehana (Ex-com)

Mr. Md. Mostafizur Rahman (Ex-com)

Dr. Swapan Kumar Sarkar (GB)

Mr. Sujan Mahamud (GB)

Asst.Prof Meher N. Sharmin (KYAMCH)

Mr. Md. Tariqul Islam (MAGOMCH)

Mr. Ariful Islam (NICRH)

Mr. Aashis Boiragi (NEMCH)

Mr. M. Shahidul Islam Mia (RMCH)

Mr. Md. Sadman Shahriar (SBMCH)

Mr. Amir Hamza (SZRMC)

Mr. Md. Motiur Rahman (TCC)

Mr. Md. Sajan Hossain (THL)

Prof. Dr. Md. Abu Saklayen (UIU)

Lt. Col. Md. Fazlul Hoque (UIU)

Mr. Masood-Ul-Alam (UIU)

Dr. Kartick Raj Mani (UHL)

Ms. Jennifer Hossain (UIU)

Mr. Md. Faruque Miah (UIU)

International Organizing Committee

Chair

Prof. Dr. Arun Chougule (India)

Members

Prof. Dr. Eva Bezak (Australia)
Prof. Dr. Yimin Hu (China)
Dr. Jin Xiance (China)
Dr. Weigang Hu (China)
Dr. Yuchuan Fu (China)
Dr. Jianrong Dai (China)
Dr. Kimi Bin Yang (Hong Kong)
Dr. Michale Lee (Hong Kong)
Dr. Dayananda Sharma (India)
Dr. S.D. Sharma (India)
Dr. Supriyanto Ardjo (Indonesia)
Dr. Freddy Haryanto (Indonesia)
Dr. M. A. Mosleh-Shirazi (Iran)
Dr. Seied Rabi Mahdavi (Iran)
Dr. Shuichi Ozawa (Japan)
Dr. Hidetoshi Saitoh (Japan)
Dr. Arimura Hidetaka (Japan)
Dr. Shinji Kawamura (Japan)
Dr. Yongyih Han (Korea)
Dr. Aik Hao Ng (Malaysia)
Dr. Chai HongYeong (Malaysia)
Dr. Ung Ngie (Malaysia)
Dr. Noriah Jamal (Malaysia)
Dr. Kwan Hoong Ng (Malaysia)
Dr. Hazif M Zin (Malaysia)
Dr. Swe Swe Lin (Malaysia)
Dr. Kanchan Adhikari (Nepal)
Dr. Suresh Poudel (Nepal)
Dr. Mansoor Naqvi (Pakistan)
Dr. Delmar Arzabal (Philippines)
Dr. James Lee (Sigapore)
Dr. Tae Suk Suh (South Korea)
Dr. B. Chul Cho (South Korea)
Dr. Jia-Cheng Lee (Taiwan)
Dr. Hui-Yu Tsai (Taiwan)
Dr. Kitiwat Khamwan (Thailand)
Dr. Puangpen T. (Thailand)
Dr. A. Kisanachinda (Thailand)
Dr. Troan Trau (Vietnam)
Dr. Nguyen Tan Chau (Vietnam)

Scientific Committee

Chair

Prof. Dr. Tomas Kron, Australia

Co-Chair

Dr. M. Akhtaruzzaman, Bangladesh

Members

Prof. Dr. Eva Bezak, Australia

Dr. M. Jahangir Alam, Bangladesh

Md. Anwarul Islam, Bangladesh

Mr. Safayet Zaman, Bangladesh

Mr. Md. Jobairul Islam, Bangladesh

Dr. Jin Xiance, China

Prof. Dr. Arun Chougule, India

Dr. V. Subramani, India

Dr. Supriyanto Ardjo Pawiro, Indonesia

Prof. Dr. Mohammad Taghi Bahreyni Toossi, Iran

Prof. Dr. Seyed Mohammad Javad Mortazavi, Iran

Dr. Hajime Monzen, Japan

Dr. Shigekazu Fukuda, Japan

Dr. Chai Hong Yeong, Malaysia

Dr. J. Jeyasugiththan, Sri Lanka

Dr. Hui-Yu Tsai, Taiwan

Advisory Committee

National

Prof. Dr. Qamruzzaman Chowdhury (AMCGH)

Prof. Dr. A M M. Shariful Alam (AMCGH)

Prof. Dr. Md. Sanowar Hossain (BAEC)

Prof. Dr. Ferdoushi Begum (BAEC)

Prof. Dr. M. A. Hai (BCS)

Prof. Dr. Mollah Obayedullah Baki (BCS)

Prof. Dr. Golam Mohiuddin Faruque (BCS)

Prof. Dr. Md. Abdul Bari (BSMMU)

Brig. Gen. Dr. Yousuf Ali (CMH)

Dr. Shafatujjahan (CMSH)

Prof. Dr. Kazi Manzur Kader (DHL)

Prof. Dr. Aliya Shahnaz (DMCH)

Prof. Dr. Narendra Kumar (EHL)

Dr. Fatema Nasreen (GB)

Asst. Prof. Dr. Mukitul Huda (KMCH)

Dr. Mostofa Aziz Sumon (KGH)

Dr. Parvin Akhter Banu (LCHSSC)

Prof. Dr. Qazi Mushtaq Hussain (NICRH)

Prof. Dr. Rowshon Ara Begum (NICRH)

Dr. AFM Kamal Uddin (NIENT)

Dr. Kamila Afroj Qadir (NINMAS)

Ferdoushi Begum (NINMAS)

Asst. Prof. Dr. Ashim K. Ghosh (RMCH)

Prof Dr Syed Md Akram Hussain (SHL)

Dr. Arunangshu Das (SHL)

Prof. Dr. Md. Abul Kashem Mia (UIU)

Prof. Dr. M. Rezwan Khan (UIU)

Prof. Dr. Raqibul Mostafa (UIU)

Prof. Dr. Mir Obaidur Rahman (UIU)

Prof. A. S. M. Salahuddin (UIU)

Prof. Dr. Khawza I. Uddin Ahmed (UIU)

Prof. Dr. Hasan Sarwar (UIU)

Dr. Sharif Ahmed (UHL)

International

Prof. Dr. Rick Franich (Australia)
Prof. Dr. Martin A. Ebert (Australia)
Dr. Mamun I. Haque (Austrailia)
Dr. Simone Kodlulovich Renha (Brazil)
Dr. Raju Srivastava (Belgium)
Prof. Dr. Jan Seuntjens (Canada)
Dr. Eslam Kamal (Egypt)
Prof. Dr. Guenther H. Hartmann (Germany)
Prof. Dr. Wolfgang Schlegel (Germany)
Dipl.Ing. Volker Steil (Germany)
Dr. Frank H. Hensely (Germany)
Prof. Dr. Oliver Jäkel (Germany)
Prof. Dipl.-Ing. Kirsten Hierholz (Germany)
Dr. med. Robert Semrau (Germany)
Dr. Andreas Block (Germany)
Dr. Wolfgang Eschner (Germany)
Dr. Ulf Dudziak (Germany)
Mr. Stefan Ueltzhoeffer (Germany)
Prof. Dr. W Semler (Germany)
Mr. ReindardMuschter (Germany)
Dr.med. Rolf Schaffhauser (Germany)
Dr. Katharina Mair (Germany)
Dr. med. Udo Zimmermann (Germany)
Dipl. Ing Holger Wirtz (Germany)
Dr. med. Martina Treiber (Germany)
Dr. Wolfgang Baus (Germany)
Dipl. Ing. Renate Walter (Germany)
Dipl. Ing. Christian Willomitzer (Germany)
Mr. Ioan Pauliuc (Germany)
Dr. Dipl.-Ing. Natasa Milickovic Skalonja (Germany)
Prof. Dr. Ing. Frank Gerrit Zöllner (Germany)
Dr. Hiba A. Moukadem (Germany)
Dr. med. Alexandru Varmaga (Germany)
Prof. Dr. Björn Poppe (Germany)
Dr. Georg Schwickert (Germany)
Dipl.-Ing. Kathrin Entz (Germany)
Dr. Stephan Garbe (Germany)
Prof. Dr. John Damilakis (Greece)
Prof. Dr. Kin Yin Cheung (Hong Kong)
Prof. Dr. Santanu Chaudhuri (India)
Dr. Mary Joan (India)
Dr. Sanjoy Mandal (India)
Dr. Sudip Haldar (India)
Dr. Sunil Das (India)
Dr. Venkataraman Poopathi (India)
Dr. Girigesh Yadav (India)
Mr. Krishna Kumar (India)
Prof. Dr. K. Joseph Maria Das (India)
Prof. Dr. Renato Padovani (Italy)
Prof. Dr. Franco Milano (Italy)
Dr. Pietro Mancosu (Italy)
Dr. Hidetoshi Shimizu (Japan)
Dr. Ibrahim Duhaini (Lebanon)
Dr. Hiba A. Moukadem (Lebanon)
Dr. Leonard Wee (Natherland)
Prof. Dr. Pawel Kukolowicz (Poland)
Dr. Syed Mansoor Naqvi (Pakistan)
Dr. Sung Yong PARK (Singapore)
Mr. Yung-Fa Lu (Taiwan)
Ms. Ting Chuan Li (Taiwan)
Ms. Miao-Jung lin (Taiwan)
Prof. Dr. Colin Orton (UK)
Prof. Dr. Liu Ho-Ling Anthony (USA)
Prof. Dr. Madan Rehani (USA)
Prof. Dr. Salahuddin Ahmad (USA)

Prof. Dr. Raymond Wu (USA)

Award and Honors Committee

Prof. Eva Bezak (Australia)
Prof. Tomas Kron (Australia)
Prof. Dr. Arun Chougule (India)
Dr. Md Akhtaruzzaman (Bangladesh)
Assoc. Prof. Dr. Chai Hong Yeong (Malaysia)
Freddy Haryanto (Indonesia)
Mr.Freddy Haryanto (Indonesia)
Dr.Shinji Kawamura (Japan)
Hidetoshi Saitoh (Japan)
Noriah Jamal (Malaysia)
Dr. Jeannie Hsiu Ding Wong (Malaysia)
Dr.Kanchan Adhikari (Nepal)
Mr.Suresh Poudel (Nepal)
Youngyih Han (South Korea)
Dr.J.Jeyasugiththan (Srilanka)

Venue Management Committee

Mr. Md. Manjurul Haque Khan
Mr. Jobairul Islam
Mr. Mohammad Ullah Shemanto
Mr. Masum Chawdhury
Mr. Md. Jahirul Islam
Mr.Kazimuddin Olin
Mr. Jannatul Ferdusy Soma
Mr.Hasan Al Banna

Publication Committee

Prof. Dr. Golam Abu Zakaria
Prof. Dr. Hasin Anupama Azhari
Dr. Md. Akhtaruzzaman
Mr. Safayet Zaman
Mr. Jobairul Islam
Mr. Mohammad Ullah Shemanto
Mr. Masum Chawdhury
Mr. Kazimuddin Olin
Ms. Jannatul Ferdusy Soma
Mr. Abu Sadat Md. Mostansirbilla
Mr. Md. Sadiqur Rahman
Mr. A.M. Fahad Hassan
Mr. Md. Sumon Ahmmad
Mr. Istiak Morshed
Mr. Saiful Islam
Fahim M. Rafiul Islam
Mr. Abdullah Al Masud

Finance Committee

Prof. Dr. Golam Abu Zakaria
Prof. Dr. Hasin Anupama Azhari
Dr. Md. Akhtaruzzaman
Mr. Md. Anwarul Islam
Mr. Safayet Zaman
Mr. Md. Anowar Hossain

Mr. Muhammad Shahidullah
Mr. G.M. Monjur Morshed Mridha
Mr. Hamudi Hasan Sonet

Technical Committee

Mr.Md. Jobairul Islam
Mr. Mohammad Ullah Shemanto
Mr. Masum Chawdhury
Mr. Kazimuddin Olin
Ms. Jannatul Ferdusy Soma
Mr. Mohammad Nazmul Hassan
Mr. G.M. Monjur Morshed Mridha
Mr. S.M. Jabid Hasan
Mr. Hamudi Hasan Sonet
Mr. Mohmmad Ali
Mr. Robiul Alam

Steering Committee

Prof. Dr. Golam Abu Zakaria
Prof. Dr. Hasin Anupama Azhari
Dr. Md. Akhtaruzzaman
Mr. Mohammad Ullah Shemanto
Mr. Md. Anwarul Islam
Mr. Safayet Zaman
Mr.Md. Jobairul Islam
Mr. Masum Chawdhury

21st Asia-Oceania Congress of Medical Physics (AOCMP-2021)

United International University

10-12 December 2021

Scientific Programme (Tentative)

Bangladesh Standard Time

Day-1 (Friday): 10 December 2021 Online			
09:00-10:00 (Online Hall-A)	09:00 - 09:10	Prof. Kiyonari Inamura Memorial AFOMP Oration: Prof. Tae Suk Suh	Arun Chougule (India)
	09:10 – 09:55	Advancement of Image Guided Technique in Radiation Therapy	Tae Suk Suh (Korea)
	09:55 – 10:00	AFOMP Lifetime Achievement Award Oration: Prof. Masahiro Endo	Hasin Anupama Azhari (Bangladesh)
10:00 - 10:30	**Break (Sponsors Promotional Video) (Online Hall-A and Hall-B)**		
10:30 - 11:40	**Plenary Session– I (Online Hall-A)**		**Chair: Tomas Kron (Australia) Co-Chair: Md Akhtaruzzaman (Bangladesh)**
10:30 - 10:50	PS-01	Radiation Protection Education and Training of Health Professionals	Ola Holmberg (IAEA)
10:50 - 11:10	PS-02	Are imaging medical physicists' equipment and technique focused or patient focused	Madan Rehani (IOMP)
11:10 - 11:40	PS-03	Medical Physics education and professional status in AFOMP region- the role of international organizations and way forward	Arun Chougule (AFOMP)
11:40-13:25	**Sponsors Presentations (Online Hall-A)**		**Chair: Golam Abu Zakaria (Germany) Co-Chair: Sayed Akram Hussain (Bangladesh)**
11:40 – 12:10	VP-1	Teambest-Advances in Radiation Therapy - ART	Krishnan Suthanthiran (Sponsored Presentation by Teambest)
12:10 – 12:40	VP-2	Elekta - Pioneer in Precision Radiation Medicine	(Sponsored Presentation by Elekta)
12:40 – 13:00	VP-3	A Framework for Developing Multicentre Knowledge Based Planning Models for State-Wide Use	C Lawford (Sponsored Presentation by Varian)
13:00 – 13:25	VP-4	BEAMSCAN, the first truly automated, wireless 3D water phantom. RUBY, The New Modular Phantom Platform for High-Precision Radiotherapy and SRS/SBRT QA.	Madjid Sharaf (Sponsored Presentation by PTW)
13:00-14:00	**AFOMP Ex-Com Meeting (Zoom Link provides by SG, AFOMP)**		
	AFOMP Council Meeting (Zoom Link provides by SG, AFOMP)		
	Break (Sponsors Promotional Video) Online Hall-A and Hall-B		
14:00-15:30	**Parallel Session - I(A): Radiotherapy (Online Hall-A)**		**Chair: Santanu Chaudhuri (India) Co-Chair: Sung Yong Park (Singapore)**
14:00-14:20	IV-01	Advances in Particle Therapy Treatment for Cancer	Salahuddin Ahmad (USA)

14:20-14:40	IV-02	Volumetric-Modulated Arc Therapy (VMAT): A Single Window system for State of Art Radiation Techniques	Murugan Appasamy (Bangladesh)
14:40-14:50	OP-01	Dosimetric Benefits Of Daily Treatment Plan Adaptation For Prostate Cancer Stereotactic Body Radiotherapy Based On Synthetic Cone-Beam CT	Miriam Eckl (Germany)
14:50-15:00	OP-02	Effect Of Applying SEMAR Filter To CT Scans Of Patients And Phantoms With Metal Implants or Inserts On Radiotherapy Treatment Planning Accuracy	Daliya Ignatius (Australia)
15:00-15:10	OP-03	Evaluation of Interfraction and Intrafraction Setup Variation of Different Anatomic sites Using On-Board Imager - Impact on Planning Target Volume Margins	CM Ibrahim Naser (Bangladesh)
15:10-15:20	OP-04	The iteratively improved method with KBP to standardize VMAT plan quality in prostate cancer	Kenji Nakamura (Japan)
15:20-15:30	OP-05	Lifetime Attributable Risk of Radiation Induced Second Cancer from Scattering and Scanning Proton Therapy for Paediatric Cranial Cancer: Age and Sex Impact on Out-of-Field Organs	Mikaela Dell' Oro (Australia)
14:00-15:30	**Parallel Session- I(B): Radiology & Imaging (Online Hall-B)**		**Chair: Kathrin Entz (Germany) Co-Chair: Jeyasingam Jeyasugiththan (Srilanka)**
14:00-14:20	IV-03	Optimization in Digital Radiology	Colin J. Martin (UK)
14:20-14:30	OP-06	Multimodal Radiomics Identifies Primary Tumor Types in Patients with Brain Metastases	Ji Zhang (China)
14:30-14:40	OP-07	Precision improvement of the Agatston score using the latest multi-slice CT (Thin slice CT scan and Agatston score correction)	Katsumi Tsujioka (Japan)
14:40-14:50	OP-08	Cluster Size Analyses of ALPIDE-CMOS Pixel Sensor for pCT	Susmita Afroz (Bangladesh)
14:50-15:00	OP-09	Translation from Non-Contrast to Contrast Images by Cycle-GAN in Head-Neck Vascular CT Imaging	Kuratani Yosuke (Japan)
15:00-15:10	OP-10	Preliminary Study on The Automated Lung Cancer Detection in CT Images Using Mask R-CNN	Oshita Yuki (Japan)
15:10-15:20	OP-11	Preoperative prediction of lymph node metastasis in cervical cancer with radiomics nomogram based on multiparameter MRI	Zhenhua Zhang (China)
15:20-15:30	OP-12	Image quality evaluation on-center and off-center FOV of CT (Spatial resolution and motion artifacts)	Katsumi Tsujioka (Japan)
15:30-17:00	**Parallel Mini symposium – I(A): Education & Training in AFOMP Region (Online Hall-A)**		**Chair: Golam Abu Zakaria (Germany) Co-Chair: Arun Chougule (India)**
15:30-15:50	MS-01	Work in Progress for AFOMP Syllabus	Franco Milano (Italy)
15:50-16:10	MS-02	South Asia Centre for Medical Physics and Cancer Research: A Good Example of Regional Cooperation	Golam Abu Zakaria (Germany)
16:10-16:30	MS-03	Education and Training of Medical Physicists - AFOMP Initiatives	Arun Chougule (India)
16:30-16:45	MS-04	Organisation of Practical Training in Medical Physics	Frank W. Hensley (Germany)
16:45-17:00	MS-05	Development of Medical Physicists as a Health Professional in Nepal	Kanchan P. Adhikari (Nepal)
15:30-17:00	**Parallel Mini Symposium –I(B): Medical physics challenges in the Middle East region (Online Hall-B)**		**Chair: Huda Al Naemi (Qatar) Co-Chair: Mohammad Hassan Kharita (Qatar)**

15:30-16:00	MS-06	Medical Physics In The MEFOMP Region: Current Status 2021	Huda Al Naemi (Qatar)
16:00-16:30	MS-07	Impact of Covid-19 on Medical Physics in Qatar	Rabih Hammoud (Qatar)
16:30 -17:00	MS-08	MEFOMP 2021 Virtual Conference: Expanding Knowledge and Meeting Challenges	Meshari Alnaaimi (Kuwait)
17:00-17:15	**Break (Sponsors Promotional Video) Online Hall-A and Hall-B**		
17:15-18:00	**AOCMP Special Ceremony Onsite (UIU Auditorium)**		
18:00-19:00	**AGM of BMPS Onsite (UIU Auditorium)**		
19:00-22:00	**Gala Dinner Onsite (UIU)**		
DAY-2 (Saturday): 11 December 2021 Online			
09:00-10:30	**Mini-Symposium -III: Setting up a certification board 101 (Online Hall-A)**		**Chair: Hasin Anupama Azhari (Bangladesh) Co-Chair: Raymond Wu (USA) Moderator: Golam Abu Zakaria (Germany)**
09:00 - 09:15	MS-09	The Importance of Certification	Colin Orton (USA)
09:15 - 9:30	MS-10	Credential Verifications and Academic Course Work Requirements	Raymond Wu (USA)
09:30 – 9:40	MS-11	Exam Deliveries	Adel Mustafa (USA)
09:40 – 09:50	MS-12	The Alumni Program and Thoughts about CPD	Tomas Kron (Australia)
09:50 – 10:00	MS-13	Importance of International Accreditation of Local Certification Board- Hong Kong Experience	K Y Cheung (Hong Kong)
10:00 – 10:10	MS-14	Experience of Creating a New Board BMPCB	Hasin Anupama Azhari (Bangladesh)
10:10 - 10:30	Q & A and Moderation		
10:30 – 10:40	**Break (Sponsors Promotional Video)**		
10:40-11:20	**Parallel Session- II(A): Nuclear Medicine and Radiopharmaceuticals (Online Hall-A)**		**Chair: Kamila Afroj Qadir (Bangladesh) Co-Chair: Mr. Md Nahid Hossain (Bangladesh)**
10:40 - 10:50	OP-13	Preclinical Testing Of 177Lu-DOTA-C595 for the Treatment of Pancreatic Cancer	Ashleigh Hull (Australia)
10:50 - 11:00	OP-14	Novel Biodegradable Microsphere Loaded With Sm-153 And Doxorubicin For Chemo-Radio embolization Therapy Of Liver Cancer	Chai H. Yeong (Malaysia)
11:00 – 11:10	OP-15	Assessment of the Small Object Detection using K-Means Clustering in PET/CT Imaging	Mu'minah IAS (Indonesia)
10:40 - 12.30	**Parallel Session – II (B): Radiotherapy (Online Hall-B)**		**Chair: Md Sayeed Hossain (Bangladesh) Co-Chair: Murugan Appasamy (Bangladesh)**
10:40-11:00	IV-04	Medical Physics in Cancer Care and Research in the Era of Precision Medicine: Quo Vadis?	V.Subramani (India)
11:00-11:20	IV-05	Challenges of Low and Middle Income Countries in Radiation Therapy	Volker Steil (Germany)

11:20-11:30	OP-16	Application of a Robustness Analysis Method to Multiple-Field Optimized IMPT Plan in Head and Neck Cancer Patients	Chen Jiayun (China)
11:30-11:40	OP-17	Photon Beam Commissioning of Elekta Versa HD Linear Accelerator: A Multi-Institutional Study	Jalalludin N.A (Malaysia)
11:40-11:50	OP-18	Profile calculation with a given incident free air profile: A Monte Carlo method	Suresh Poudel (Nepal)
11:50-12:00	OP-19	Deep Inspiration Breath-Hold Technique for Left-Sided Breast Cancer: A Single Institutional Review	Abu Kausar (Bangladesh)
12:00-12:10	OP-20	Dosimetric Comparison between Intensity modulated radiotherapy versus volumetric modulated arc therapy treatment plans for Breast Cancer	Mahfuzur Rahman (Bangladesh)
12:10-12:20	OP-21	Electron Beam Commissioning of Elekta Versa HD Linear Accelerator: A Multi-Institutional Study	Huang E.P.S (Malaysia)
12:20-12:30	OP-22	The Role of Dose Rate and Gantry Speed Variations in Progressive Resolution Optimizer (PRO) and Photon Optimizer (PO) Algorithms for Rapidarctm Volumetric Modulated Arc Therapy Delivery	Sundaram Venugopal (India)
12:30-13:30	**Plenary Session– II (Online Hall-A)**		**Chair: Leonard Wee (Netherland) Co-Chair: KJ Maria Das (India)**
12:30-12:50	PS-04	Medical physicist curricular and professional programme to include Artificial Intelligence	Golam Abu Zakaria (EFOMP)
12:50 – 13:10	PS-05	Contribution of Medical Physicists During COVID-19 in the Middle East	Mohammad Hassan Kharita (MEFOMP)
13:10-13:30	PS-06	Recent Advancement in Medical Physics: Photon Counting CT	Marc Kachlriess (DGMP)
13:30-14:00	**Break (Sponsors Promotional Video)**		
14:00-15:20	**Parallel Session- III(A): Brachytherapy (Online Hall-A)**		**Chair: Parvin Akhter Banu (Bangladesh) Co-Chair: Natasa Milickovic-Skalonja (Germany)**
14:00-14:20	IV-06	New Low and Medium Energy Sources for Brachytherapy	Frank Hensley (Germany)
14:20-14:40	IV-07	Mind The Gradient	Renate Walter (Germany)
14:40-14:50	OP-23	Impact of Dwell Time Deviation Constraint on Dosimetric Parameters in Interstitial Brachytherapy Of Cervical Carcinoma Using Ipsa Technique	Shraddha Srivastava (India)
14:50-15:00	OP-24	A Retrospective Study on The Dosimetric Effect of Not Applying A Shift in Varian Ring Applicators For HDR Cervix Brachytherapy Treatments	Abdul Sattar Khalid (Qatar)
15:00-15:10	OP-25	Dose Comparison Between TG-43 and TG-186 Behind Small Air Cavity	M Juel Khondakar (Bangladesh)
15:10-15:20	OP-26	High Dose Rate Brachytherapy Machine Installation and Quality Management	Md. Shahidul (Bangladesh)
14:00-15:50	**Parallel Session-III (B): Machine Learning and Artificial Intelligence in RT (Online Hall-B)**		**Chair: Rakibul Mostafa (Bangladesh) Co-Chair: Md. Taslim Reza (Bangladesh)**
14:00-14:20	IV-08	Ultrasound Images Based Radiomics for Cervical Cancer	Xiance Jin (China)
14:20-14:30	OP-27	Designing of a Decision Support System for Cancer Treatment Using Artificial Intelligence	Anwarul Islam (Bangladesh)

14:30-14:40	OP-28	Detection and of Lung Cancer Based on Deep Learning: A Comprehensive Review	Lestari Fauzia P (Indonesia)
14:40-14:50	OP-29	Efficient Dose Volume Histogram Based Pretreatment Patient Specific Quality Assurance Methodology with Combined Deep Learning and Machine Learning Models for Volumetric Modulated Arc Radiotherapy	Kecheng Zhu (China)
14:50-15:00	OP-30	Automated approach for estimation of the normal or abnormal stages of the kidney using an artificial neural network for the prediction model of the Glomerular Filtration Rate	Alamgir Hossain (Bangladesh)
15:00-15:10	OP-31	Radiomic prediction of distant metastasis after dynamic tumor tracking stereotactic body radiation therapy for non-small cell lung cancer: a multi-institutional analysis	Takanori Adachi (Japan)
15:10-15:20	OP-32	The effects of automatic segmentations on preoperative lymph node status prediction models with ultrasound radiomics for patients with early-stage cervical cancer	Juebin Jin (China)
15:20-15:30	OP-33	Lesion Image Synthesis Using AI-Based Sketch-to-Image Translation: A Preliminary Study on Lung Cancer CT Images	Ryo Toda (Japan)
15:30-15:40	OP-34	Deep Learning-Based Auto-Segmentation Of Breast Cancer: A Systematic Review Of Multi-Modality Imaging Methods	Yazid, F. N. A (Malaysia)
15:40-15:50	OP-35	Preliminary study on virtual cleansing by Cycle GAN in CT colonography	Isobe Yoshitaka (Japan)
15:50-17:00	**Parallel Session-IV (A): Dosimetry & QA-1 (Online Hall-A)**		**Chair: Bjoern Poppe (Germany) Co-Chair: Sadia Sharmin (Bangladesh)**
15:50-16:10	IV-09	In-vivo dosimetry for sarcoma patients irradiated with IMRT techniques.	Paweł Kukołowicz (Poland)
16:10-16:30	IV-10	Cema-based formalism for the determination of absorbed dose for high energy photon beams	Günther H. Hartmann (Germany)
16:30-16:40	OP-36	Influence of Post-synthesis and Post-irradiation Times on Dosimetric Properties of a VIPET-type Gel Dosimeter	Mosleh-Shirazi MA (Iran)
16:40-16:50	OP-37	Isodose-Shaped Scintillation Detectors for Measurement of Small Field Output Factors	Chung Hyun-Tai (Korea)
16:50-17:00	OP-38	Effect of Gamma Radiation-Induced Crosslinking on Long-Term Dose Response of Novel Graphene Oxide Dosimeter Using Raman Spectroscopy	Shahryar Malekie (Iran)
17:00-17:10	OP-39	Comparison of the different dosimetric indices for volumetric arc modulated treatment planning using two different treatment planning systems: A Feasibility study for Total Body Irradiation	Sharma Reena (India)
17:10-17:20	OP-40	Dosimetric Properties of Graphene Oxide Nano-Powder After Electron Irradiation in the Range of Radiation Processing Doses (20-200 kGy)	Shahryar Malekie (Iran)
15:50-18:00	**Parallel Session- IV(B): Biomedical Engineering (Online Hall-B)**		**Chair: Xiance Jin (China) Co-Chair: Khawza Iftekhar Uddin Ahmed (Bangladesh)**
15:50-16:10	IV -11	Digital Health Inclusion to Achieve Universal Health Coverage in the Era of 4IR	Khondaker Abdullah Al Mamun (Bangladesh)
16:10-16:30	IV-12	Augmentation of Heath Technology Management through Effective Implementation and Proper Engagement of	Md. Ashrafuzzaman (Bangladesh)

		Biomedical Engineers at all Level of Hospitals in Bangladesh	
16:30-16:50	IV-13	Necessity of Implementation of Metrology for Medical Device in Bangladesh	Mala Khan (Bangladesh)
16:50-17:00	OP-41	The Safe Sticker: Verification Of Solar Disinfection Of Water By Solar Ultraviolet (UV) Radiation	Butson Martin Jonathan (Australia)
17:00-17:10	OP-42	An Automated Classification Scheme of Cytological Images Using Attention-based Deep Multiple Instance Learning	Teramoto Atsushi (Japan)
17:10-17:20	OP-43	A Study on EEG Signal Classification using Deep Learning Method	Mohammad Haekal (Indonesia)
17:20-17:30	OP-44	Skin Disease Detection Module through Image Processing	Sk. Saima (Bangladesh)
17:30-17:40	OP-45	Studies on the Propagation of Elastic Waves In Bovine Compact Bones As A Function Of Temperature	Syed Mohammed Shoaib (India)
17:50-18:00	OP-46	Design and Construction of a Portable ECG Machine Operated by Mobile Application for Patients	Alamgir Hossain (Bangladesh)
18:00-18:30	**Break (Sponsors Promotional Video)**		

Parallel Poster Session
Online E-poster Hall

Participants can visit E-poster booth in the lobby to view the posters at any time in 3 days. Schedule for Q/A are arranged for the Judges as per categories are as follows. Poster Presenters are requested to be present at that time.

Brachytherapy		**Judge Pannel: Frank W. Hensley (Germany) Hasin Anupama Azhari (Bangladesh) Mr. Safayet Zaman (Bangladesh) (Convener)**
PP-01	A Single Institution Study Of Dosimetric Comparison Between Tandem Ovoid And Tandem Ring Applicators In Cervical Cancer Brachytherapy	Neelima Pokala (India)
PP-02	The Effect of Total Reference Air Kerma on the Outcomes of Single-Channel and Tri-Channel Applicators in High-Dose-Rate Brachytherapy for Cervical Cancer	Alamgir Hossain (Bangladesh)
PP-03	Plan Quality Score To Evaluate The Impact Of Dtdc On Ipsa Optimized Treatment Plans Of Mupit Based Interstitial Brachytherapy In Cervical Cancer	Kalyan Mondal (India)
Dosimetry & QA		**Judge Pannel: Tomas Kron (Australia) Renate Walter (Germany) Md Akhtaruzzaman (Bangladesh) (Convener) Mr. Suresh Das (India)**
PP-04	Dosimetric Evaluation of Helical Tomotherapy (HT) versus Volumetric Arc Therapy (VMAT) in Patients with Liver Radiotherapy Treatment.	Anson H.Y. Cheung (Hong Kong)
PP-05	A Dosimetric Comparison Between Intensity Modulated Radiation Therapy and volumetric Modulated Arc Therapy In Stereotactic Body Radiotherapy Treatment of non-Small Cell Lung Cancer Using 6mv Flattening Filter Free Technique.	Lei Man I Michelle (Hong Kong)

PP-06	Simplified sigmoidal curve fitting for 6 MV FFF photon beam of Halcyon to determine field size for Beam commissioning and quality assurance	Min-Geon Choi (Japan)
PP-07	Effect of Off-axis Ion Recombination Factor on The Beam Profile In Flattening Filter-Free Photon Beams	Tanimoto Yuuki (Japan)
PP-08	Gamma Knife Quality Assurance	Asad Zameer (Pakistan)
PP-09	Dosimetric Measurement of Co-60 Teletherapy Unit	Md. Shahidul (Bangladesh)
PP-10	Quality Assurance Verification of Carcinoma Breast VMAT Treatment Plans: A Retrospective Analysis Of Portal Dosimetry	Bisht Jyoti (India)
PP-11	Validation of non-coplanar dosimetry of SRS/SRT using Octavius 4d dosimetry system	Sathiyaraj (India)
PP-12	Dosimetric Comparison of aSi 1200 EPID and Octavius 4D 1500 Detector Array for Patient Specific Quality Assurance	Sumanta Manna (India)
PP-13	Calibration coefficient of a parallel plate ionization chamber in high-energy small field photon beams	Masakatsu Takeda (Japan)
Radiology & Imaging		**Judge Pannel:** **Franco Milano (Italy)** **J. Jeyasingham (Srilanka) (Convener)** **Kathrin Entz (Germany)**
PP-14	The Way Forward for Diagnostic Radiology Medical Physicists in Sri Lanka	Vijitha Ramanathan (Srilanka)
PP-15	Hounsfield Unit Calibration for Radiotherapy Treatment Planning Using an In-house Phantom and a Stoichiometric Algorithm: Improved Accuracy Compared to the Conventional approach	Maziyar Mahdavi (Iran)
PP-16	Benchmarking of a New Automatic CT Radiation Dose Calculator	Akyea-Larbi Kofi Okyere (Ghana)
PP-17	Optimizing Image Noise as a means to Improve Computed Tomography ATCM in Sri Lanka	U Hishaam (Srilanka)
PP-18	Protection of radiation exposure for physician's brain using a tungsten rubber flap in interventional radiology	Shota Hattori (Japan)
PP-19	Establishment of Local Diagnostic Reference Levels of Digital Mammography	Ram Narayan Yadav (Nepal)
PP-20	Assessment of Abdomen-Pelvis CT Protocols Based on Doses for Various Patient Sizes using Anthropomorphic (XCAT) Phantoms and Monte Carlo Simulation	Bijan Hashemi (Iran)
Radiobiology & Radioprotection		**Judge Pannel:** **Martin Ebert (Australia)** **Md Akhtaruzzaman (Convener) (Bangladesh)**
PP-21	Radiation Protection of Nail with Real-time Shapeable Tungsten Rubber in the Total Skin Electron Beam (TSEB) Therapy	Yuya Yanagi (Japan)
PP-22	Application of New Aluminum-Oxide (Al2O3) Composites as X-ray and Gamma Radiation Shields Using a Numerical and Experimental Approach	Mohammad Amin H (Iran)
PP-23	Radiation Protection Properties of Polyethylene/Bismuth Composites: An Experimental Study	Mohammad Amin H (Iran)
PP-24	In-Vitro Role of Radiofrequency Hyperthermia on Cell Cycle and Assessing Appropriate Time Interval for Carrying out Radiotherapy	Bijan Hashemi (Iran)
PP-25	Shielding Calculation and Verification for 15MV Medical Linear Accelerator Treatment Facilities	M U Shemanto (Bangladesh)
Radiotherapy		**Judge Pannel:** **Mary Joan (Convener) (India)**

			Mr. Md. Anwarul Islam (Bangladesh) **V Poopathi (India)** **Mr. Safayet Zaman (Bangladesh)**
PP-26	Dosimetric Advantages Of Volumetric Modulated Arc Therapy (VMAT) With Deep inspiration Breath Hold (DIBH) Technique In Halcyon Linac For Left Breast Cancer treatment		Chau Ming Chun Ricky (Hong Kong)
PP-27	Development Of Infrared Marker For Thermoplastic Immobilization Tool		Yongjin Kim (Korea)
PP-28	To Evaluate Conformity Index In Ilrt And 3dcrt Plans And Analyzed Volumetric Variation In The Target Volume Obtained Ilrt Treatment In Carcinoma Lung Patients		Ravi Kant (India)
PP-29	Comparison of Three-Dimensional Conformal Radiotherapy and Intensity Modulated Radiotherapy in Cervix Cancer		Samiul Alim (Bangladesh)
PP-30	Can Truebeam Trajectory Log File Have Used As Patient Verification Tool For Rapidarctm Treatment Delivery?		Sundaram Venugopal (India)
PP-31	Smart Armour For Radiotherapy: Reduction Of Unwanted Radiation		Martin Jonathan Butson (Australia)
PP-32	Evaluation of Radio sensitization effect of Gold and Hafnium Oxide Nanoparticles on HeLa Cancer Cells under 6 MV Radiotherapy		Bijan Hashemi (Iran)
PP-33	Establish of dose-parameter analysis model to improve VMAT plan quality for prostate cancer		Takaaki Ito (Japan)
PP-34	The basic research for optimizing gantry angle according to differences in hepatic segment in proton therapy		Taku Tochinai (Japan)
PP-35	Development of a Novel Real-Time Shapeable Bolus for Electron Radiotherapy		Kazuki Wakabayashi (Japan)
PP-36	Assessment of Novel Developed IMRT Planning Protocols for Treating Nasopharyngeal Cancer Patients Based on the Target and Organs at Risks Common Volumes		Bijan Hashemi (Iran)
PP-37	A Present Scenario of Radiotherapy Services in Nepal		Suraj Sah (Nepal)
Nuclear Medicine & Radiopharmaceuticals			**Judge Pannel:** **S.D. Sharma (Convener) (India)** **Mr. Md Nahid Hossain (Bangladesh)**
PP-38	Medical Imaging Capabilities Of Neutron-Activated Samarium-153 Polystyrene Microspheres As A Theranostics Agent After Direct Intra-Tumoural Injection On Sprague-Dawley Rats With Xeno transplanted Liver Tumours		Chai Hong Yeong (Malaysia)
PP-39	Respiratory gated (4D) FDG-PET/CT scan for liver malignancies: Feasibility in liver cancer patient and tumour quantitative analysis.		Anson H.Y. Cheung (Hong Kong)
PP-40	Reduction of γ-Ray Attenuation with a New Rigid Couch in SPECT		Yasunori Nakamura (Japan)
PP-41	Study on the evaluation method of 125I source strength inserted in a sterilized cartridge		Shinji Kawamura (Japan)
18:30-20:10	**Parallel Session- V (A): Radiotherapy (Online Hall-A)**		**Chair: Hayashi Naoki (Japan)** **Co-Chair: Tannima Adhikary (Bangladesh)**
18:30-18:50	IV- 14	Technological Advances in Radiotherapy.	S. D. Sharma India)
18:50-19:10	IV-15	Rethinking some issues pertaining to Medical Physics	Khondkar Siddique-e-Rabbani (Bangladesh)

19:10-19:20	OP-47	Short-term pain management of severe osteoarthritis patient for the hip or knee joint using low-dose radiotherapy: a literature review	Ropak Roy (Bangladesh)
19:20-19:30	OP-48	Robust Planning Evaluation of Stereotactic Body Radiation Therapy on Hepatocellular Carcinoma	Akbar Azzi (Indonesia)
19:30-19:40	OP-49	Comparison of Progressive Resolution Optimizer (PRO) and Photon Optimizer (PO) Algorithms in Rapid Arc (VMAT) Delivery for Head and Neck Sib Treatments	Sundaram Venugopal (India)
19:40-19:50	OP-50	Evaluation of Intrafractional Prostate Displacement during Prostate Radiotherapy using Clarity Ultrasound System	MZ Nur Syazana (Malaysia)
19:50- 20:00	OP-51	Evaluation of digital linac log data for patient-specific VMAT quality assurance	Fatima Adel U'wais (Malaysia)
20:00-20:10	OP-52	Investigation Of Uncertainty In Internal Target Volume Definition For Lung Stereotactic Body Radiotherapy	Daiki Nakanishi (Japan)
18:30-19:50	**Parallel Session –V(B): Dosimetry & QA-II (Online Hall-B)**		**Chair: Raju Srivastava (Belgium) Co-Chair: S. D. Sharma (India)**
18:30-18:50	IV-16	Properties Optimization of KCl: Sm 3+ using TA-OSL for radiation dosimetry	Pratik Kumar (India)
18:50-19:00	OP-53	Is a Reference Field Enough for Calibration of VMAT Quality Assurance?	P. Sathiyaraj (India)
19:00-19:10	OP-54	A Simplified Method To Estimate Energy Spectra At The Central And Off-axis By Reconstructing The Monoenergetic Depth Doses	Puspen Chakraborty (Bangladesh)
19:10-19:20	OP-55	The Perturbation Factor of Plane-Parallel Chamber to Scanning Proton Beams: A Monte Carlo Study	Hironari Kumazaki (Japan)
19:20-19:30	OP-56	Study and Analysis of Small Field Photon Beam Dosimetry Using Diamond Detector and Comparison with PTW Pinpoint Ionization Chamber and PTW Silicon Diode Detector: A Review	Alif Khan (Bangladesh)
19:30-19:40	OP-57	Design and Dosimetry of 6 MV Elekta Synergy Linear Accelerator using EGSnrc based Monte Carlo Simulation code.	Md. Anwarul Islam (Bangladesh)
19:40-19:50	OP-58	Profile Measurements for SOBP Carbon Ion Beams Using Radiochromic Films	Masato Kobayashi (Japan)
DAY-3 (Sunday): 12 December Online			
08:00-09:40	**Parallel Session- VI(A): Radiobiology & Radio Protection (Online Hall-A)**		**Chair: Kazi Manzur Kader (Bangladesh) Co-Chair: Mamun I. Haque (Australia)**
08:00-08:20	IV-17	Remembering the Importance of Biology in Radiotherapy	Martin A Ebert (Australia)
08:20-08:40	IV-18	Misconceptions of Radiation: What Can be done	Pradip Deb (Australia)
08:40-09:00	IV-19	Dose Limit and Constraints in Shielding Planning of a MV Radiotherapy Facility.	Franco Milano (Italy)
09:00-09:10	OP-59	Computed Tomography Dose Reference Levels for head, chest and abdomen regions: A nationwide survey	Thangaraja Amalaraj (Sri Lanka)
09:10-09:20	OP-60	Gadolinium Oxide in Polyamide Substrate: A New Composite for Protection Against Neutron Radiation	Mohammad Amin H (Iran)

09:20-09:30	OP-61	The Effect of High Dose Rate Irradiation On Cell Survival: Simple Investigation With Non-Cancer And Cancer Cells.	Maki Kurimoto (Japan)
09:30-09:40	OP-62	Influence Of The Average Adult Definition On International DRL Comparison And Optimization	Satharasinghe Duminda (Sri Lanka)
08:00-09:30	**Parallel Session- V I(B): Dosimetry & Radiotherapy (Online Hall-B)**		**Chair: Narendra Kumar (India) Co-Chair: V Poopathi (India)**
08:00-08:20	IV-20	Single institutional experience of testing IAEA - AAPM Code of practice for small static fields used in external beam radiotherapy	Karthick Raj Mani (Bangladesh)
08:20-08:40	IV-21	Stereotactic radiotherapy (SRT) with Rapid Arc: challenge and implementation into routine clinical work	Raju Srivastava (Belgium)
08:40-08:50	OP-63	Dosimetric Comparison of FF And FFF Beams for SRS And SBRT	Sharma Reena (India)
08:50-09:00	OP-64	The Current Status of Radiotherapy Facilities in Developing Countries	Vijitha Ramanathan (Sri Lanka)
09:00-09:10	OP-65	BMI-adjusted Dose Conversion Factor of Effective Dose Estimation for Coronary Computed Tomography Angiography: Patient Study	Hui-Yu Tsai (Taiwan)
09:10-09:20	OP-66	Comparing Step-and-Shoot IMRT with Dose Painting using a Histopathologically Verified Model Based on Hierarchical Clustering and mpMRI to Treat Prostate Cancer	Bijan Hashemi (Iran)
09:20-09:30	OP-67	Comparison Of Different Radiotherapy Planning Techniques For Carcinoma Of Breast Conserving Surgery	Naznin Aktar Pina (Bangladesh)
09:30-9:40	OP-68	Moliere weighted multicomponent analysis of flat top Gaussian radiotherapy beam for small fields	Silpa Ajaykumar (India)
09:40 – 10:00	**Break (Sponsors Promotional Video)**		
10:00-11:30	**Mini-Symposium -III: Women for Women – connecting women health scientists for the benefit of women in the AFOMP region. (Online Hall-A)**		**Chair: Hasin Anupama Azhari (Bangladesh) Co-Chair: Eva Bezak (Australia)**
10:00-10:15	MS-15	The biggest challenges resulting from CoVID-19 pandemic on gender-related work from home in STEM fields- qualitative e survey analysis	Eva Bezak (Australia)
10:50-10:30	MS-16	Point of Care Ultrasound (POCUS) – A feasible solution to reduce inequities in antenatal care in low resourced settings	Nayana Parange (Australia)
10:30-10:45	MS-17	Women entrepreneurship in medical physics	Prof Chai Hong Yeong (Malaysia)
10:45-10:55	MS-18	Navigating a PhD during a pandemic	Mikaela Dell'Oro (Australia)
10:55-11:05	MS-19	Difficulties encountered in my postgraduate work during the COVID-19 pandemic and how I am managing to overcome them.	Jivendra Wickramasinghe (Sri Lanka)
11:05-11:15	MS-20	Experience of Completing MSc Thesis work during Covid Pandemic.	Jannatul Soma, (Bangladesh)
11:15-11:25	MS-21	Effect of Research: In vivo dose measurements of Breast Cancer Radiotherapy with various treatment plans.	Sushma Pooja (India)
11:25-11:30	**Q&A**		
11:30-13:00	**Parallel Session – VII (A): Radiotherapy (Online Hall-A)**		**Chair: Aliya Shahnaz (Bangladesh)**

			Co-Chair: Fatema Nasrin (Bangladesh)
11:30–11:50	IV-22	Delivery of VMAT technique for whole breast irradiation with five fractions (Fast-Forward trial)- an initial experience in Bangladesh	M. Akhtaruzzaman (Bangladesh)
11:50-12:00	OP-69	Introducing new indices for assessment of dose-painting prostate IMRT plans using diffusion weighted-MRI based on weighted dose distribution homogeneity and conformity indices	Bijan Hashemi (Iran)
12:00-12:10	OP-70	Design Fabrication and Validation of 3D Printed Specific End Term Applicator for Electron Radiation Therapy	Jobairul Islam (Bangladesh)
12:10-12:20	OP-71	Target Volume Delineation Based on Respiratory Gated (4D) PET/CT for Liver SBRT Treatment Planning	Anson H.Y. Cheun (Hong Kong)
12:20-12:30	OP-72	A Comparative Treatment Planning Study on the Feasibility of Hybrid IMRT Treatment Planning for Left-Sided Chest Wall Irradiation	Subhas Haldar (India)
12:30-12:40	OP-73	Advantages of Thermoplastic Sheet Bolus in Post mastectomy Radiation Therapy	Sakai Y (Japan)
12:40-12:50	OP-74	Unification of QA criteria considering the systematic errors of measurement-, calculation-, and prediction-based QA methods for VMAT	Tomohiro Ono (Japan)
12:50-13:00	OP-75	Dosimetric Verification between 6mv FF & 6 mv FFF Beam for SBRT Lung & SBRT Spine Treatment Plan	Sadia Afrin Sarah (Bangladesh)
11:30-13:00	**Mini -Symposium IV: Medical Physics Contributes during COVID-19 (Online Hall-B)**		**Chair: Jeannie Wong (Malaysia) Co-Chair: Kwan Hoong Ng (Malaysia)**
11:30-11:50	MS-23	COVID-19 pandemic planning: considerations for radiation oncology medical physics	Tomas Kron (Austrailia)
11:50-12:10	MS-23	Chest X-Ray Imaging Through the Glass During the COVID-19 Pandemic	Zoe Brady (Austrailia)
12:10-12:30	MS-24	Fighting Covid-19 through the invisible light – UV-C	Kwan Hoong Ng (Malaysia)
12:30-12:50	MS-25	Creativity and innovation – beyond the conventional medical physics	Chai Hong Yeong (Malaysia)
12:50-13:00	Q & A		
13:00-14:00	**Sponsors Presentations (Online Hall-A)**		**Chair: Golam Abu Zakaria (Bangladesh) Co-Chair: Mr. Safayet Zaman (Bangladesh)**
13:00 – 13:20	VP-5	INTRABEAM System-Physics	Steve Braun (Sponsored Presentation by Carl Zeiss)
13:20 – 13:40	VP-6	RadiCalc – Simply Precise 3D Dose Verification	Carlos Bohorquez (Sponsored Presentation by LAP Laser)
13:40 – 14:00	VP-7	Clinical Decision Support using Intelligent Cancer Care	Shaun Graydon (Sponsored Presentation by Varian)
13:00-14:20	**Break (Sponsors Promotional Video)**		
14:20-15:00	**Awardee Presentations (Online Hall-A)**		**Chair: Eva Bezak (Australia) Co-Chair: Hasin Anupama Azhari (Bangladesh)**
14:20-14:30	Best Paper Award		Yoshiro Ieko (Japan)
14:30-14:40	C. V. Saraswathi – A.N. Parameswaran Memorial AFOMP Best PhD Award / Going deeper with Colleagues.		Wonjoong Cheon (Korea)
14:40-14:50	Young Acheiver Award		Ying Song (China)
14:50-15:00	Prof. Sung Sil Chu's AFOMP Best Student Publication Award		Hemalatha Athiyaman (India)
15:00 – 16:30	**Valedictory and Closing Session (Online Hall-A)**		

ABSTRACTS

AFOMP Awards
Abstracts of Plenary Session
Abstracts of Invited Presentation
Abstracts of Mini-Symposium
Abstracts of Oral Presentation
Abstracts of Poster Presentation

AFOMP Oration Award, 2021

Prof. Kiyonari Inamura Memorial Oration Award is awarded to Prof. Dr. Tae Suk Suh for the year 2021

Tae Suk Suh, Ph.D.
Department of Biomedical Engineering and Research Institute of Biomedical Engineering, College of Medicine, The Catholic University of Korea.

Dr. Suh is a professor of Medical Physics at Dept. of Biomedical Engineering, the Catholic University of Korea. He obtained BS in nuclear engineering from Seoul National University of Korea and received MS and Ph.D in medical physics from the University of Florida, USA.
Dr. Suh's career in medical physics has spanned more than 40 years. he pioneered many technologies, including the development of radiosurgery and radiation treatment. Dr. Suh published over 300 peer-reviewed papers and more than 1300 proceedings.

Dr. Suh has served as an editor and editorial board member for many international journals of medical physics. He organized the World Congress on Medical Physics and Biomedical Engineering in 2006(WC 2006, Seoul) and the Asia-Oceania Congress of Medical Physics three times in Asia (AOCMP 2002, 2006, 2011).

Dr. Suh had served as Secretary General of AFOMP during 9 years since 2003 and President of AFOMP. Dr. suh also worked as a chair of publication committee of IOMP and IMPCB Record and Registry Committee chair.

Advancement of Image Guided Technique in Radiation Therapy

Tae Suk Suh, Ph.D.
College of Medicine, The Catholic University of Korea.

Recently, advances in medical imaging technology have accelerated the development of radiation therapy in intensity modulated radiation therapy (IMRT), image guided radiation therapy (IGRT), Tomotherapy and Robot-guided RT. Many new technologies have been developed in medical imaging using multi-modality image, 4D image, high resolution image, functional image, molecular image, metabolic image. virtual reality image etc. These new imaging technologies have been applied in the field of medical area to determine the local tumor volume and location of the tumor. While all radiation therapy are more or less image guided traditionally, imaging technology has primarily been used in producing 3D information of patient anatomy to identify the location of the tumor to treatment. New radiation treatment technique derived from the image guided technique has been developed to optimize the accuracy of radiotherapy. Especially, image guided applications in radiation therapy are classified into two major aspects: (1) multi-modality imaging for better definition of tumor volume, 2) time-resolved imaging for modeling the intrafraction organ motion. To diagnose legion of the patient, the more advanced image technology have been developed using various types of imaging modality. Some of these new techniques could be used to determine the target in radiation therapy. Recently, new technologies such as AI, big data, 3D printing have also been implemented in radiation therapy. In this presentation, multi-modality imaging and time-resolved or 4D imaging techniques in radiation therapy will be highlighted, with emphasis on the principle and recent studies of our colleagues.

Multi-modality imaging involves the incorporation of two or more of the following imaging modalities: single photon emission computed tomography (SPECT), positron emission tomography (PET), magnetic resonance imaging (MRI), computed tomography (CT) and other imaging modality.

The incorporation of multi-modality imaging provides functional and anatomic information. Multi-modality imaging is essential for a primary diagnosis and determining the most suitable treatment plan, and can help us to reduce errors. In addition, it has attracted interest in the fields of molecular and functional imaging for primary-to-metastatic cancer screening and functional neuroimaging. Therefore, the application of multi-modality imaging should lead to a better and more reliable diagnosis and lead to optimal treatment in radiation therapy.

Intrafraction motion has been an issue that is becoming increasingly important in the era of IGRT. Estimation of surrogated respiration motion through breathing cycle and 4D images is the biggest focus to correlate with actual organ motion. If target is moving, we need to use larger beam field, which delivers extra radiation dose to normal tissue. The solutions to avoid this extra dose to normal tissue due to moving organ are to utilize respiratory motion control techniques or 4D image guidance. The common methods used in the management of respiration motion in radiation therapy are breath-hold, gating, and tumor tracking techniques. Time resolved 4D images are generally implemented in radiation therapy to evaluate moving organ accurately.

The analysis of the multi-modality images provides useful information in delineating the target volume for radiation treatment. In addition, we need more accurate time-resolved 4D image guided technique for modeling the intrafraction organ motion.

AFOMP congratulates and confers Lifetime Achievement, 2021 award on Prof Masahiro Endo!

Masahiro Endo, PhD
Association for Nuclear Technology in Medicine, Tokyo, Japan

Born in Tokyo in 1948. Dr. Endo majored in physical sciences at the University of Tokyo, earning a bachelor's degree in 1971 and a master's degree in 1973. He joined the National Institute of Radiological Sciences (NIRS) in 1973, where he developed and researched medical imaging devices. He received his PhD in the field of medical science from Chiba University in 1982. He stayed at Lawrence Berkeley Laboratory in 1984, studying heavy ion radiotherapy. After returning to Japan, he participated in the HIMAC construction project and was in charge of the development of treatment planning and image guidance system. He became NIRS's Chief Medical Physicist in 2000. He retired from NIRS in 2009 and immediately participated in the construction of SAGA HIMAT. He was awarded several awards from the Japanese Government for the research, development and medical use of 4-dimensinal CT. He is currently the Executive Director of ANTM.

AFOMP congratulates Yoshiro Ieko for winning AFOMP Journal Prize for the Best Paper published in an AFOMP journal publication, 2021

Yoshiro Ieko
Department of Radiation Oncology, Tohoku University Graduate School of Medicine, 1-1 Seiryo-machi, Aoba-ku, Sendai, 980-8574, Japan
Department of Heavy Particle Medical Science, Yamagata University Graduate School of Medical Science, Yamagata, Japan

Yoshiro Ieko received a bachelor's degree from the Tohoku University School of Health Science in 2016 and a master's degree from the Tohoku University Graduate School of Medicine in 2018, where he is currently pursuing Doctorate. From 2018 to 2019, he worked at the Department of Heavy Particle Medical Science, Yamagata University Graduate School of Medicine, as a medical physicist and an assistant professor. Since 2020, he is working at the Department of Radiation Oncology, Iwate Medical University School of Medicine, as a medical physicist and an assistant professor. His research interest includes radiation pneumonitis, deformable image registration (DIR), 4D-CT ventilation, and 4D-CT ventilation-based functional treatment planning. He has received the 73rd Annual Meeting of the Japanese Society of Radiological Technology (JSRT) Best Student award in 2017, Radiological Physics and Technology (RPT) Doi Award (Best paper award), and Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) Journal Prize in 2021

AFOMP congratulates Dr. Wonjoong Cheon on winning C.V Saraswathi-A.NParameswaran AFOMP Best PhD award, 2021

Wonjoong Cheon, Ph.D
Medical Physicist (R2)
Proton Therapy Center, National Cancer Center
323 Ilsanro, Ilsandong-gu, Goyang-si, Gyonggi-do,
10408 Republic of Korea

- Wonjoong Cheon is working at the National cancer center Korea as a medical physics residency.
- He is both a medical physicist and an A.I researcher.
- He received two bachelor degrees in 2014: Computer engineering (B.E), Radiological science (B.S)
- He received his Ph.D. in Health science and technology: medical physics from Sungkynkwan Univ. in the Republic of Korea.
- His research area is based on computer engineering: (1) 3D QA for dosimetric and mechanical QA, (2) Auto planning for proton therapy, (3) Outcome/Complication prediction, (4) Super-resolution for gamma camera, (5) Noise reduction for NDT.
- He published 9 SCI/(E) papers and issued 8 Korea/USA patents from 2015 to now

AFOMP congratulates Ms. HemalathaAthiyamanon winning Prof. Sung Sil Chu's AFOMP Best Student Publication Award 2021

Dr. Hemalatha. M.Sc. Ph.D
Assistant Professor
Radiological Physics Department
SP Medical college, Bikaner, Rajasthan

I am Mrs. HemalathaAthiyaman. I did my post-graduation in Medical physics at Bharathiyar University, Coimbatore and successfully completed Radiation Safety Officer course from BARC, Mumbai in 2009. I completed my senior residency at Sardar Patel Medical college, Bikaner, Rajasthan in 2014 and there after working as Assistant Professor till date. This center has a history of treating cancer patients for more than fifty-year. It has all of the advanced radiotherapy equipment, such as an Advanced High Energy Linear Accelerator, and treats around 3000 patients each year. I have enrolled in the Rajasthan University of Health Sciences' Ph.D. programme in Jaipur. under the guidance of Dr. Arun Chougule, Senior Professor, Department of Radiological Physics, SMS Medical College Jaipur in 2015. I've written four research papers in peer-reviewed publications and presented them at numerous national and International conferences under his direction about out of field radiation dosimetry. In addition, I am continuing my research into innovative approaches for out-of-field dosimetry.

AFOMP congratulates Ms. Ying Song on winning P.N Krishnamoorthy Memorial AFOMP Young Achiever Award, 2021

Ms. Ying Song
Physicists, Division of Medical Physics
West China Hospital, No. 37, Guoxue Alley, Wuhou District,
Chengdu, Sichuan, China

Ying Song is an advanced radiotherapy physicist of division of Radiation Physics, West China Hospital, China. She received the master degree in biomedical engineering from the Shanghai Jiao Tong University in 2013 and continued her doctor degree in computer science in Sichuan University. She received the advanced physicist certification from the national joint education program with the Department of Medical physics, Wisconsin University in 2017. Ying Song has long been dedicated to new technology research, development, and promotion in medical physics domain with interdisciplinary educational background and working experience. She has authored or co-authored over 20 refereed scientific publications and her research has been funded by National Natural Science Funding of China. She is a member of the Chinese Institute of Biomedical Engineering. In clinical application, she is qualified in quality control and technology development. In medical education domain, she works indefatigably to promote and perfect the undergraduate and graduate education.

Plenary Session

PS-01

Dr. Ola Holmberg, PhD
Head, Radiation Protection of Patients Unit (RPOP),
International Atomic Energy Agency (IAEA)

Dr. Ola Holmberg is the Head of the Radiation Protection of Patients Unit at the International Atomic Energy Agency (IAEA), Vienna, Austria – an organization within the United Nations family. He is a medical physicist from Sweden with radiotherapy experience from Skåne University Hospital, Malmö; Sweden, St. Luke's Hospital, Dublin, Ireland; and The Netherlands Cancer Institute, Amsterdam. Prior to his appointment to the IAEA in 2008, he was the Chief Physicist at Copenhagen University Hospital, Herlev, Denmark.
He is a co-founder of the Radiation Oncology Safety Information System (ROSIS, 2001) an international voluntary safety reporting system for radiotherapy, and has also participated as a Task Group member for the International Commission on Radiological Protection (ICRP) on prevention of accidental exposures from new external beam radiation therapy technologies, which led to the ICRP Publication 112.

Dr Holmberg has published scientific papers on radiation protection of patients in journals such as The Lancet. He has served as Course Director for ESTRO on radiotherapy treatment planning and has also lectured on prevention of accidents in radiotherapy in many different countries. He was the Scientific Secretary for the International Conference on Radiation Protection in Medicine - Setting the Scene for the Next Decade, held in Bonn, Germany, in December 2012, which led to the Bonn Call for Action – a joint position statement by the IAEA and the WHO, as well as for the International Conference on Radiation Protection in Medicine – Achieving Change in Practice, held in Vienna, Austria, in December 2017.

Radiation Protection Education and Training of Health Professionals

Dr. Ola Holmberg, PhD

Head, Radiation Protection of Patients Unit (RPOP), International Atomic Energy Agency (IAEA)

Medical uses of ionizing radiation involve several groups of health professionals performing diagnostic examinations, interventional procedures or treatment, whose knowledge, skills and competence are of critical importance for maintaining radiation protection and safety. The Medical Physicists have a key-role among these groups. The IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards require specialist education and training in a particular discipline, including radiation protection and safety for each of the key roles. The programme of the International Atomic Energy Agency (IAEA) for supporting its Member States in radiation protection and safety education and training of health professionals, includes the development of standard syllabi, training packages and train the trainer courses in different languages. Since the last five years, it could be noted that free online resources such as webinars and eLearning courses have been made available through the Radiation Protection of Patients (RPOP) website.

In 2021, an IAEA survey was conducted with the objective to collect information in order to provide insight into the current educational practices, resources and barriers to the education and ongoing training in radiation protection of healthcare professionals in the IAEA Member States. A total of 135 responses were received from 59 countries from all regions. By profession, 40 % of the responders

were medical physicists, 16% regulators, 15% medical radiological practitioners (oncologists, radiologists, nuclear medicine physicians, dentists or other physicians performing interventional procedures), 14% radiation medical technologists/radiographers, and 15% other professionals involved in radiation protection training. The results of the survey will be presented at the meeting, together with the overall approach of the IAEA on this topic.

PS-02

Dr. Madan M. Rehani
President, IOMP

Dr. Madan M. Rehani is Director, Global Outreach for Radiation Protection at the Massachusetts General Hospital, Boston, USA. He is President, International Organization for Medical Physics (2018-2021). He has been on the faculty of Harvard Medical School and Duke University, USA. He was earlier Radiation Safety Specialist at the International Atomic Energy Agency for 11 years and prior to that Professor and Head of Medical Physics at the All India Institute of Medical Sciences, New Delhi, India. Dr. Rehani is an Emeritus Member, International Commission on Radiological Protection (ICRP), having been active member for 24 years. He is author of 9 Annals of ICRP, 4 of which as Chair of the Task Group. He is Senior Editor Br J Radiology and Assoc Editor, Eur J Medical Physics. He has more than 175 publications, has written 40 chapters in Books and has edited 5 books. Besides radiology journals, he has published papers in high impact factor journals e.g. JAMA Intern Med, Br Med J, Eur Heart J, Cardiovascular Imaging, Am J Gastroenterol, Circulation J, The Lancet.

Are imaging medical physicist's equipment and technique focused or patient focused

Madan M. Rehani, PhD

Massachusetts General Hospital, Boston, USA

Way back in 1980's equipment was the focus for diagnostic medical physicists. There was great emphasis to acceptance testing of the new imaging equipment and periodic performance evaluation. A number of organizations had provided guidance on testing frequency and protocols for testing. Many medical physicists established private consultancies and thus the scope of private business grew. Most regulatory bodies established requirements for equipment testing and that gave employment opportunities to many medical physicists. There was a realization in 1990's that equipment testing alone is not quality assurance and it is overuse of the word QA unless the testing is associated with repair of faults detected and additionally image quality considerations need attention. The radiation induced injuries from fluoroscopic guided interventional procedures in 1990's and from CT in 2000's led to avoidance of injuries as a part of the patient protection. The launch of Radiation Protection of Patients Unit at the International Atomic Energy Agency (IAEA) gave impetus to patient protection and technique optimization. The number of papers published in peer reviewed journals in 2000's and in 2010's has been phenomenal and medical physicists got technique focused in addition to equipment. Although all actions above lead to patient's benefit, the concept of tracking of radiation doses to patients resulted in patient focus. Publications in last 2 years have indicated that focus on equipment and technique is not enough and medical physicists need to be patient focused. These publications have shown that sizable number of patients receive several tens of mSv on a single day and millions of patients globally are receiving doses in excess of 100 mSv within a short period of a few days to a few years. This has created the need for patient focus and it is expected that medical physicists will rise to the occasion.

PS-03

Prof. Dr. Arun Chougule
President, AFOMP

Dr. Arun Chougule is the Senior Professor and Head of Department of Radiological Physics, SMS Medical College & Hospitals, Jaipur, Ex. Pro Vice Chancellor, Rajasthan University of Health Sciences and Dean Faculty of Paramedical Science, Jaipur India. He has 37 years of professional and teaching experience in medical physics. He is considered as one of the pioneers in radiation experiment dosimetry and radiobiology in India. He has been on many significant positions and member to countless committee and organizations. He is the past President of Association of Medical Physicist of India (AMPI) and currently he is President of Asia-Oceania Federation of Organization for Medical Physics (AFOMP) and Chair of education and training committee of International Organization of Medical Physics (IOMP), Chairman IOMP Accreditation Board. He is member of Board of Directors of International Medical Physics Certification Board [IMPCB]. He has more than 120 publications in national and international journals and presented more than 350 papers in national and international conferences. He has been authoring to two books. His research interest includes radiation biology, experimental dosimetry in teletherapy, radiation safety and protection in radiology and radiotherapy, QA-QC in Radiology.

He has served as an expert to IAEA and has been regular associate to ICTP for 8 years. He has done a significant work for radiation safety Training programs of VLIR, Belgium, for many years as key resource person. He has been awarded with numerous fellowships and awards mainly IOMP-IDMP 2016 for contribution of Medical Physics, AFOMP Member Excellent Presentation Awards, Outstanding Faculty award 2019 SMS Medical College, Govt. of Rajasthan, Dr. Farukh Abdulla Sher – e- Kashmir best researcher award for 2011-12. Recently he has been awarded as AFOMP outstanding medical physicists 2020 for his contribution to Medical Physics education, research and professional development. His contribution to health sciences and awarded prestigious fellow National Academy of Medical Sciences- FAMS in 2021. He is associated with over 27 national and international scientific organizations, Associate editor of 4 international journals and editorial board member of many journals. He is associate with many NGO's working in the field of cancer awareness. He is very widely travelled across the world.

Medical Physics education and professional status in AFOMP region- role of international organisations and way forward

Arun Chougule PhD

President AFOMP
Senior Professor & Head Radiological Physics
SMS Medical College &hospitals, Jaipur, India

Medical Physics is one of the most challenging and rewarding application of physics to human health care programme and is mainly concerned with use of ionizing radiation in diagnosis, therapy, and research in health care. Medical physics was classified among the healthcare professions by the International Labor Organization [ILO]. The International Basic Safety Standards [IBSS] specifically refers to medical physics professionals with respect to medical exposure, patient protection and safety. In order to fulfil their duties, medical physicists working as health professionals are expected to acquire competency in their area of specialization by completing the appropriate educational qualification and structured and supervised clinical training in one or more specialties of medical

physics from recognized institution. To become clinically qualified medical physicists (CQMPs), the graduates of the academic programs are expected to then undergo specialized clinical training in accordance with the IAEA Human Health Series No. 25.

Asia Oceania Federation of Organizations of Medical Physics [AFOMP] was founded in 2000 and is one the largest regional organization of International Organization for Medical Physics [IOMP]. AFOMP have 19 national medical physics member organizations [NMO] as members and 2 NMO's as affiliate members.

Asia Oceania region hosts more than 4.5 billion populations, and this region is very diverse socioeconomically, culturally. Further the rapidly growing health system require increasing number of MPs and to cope to increasing demand of MPs, many countries in this region have started master's in medical physics education program [MMP] in last decade. The data collected from 21 countries of Asia Oceania region regarding the number MMP, intake capacity, accreditation, certification, and registration of medical physicists as health professionals. In 21 countries of the AFOMP over 11000 medical physicists are working in radiation oncology, radiology, nuclear medicine, and regulatory authority. Further analysis showed that maximum numbers of medical physicists are working in radiation oncology [71.05 %], in radiology [7.24%] and in nuclear medicine [4.70 %]. It is observed that the number of medical physicists per million populations varies from 0.56 MP/million to 20.0 MP/million with average of 2.56 MP/million. For many countries in AFOMP the number of MP/million population is far below the number of 18 MP/million recommended by European Federation of Organisation for Medical Physics [EFOMP]. Further we made the comparison of number of MP/million population for all the RO's of IOMP and found that the number of MP/million in AFOMP region is far below the number of MP/million in USA & Canada and EFOMP region. However, in last 10 years more and more medical physics education programs have started and presently 106 institutes/universities are imparting MMP with annual intake capacity of about 750 students.

The present question is whether all the medical physicists trained by various universities/institutions fulfil these expectations? Whether the medical physicists trained by different universities/ institutions are competent enough to discharge the duty of unsupervised clinical medical physicists?To access and standardise the medical physics education and profession, IOMP has started accreditation of medical physics education program. For accreditation of national certification boards and individual certification of medical physicists, International Medical Physics Certification Board [IMPCB] has started accreditation of certification boards and certification of individual medical physicists. To help member state to establish the certification and registration of medical physicists as health professional IAEA has brought out Training Course Series TCS 71 document in February 2021 on "Guidelines on certification of Clinically Qualified Medical Physicists, this document is endorsed by IOMP and IMPCB.

IAEA has brought out the Technical Series Document TCS 56 for model Postgraduate medical physics academic programme in 2013. Since them lot of technological developments in healthcare delivery system and increased professional competency requirement of CQMP has taken place and therefore the training and educational curriculum needs to be tuned with the requirement to produce the competent CQMP not for the present but also for the future needs. Furthermore, the major outcome of the academic programme is to provide the students with a thorough grounding in medical physics, critical thinking, scientific rigor, and adequate professional ethics, to facilitate the integration of the graduates in a healthcare profession, where the benefit of the patient is at the centre of all activities. Medical physics is facing significant changes, particularly with quick development of biological sciences, more complex research requiring interdisciplinary teams and strong need for translational research. The changes towards personalized medicine are opening new avenues for medical physicists like molecular imaging and extending beyond radiation therapy. To prepare medical physicists for the

future, education and training should be properly adjusted including more basic non-physical sciences, particularly biology, more imaging, especially molecular imaging, and with more interdisciplinary and translational research components.

AFOMP has taken imitative and formed a task group to revise the curriculum and syllabus to train the CQMP for the need of AFOMP region. Similarly, IOMP and IAEA has undertaken the revision of TCS 56 document.

Overall situation of medical physics education & training, accreditation, certification, and registration in AFOMP region has increased in last 20 years, however, the rising population, increasing number of patients needing radiological services coupled with complexity of techniques, we need a greater number of certified CQMP for providing effective and efficient services. To bridge the huge gap between supply and need, lot needs to be done for availability of sufficient number of certified CQMP not only in AFOMP region but other regions of the world. For mobility of CQMP from one region to other, harmonization of medical physics curriculum and certification is required.

Key words: Medical Physics Education, AFOMP, Accreditation, Certification, Clinically Qualified Medical Physicist [CQMP]

PS-04

Prof. Dr. Golam Abu Zakaria
Prof. of Clinical Engineering,
Anhalt University of Applied Sciences,
Koethen, Germany (EFOMP)

Dr. Golam Zakaria is currently the Prof. of Clinical Engineering in the Anhalt University of Applied Sciences, Koethen, Germany.After his post-graduate studies on medical physics at the University of Goettingen, he received his doctorate in medical physics at the University of Heidelberg in 1986. From 1987, Prof. Dr. Zakaria was chairman and chief medical physicist of the independent Department of Medical Radiation Physics at Gummersbach Hospital, an academic teaching hospital of the University of Cologne. In 1990 Dr. Zakaria was recognized as a qualified expert in medical physics (radio-oncology, nuclear medicine and radiological diagnostic) by the German Society for Medical Physics (DGMP). Prof. Zakaria has been invited as Guest/honorary/adjunct professor in many institutes or universities in Germany, Italy, China, India and Bangladesh. Furthermore, he set up cooperation with various institutes, hospitals and universities in all those countries for teacher- student- exchange programs and medical physicists training.

Prof. Dr. Zakaria is also the founder chairman of the "South Asia Centre for Medical Physics and Cancer Research" in Dhaka, Bangladesh (was founded July 2018). Dr. Zakaria is nominated as the Accreditation Committee-2 Chair (Radio-Oncology Physics) of the International Medical Physics Certification Board (IMPCB) since January 2018 and Vice Chair of the International Organization Medical Physics (IOMP) Accreditation Board since October 2018. He is one of the member of EFOMP Working Group on "Artificial Intelligence"

Medical physicist curricular and professional programme to include Artificial Intelligence

F. Zanca, I. Hernandez-Giron, M. Avanzo, G. Guidi, W. Crijns, O. Diaz, G.C. Kagadis, O. Rampado, P.I. Lønne, S. Ken, N. Colgan, H. Zaidi, G.A. Zakaria, M. Kortesniemi

Working Group (WG) Artificial Intelligence (AI), The European Federation of Organisations for Medical Physics (EFOMP)

The Medical Physicists (MPs) community was given access to a pilot online international survey with AI-specific questions. 219 people from 31 nations participated in the survey, and the majority of them (88%) agreed with the statements "MPs require specific AI training" and (80%) with the statement "I strongly believe AI should be part of the MPs curriculum." The importance of AI for MPs was clearly stated in that survey. As a result, we endeavored to develop a guideline curriculum for Artificial Intelligence (AI) education and training for European MPs. This curriculum is the first designed guideline for MPs in Europe, and it expands on the current educational structure. There are two levels to our curriculum: basic and advanced. The learning outcomes of training are presented as knowledge, skills and competences (KSC) approach. For the Basic section, KSCs were stratified in four subsections: (1) Medical imaging analysis and AI Basics; (2) Implementation of AI applications in clinical practice; (3) Big data and enterprise imaging, and (4) Quality, Regulatory and Ethical Issues of AI processes. For the Advanced section, a common block was proposed. Each subspecialty's core curriculum should elaborate on this. MPs must update their training and education programs to ready for the transformational technologies. However, there are currently few courses and workshops that are specifically tailored to the needs of MPs.

This type of education could be provided through the European School of Medical Physics Expert (ESMPE) training modules, which are in line with the goals of the European Federation of Organizations for Medical Physics (EFOMP). The expertise and responsibilities of MPs have centered on overall quality principles, optimization, research, and creation of new analytical procedures. We also wanted to create a curriculum that adhered to the Bologna Declaration and the European Parliament and Council recommendations on the formation of a European credentials framework for lifelong learning from April 23, 2008. Advanced knowledge and skills needed to develop in-house AI software are considered outside the scope of the current curriculum. It is clear that the field of AI is undergoing significant transformations now and in the future, making it difficult to predict how quickly some of our responsibilities as MPs will alter and adapt.

PS-05

Mohammad Hassan Kharita
Assistant Executive Director for
OHS – Medical Physics Section
Hamad Medical Corporation -Doha - Qatar
Secretary General of MEFOMP

Dr. Mohammad Hassan KHARITA is the Assistant Executive Director (of Occupational Health and Safety Department – Medical Physics) Hamad Medical Corporation (HMC) overseeing all medical physics aspects in diagnostic radiology and nuclear medicine in addition to radiation safety issues at all 15 HMC hospitals.

Dr Kharita was a Radiation Safety Consultant in the International Atomic Energy Agency (IAEA) 2014-2015. He obtained a PhD. Degree in Radiation Dosimetry in 1996 and M.Sc. degree in Applied Radiation Physics in 1992 at the University of Birmingham, UK. He had vast experience with the IAEA as an expert to more than 35 missions.

He is Secretary General of the Middle Eastern Federation for Medical Physics (MEFOMP) 2018-2022 and the Vice president of the Qatar Medical Physics Society (QaMPS) 2018-2022.

Contribution of Medical Physicists During COVID-19 in the Middle East

Mohammad Hassan Kharita

COVID-19 virus has had an unparalleled impact on all aspects of our lives. This paper describes how the COVID-19 pandemic has affected clinical practice, education, and research in medical physics, and how colleagues on the frontline dealt with this unpredictable and unprecedented pandemic. The paper summarizes the contribution from the national societies in the MEFOMP countries with emphasis on the importance of protection of staff and patients in addition to the cooperation with physicians for better diagnosis and treatment for the COVID-19 patients. Furthermore, it addresses the activities related to all aspects of medical physics, health physics and radiation safety in radiology, radiotherapy, and nuclear medicine during the COVID-19 pandemic, with some examples from the different MEFOMP member countries.

It focuses on the different experiences of medical physicists in different countries and it tackles key questions such as: the response of medical physicists to the pandemic, any strategies used and the

PS-06

Prof. Dr. Marc Kachelrieß
Division Head and Group Leader
X-Ray Imaging and Computed Tomography
German Cancer Research Center (DKFZ)
Heidelberg, Germany (DGMP)

Prof. Dr. Marc Kachelrieß is chair of the division of X-Ray Imaging and CT of the German Cancer Research Center (DKFZ), Heidelberg, Germany. After finishing his diploma in theoretical physics he started his PhD research on metal artifact reduction in CT in 1995. In 2002 Marc Kachelrieß complet-ed all post-doctoral lecturing qualifications (habilitation) for Medical Physics and in 2005 he was ap-pointed Professor of Medical Imaging at the University of Erlangen-Nürnberg. Since 2009 Marc Ka-chelrieß additionally holds an Adjunct Associate Professor position at the Department of Radiology at the University of Utah, USA. In 2014 Marc Kachelrieß was appointed full Professor of X-Ray Imaging and CT at the German Cancer Research Center (DKFZ) in Heidelberg, Germany. His research interests are basic algorithmic and physics aspects of tomographic imaging with ionizing radiation, with a focus on x-ray computed tomography.

Recent Advancement in Medical Physics: Photon-Counting CT

Marc Kachelrieß

German Cancer Research Center (DKFZ), Heidelberg

Diagnostic x-ray CT is the most widely used tomographic imaging modality and the workhorse of the radiologist. The modality is highly mature. Today's systems use so-called energy integrating (EI) detectors. These are indirect converters that detect the sum of all energies of the x-ray photons arriving during a readout interval. Very recently, photon-counting (PC) detector technology has been introduced into diagnostic CT. These detectors are direct converters and are able to detect and count each single x-ray photon and they can simultaneously measure the photon energy. Thereby, energy- and thus material-selective information is acquired, similar to but better than what is acquired in dual energy CT. These photon-counting CT (PCCT) systems have manifold advantages over today's CT scanners: far better dose usage, better image quality, less patient exposure, higher spatial resolution and spectral information on demand. This keynote lecture describes the basic physical principles, discusses actual realizations and scan modes of PCCT systems, and demonstrates some of their capabilities using preclinical and clinical data.

Invited Speakers

IV-01

Dr. Salahuddin Ahmad
Ph.D., DABR, FACMP, FAAPM, FACR
Professor of Radiation Oncology and Director of Medical Physics
Dosimetry and Medical Physics Residency
Peggy and Charles Stephenson Cancer Center
University of Oklahoma Health Sciences Center
Oklahoma City, USA

Salahuddin Ahmad received Ph.D. degree in Nuclear Physics from Canada in 1981, postdoctoral training in Therapeutic Physics from MD Anderson Cancer Center in 1998. He served as a Lecturer of Physics at Dhaka University, Commonwealth Fellow at University of Victoria, Research Scientist at University of Paris, Research Associate at University of Saskatchewan and at TRIUMF and Research Assistant Professor at Rice University in USA. He was then an Assistant Professor of Radiology at Houston's Baylor College of Medicine and Chief Physicist at VA Medical Center. Currently he is the Director of Medical Physics, Dosimetry and Medical Physics Residency, and a tenured Full Professor of Radiation Oncology at the University of Oklahoma, Oklahoma City, USA. Dr. Ahmad has co-authored 190 papers in peer reviewed international journals, 66 book chapters and 440 conference abstracts. He is a Fellow of ACMP, AAPM and ACR and a Raja Kali Narayan Scholar of Dhaka University.

Advances in Particle Therapy Treatment for Cancer

Salahuddin Ahmad

University of Oklahoma Health Sciences Center, Oklahoma City, USA

The goal of radiotherapy is to deposit as much dose as possible in a tumor while minimizing the dose that reaches the surrounding normal tissue. Beams of charged particles (protons and heavy-ions) offer significant advantages for the treatment of wide variety of cancers compared to conventional high energy x-rays. Their physical depth-dose distribution in tissue is characterized by a small entrance dose and a distinct maximum (Bragg peak) dose near the end of the particle range with a sharp dose fall-off at the distal edge. Taking full advantage of the range and the small lateral beam spread, modern scanning beam systems allow delivery of the dose with high precision. Projectiles heavier than protons such as carbon-ions exhibit an enhanced biological effectiveness in the Bragg peak region due to dense ionization of particle tracks. There is a great interest to expand the availability of Proton Beam Radiation Therapy (PBRT) beyond the limited number of large institutions able to afford the high cost of existing systems.

At our institution in Oklahoma University Health Sciences Center, we have installed and commissioned a cost efficient, single room PBRT system, which is compact with superconducting high magnetic field that directs proton beam towards a precisely defined iso-center. Since January 2019, we are treating cancer patients with this machine using intensity modulated proton therapy technique. This system has become increasingly popular for its use at cancer centers after its successful operation in our institution as well as few others. Also, plans for new clinical centers for heavy-ion or combined proton and heavy-ion therapy have recently received a substantial boost following promising clinical results obtained with carbon-ion beams in the past ten years at the Heavy-Ion Medical Accelerator facility (Japan) and in pilot projects at GSI Darmstadt (Germany).

IV-02

Dr. Murugan Appasamy
Chief Medical Physicists
Department of Radiation Oncology
Evercare Hospital Dhaka, Bangladesh

Murugan Appasamy, PhD is a graduate of Anna University, Chennai where he attended his master's in medical physics and Doctorate from VIT University, Vellore, India. During masters he also underwent clinical training in Cancer Institute (WIA), Adyar as part of his master's program. In 2003 he joined in Guntur Medical college as Medical Physicist &Asst Professor in the department of radiotherapy and started LDR Brachytherapy program. Later in 2005, he joined in DrKamakshi Memorial Hospital, Chennai, India, where he was involved in establishing Radiotherapy department and installed 2 linear accelerators, a HDR Brachytherapy unit, a PET-CT and Cyclotron. He was trained in Wisconcin University, USA for IMRT and IGRT under the UICC-ICRTT fellowship and he also involved in teaching and training of Medical Physics students from various universities.

He joined Evercare Hospitals Dhaka (Former Apollo Hospitals Dhaka) in 2017, where he was involved in establishing start of art Radiotherapy Department, installed a linear accelerator capable of VMAT and SRS/SRT facility and a HDR Brachytherapy unit and established JCI standard work practice and got accreditation for 2 consecutive times. He successfully implemented various modern techniques into clinics including SRS/SRT and TBI by VMAT. In 2019 he underwent training at Wake Forest University, USA for handling SRS/SRT and SBRT.

He is member of various professional societies including American Association of Medical Physicist (AAPM, USA) and Institute of Physics and Engineering in Medicine (IPEM, UK) and currently he holds HCPC registration as Clinical Scientist.

Volumetric-Modulated Arc Therapy (VMAT): A Single Window system for State of Art Radiation Techniques

Dr Murugan Appasamy, Masud Rana K M, Dr Narendra Kumar, DrBiswajitBhattacharjee, DrTaohida Yasmin, Arunkumar Raman

Department of Radiation Oncology, Evercare Hospitals Dhaka, Bangladesh.

Introduction: Recently, there has been some improvement in arc based or rotational therapies to overcome some of the limitations associated with conventional and fixed field IMRT. Arc therapies can achieve highly conformal dose distributions and are essentially an alternative form of IMRT with additional advantage of shorter treatment delivery. The main aim of this article is to summaries new avenues of VMAT, where is has been used to overcome the limitation of conventional treatment techniques and its advantages.

Treatment for Multiple intra-cranial lesions

The introduction of VMAT technology, there is a paradigm shift in the method of treatment, i.e., SRS/SRT can be delivered without frames and accuracy can be achieved nearly equivalent to that of conventional SRS/SRT. Inverse treatment planning optimization method will be adopted to achieve the required coverage to the target at the same time importance is given to the OAR's and the RTOG SRS/SRT dose constraints are used to restrict dose to OAR's during optimization. Another advantage of VMAT is that multiple lesions can be treated simultaneously with a common isocenter, which is not possible in conventional method. Differential prescription also possible and as it uses single arc, the treatment time will be significantly reduced when compared with older techniques.

Craniospinal irradiation with VMAT

Craniospinal irradiation (CSI) is an essential component for the treatment of primary intracranial tumors with a risk of leptomeningeal spread. However, CSI is technically challenging due to the large and irregular target volume and the radiosensitivity of the spinal cord and other critical structures. The use of VMAT techniques for CSI eliminates all conventional limitations as it uses inverse optimization algorithm, filed matching will not be an issue and uniform dose can be delivered hassle-free throughout the PTV.

Total Body Irradiation with VAMT

Total body irradiation is another technique, where they will use large treatment fields and extended SSD's. The disadvantage of this techniques is it requires additional treatment accessories like Beam spoiler, Patient in-vivo dosimetry system, shielding, patient positioning couch etc. But due to the availability of VMAT techniques the same can be delivered with nominal treatment distance and with multiple isocenters with carful treatment planning techniques.

Summary

VMAT technique is a versatile technology, and it helps clinicians and medical physicist to overcome the conventional limits of large field irradiation and high precision radiotherapy treatments.

IV-03

Dr. Colin J Martin
Department of Clinical Physics and Bio-engineering
University of Glasgow, Glasgow, Scotland, UK
International Commission on Radiological Protection (ICRP)

Dr. Colin Martin worked as a hospital-based Medical Physicist in Radiation Protection in Glasgow and Aberdeen, Scotland for over 30 years. He has now retired from the NHS but is an honorary senior lecturer for the University of Glasgow. Colin is Vice-Chair of ICRP Committee 3 (Protection in Medicine), chairs two ICRP Task groups and is a member of several others. He is a member of various UK and EU working parties, COMARE, which advises the UK government on medical uses of radiation, and he has chaired two IAEA Technical Meetings on avoidance and prevention of radiation incidents in medicine. His research interests include radiation protection, diagnostic radiology, radiation dosimetry, and non-ionising physics. He has co-authored/edited several textbooks on radiation protection, written over 300 articles including 150 papers in peer reviewed scientific journals. Colin is a member of Editorial Boards for the Journal of Radiological Protection and Radiation Protection Dosimetry.

Optimization in Digital Radiology

Martin, Colin J

Department of Clinical Physics and Bio-engineering, University of Glasgow, Glasgow, Scotland, UK
International Commission on Radiological Protection (ICRP)

Introduction: Optimisation of radiation protection in medical imaging is key to maintaining doses at acceptable levels. It requires keeping patient exposure to be the minimum necessary to achieve the medical objective, i.e. images are adequate to provide the diagnostic information needed. The move to digital imaging provides versatile image acquisition and presentation options, but because images

are adjusted for optimal viewing, the appearance may not reveal whether doses are too high. In addition, as equipment becomes more complex, operators require extensive training to gain the necessary expertise, because otherwise dose levels from incorrect settings could be unreasonably high or low without anyone realising.

Materials and Methods: Optimisation of radiological protection for digital radiology involves selection and installation of equipment, design and construction of facilities, optimal equipment settings, day-to-day operation and quality control programmes, and ensuring that personnel receive proper initial and career-long training.

Results: Different aspects of optimisation need to be developed: 1) Collaboration between radiologists, radiographers, and medical physicists, each of whom have key skills that can only contribute effectively to the process when individuals work together as a core team. 2) Appropriate methodologies and technology, together with the knowledge and expertise required to use each effectively. 3) Organisational processes that establish when and how required tasks, such as equipment performance tests, patient dose surveys, and review of protocols are carried out. It is only through continual re-evaluation of protocols and performance in all these areas that full optimisation can be achieved.

Conclusion: ICRP is preparing a publication for public consultation in 2022. This sets out broad categories for levels of optimisation for different facilities divided into D: Preliminary, C: Basic, B: Intermediate, and A: Advanced. This aims to provide guidance on aspects that each facility should put in place to progress along the road to improve their optimisation.

IV-04

Dr. Vellaiyan Subramani
Sr. Medical Physicist-cum-RSO & Head of Medical Physics Unit
Department of Radiation Oncology
All India Institute of Medical Sciences, New Delhi, India

I am currently working as Assistant Professor of Radiation Oncology Medical Physics at All India Institute of Medical Sciences (AIIMS), New Delhi, India. I have experience and expertise in the field of medical physics specializing in radiation oncology for the last 25 years. I completed the doctoral research study on dosimetric evaluation of conformal and intensity modulated radiation therapy (IMRT) in 2006. I have undergone two months practical training on IMRT at McGill University, Canada and thereafter I established IMRT program at my institute in 2002.

As a chief-supervisor, four PhD students have completed their doctoral degree and 4 more are perusing and also I acted as PhD external examiners in many universities/institutions in India. I have involved in many researches as co-investigator for several post-graduate students of MD radiation oncology students. I have been involving and providing physics support for the multicentre randomized clinical trials of many intramural and extramural research projects. I published around 35 full papers and more than 50 abstracts in the national and international scientific journals. Also I delivered more than 50 invited guest lectures in the national and international conferences. Currently, I am heading the Radiation Oncology Medical Physics in the department of Radiation Oncology at AIIMS and also I am mentoring for Radiation Oncology Medical Physicists at AIIMS-National Cancer Institute of India.

Also, I serve as national Secretary of Association of Medical Physicists of India (2021-2024), Scientific Committee member in IOMP (2015-2021) and Editor of AFOMP Newsletter.

Medical Physics in Cancer Care and Research in the Era of Precision Medicine: Quo Vadis?

V.Subramani

Department of Radiation Oncology, All India Institute of Medical Sciences, New Delhi, India

The medical physics predominantly deals with the use of ionizing or non-ionizing radiation in the diagnosis and treatment of disease. The ionizing radiation is one of the indispensable methods of cancer treatment. Traditionally clinical medical physicists were shouldering the responsibilities of equipment commissioning, dosimetry, quality assurance, treatment planning, and radiation protection of radiation equipment and cancer patient care. However, due to rapid advances in radiation physics, biomedical engineering, computational science and information technology, the discipline of radiation oncology has become a technology-driven clinical medicine. Currently, the clinical practices of radiation oncology medical physics are with various technology-based highly conformal treatment techniques such as IMRT, IGRT, SRS/SBRT, 4D-RT, Adaptive RT, Image Guided Brachytherapy and Particle Therapy using proton and carbon ions beams for better treatment outcome and quality of life of the patient care.

The roles of imaging and of therapy using radiation have traditionally been separate, and imaging has traditionally been limited to the diagnosis of disease. However, we are currently witnessing a radically increasing role for imaging during and after therapy for plan, guide, verify, monitor and adapt the radiation treatment. Imaging developments provides not only the anatomical-based structural information but also about biology, metabolic activity and molecular functions of both tumor and critical organs functions. The quantitative imaging or radiomics with artificial intelligence shows great potential in tumor phenotype classification, prognosis, prediction of treatment response and outcome, as well as personalized therapy. Hence, the integration of imaging and therapy technologies have become the essential and the emerging technologies such as PET/MR, PET-CT, CT-Linac, MR-Linac, PET-Linac, MR-Proton etc. will certainly pave the way towards the optimised, adaptive, personalized cancer treatment.

This presentation will outline about the current and emerging trends in clinical practices and cancer research areas, expanding roles and essentials for preparing the future of Medical physics generations to meet the translational challenges in implementing precision medicine oncology practice in the coming years.

IV-05

Dipl.-Ing. Volker Steil
Authorized Representative for Radiation Protection
Head of Department Medical Physics and Radiation Protection
University Medical Centre
Medical Faculty Mannheim of University Heidelberg, Germany

- Fully licensed as Medical Physicist (Radiotherapy, Nuclear medicine and Radiodiagnostic).
- Since 2020 Head of Department Medical Physics and Radiation Protection (actual 14 licensed MPE and 4 MPE on training) and responsible for Radiation Protection for the University Medical Centre and the Medical Faculty Mannheim of the University of Heidelberg.
- Lecturer Master course “Biomedical engineering”.
- Member of the German Medical Physicist Association (DGMP).
- Member the German Radiation Oncologist Association (DEGRO).
- Board member of the Committee for the certification of Medical Physicist in DGMP from 2003 till 2010.

• Member of the German Commission on Radiological Protection / Committee Radiological Protection in Medicine 2011-2016.
• Since 2013 project coordinator of "Promoting the quality of medical physics education in Bangladesh and South Asia" a project of the German Academic Exchange Service (DAAD) between the University Gono Bishwabidyalay, Bangladesh and the University Heidelberg, Germany.

Challenges of low and middle income countries in Radiation Therapy

Dipl.-Ing. Volker Steil

University Medical Centre, Medical Faculty Mannheim of University Heidelberg, Germany

Radiotherapy, is an inexpensive form of cancer therapy compared to surgery and chemotherapy. This is important if the therapy capacity for treating cancer patients is to be expanded. In addition to the already known obstacles such as lack of investment and infrastructure, there are new challenges such as

- The application of curative treatment regimens for radiotherapy based on preventive and screening investigations
- Lack of trained staff
- Interdisciplinary exchange of digital data.

With an improvement in prevention and screening programmes, the detection of early tumour stages and thus the proportion of potentially curable patients increases. With overcome the restrictions on investments and in parallel the establishment of further radiotherapy capacity, the lack of well-trained staff to operate these high-tech facilities of the newest generation is becoming noticeable.

The interdisciplinary exchange of digital data is of particular importance for radiotherapy, as a strongly interdisciplinary, clinically integrated discipline with the DICOM-RT data generated (Keywords: Distances between diagnostic and treatment facilities, transmission of external examination results and images (DICOM) to the therapy unit, interdisciplinary tumour boards). With the increasing application of methods based on artificial intelligence, it is becoming more important to use own research data as the basis for such algorithms.

By overcoming past and future challenges, the quality of treatment will increase even as patient numbers rise.

IV-06

Dr. Frank William Hensley
Medical Physicist and Researcher
Dept. of Radiation Oncology
University Hospital Heidelberg, Germany

Physicist, since 1978 specialization in Medical Physics

Studies: 1974 Diploma in Physics (Nuclear Physics, University of Heidelberg)

Ph.D.: 1979 Dr.rer.nat. (Nuclear Physics & Astrophysics, University of Heidelberg)

Professional: Since 1978 specialization in Medical Physics

1990 to 11.2014: Medical Physicist and researcher at Dept. of Radiation Oncology/ University Hospital Heidelberg

Main focus: Dosimetry, Brachytherapy, Intraoperative Radiotherapy, Total Body and Total Skin Radiotherapy, general Radiotherapy Physics with Photons and Electrons

Teaching: Lecturer in Radiation Physics and Radiation Protection at:
Heidelberg University Medical School
Karlsruhe Institut für Technologie (KIT)
Forschungszentrum für Technik und Umwelt (FTU)
European School of Medical Physics (ESMP), Archamps
Summer Schools in Medical Physics, Santiago, Chile
Gono University, Dhaka, Bangladesh

New Low and Medium Energy Sources for Brachytherapy

Frank Hensley

University Hospital Heidelberg, Dept. Radioonkologie und Strahlentherapie

A number of low and medium energy sources as well as electronic sources are currently investigated for use in brachytherapy. Their advantages are less need for room shielding and the potential to develop partially shielded applicators which allow elaborate shaping of the dose distribution to the patient and better protection of risk organs. Drawbacks of lower energy sources are the larger uncertainties in dose calculation due to the stronger dependence of dose deposition on material composition and on the varying photon energy in the target. For exact calculations, model based calculation algorithms are needed. These have so far only been developed and implemented into treatment planning systems for high energy sources. Additionally, traceable source calibrations by standards labs exist only for few of the sources. Pros and cons of low and medium energy sources for brachytherapy will be discussed.

IV-07

Dipl. Eng. Renate Walter
Medical Physicist and Radiation Protection Commissioner
University Hospital Augsburg
Augsburg, Germany

After graduating in 1998 in Geophysics at Bergakademie Freiberg Technical University of Mining and Technology and adding supplement studies in Medical Physics I started my career in 2005 in Dresden. Since 2007 I am working as medical physicist and radiation protection commissioner at General Hospital Augsburg now University Hospital Augsburg. In 2008 the radiation oncology department started with a new equipped brachytherapy unit of which I am in charge of. Since than we treated not only gynea cases but skin, anorectal and head-neck cases, too. In 2010 I was certified for the field of radiation therapy by DGMP. I took part in working groups for the dosimetry norm (DIN 6803-3) and consistency test norm (DIN 6853-5) which are part of the German system of standards. In 2019 I was invited to contribute to GEC-ESTRO Brachytherapy Workshop and on the ESTRO endorsed Interdisciplinary Teaching Course On Head & Neck Brachytherapy.

Mind the gradient

Walter R[1]

[1] University Hospital Augsburg, Augsburg, Germany

Background: Brachy sources are tiny, and the surrounding dose field is characterized by a steep gradient in the close vicinity of the source. In modern Brachytherapy we ca trust planning system with TG-43 or even TG-186 which takes material densities into account, and we can rely on DVH's to analyse the plan and know the dose to tissue. In clinical day life it is often overseen in discussions that

the gradient of a whole plan may differ significantly from the invers square law and used to work with planning system we may not be able to estimate the dose before the patient is scanned on CT and planned.

Methods: A simplified model is taken to describe the encompassing isodose surface and how it grows by distance for cylindrical and flap plans to find a thumb rule for knowing giving a rough idea of the gradient's behaviour.

Results: Describing the encompassing surface depending on distance r and solving we can give a rough description how the gradient changes by distance. For large flaps it can be shown that even in the first mm of tissue the gradient of the plan is not following the inverse-square-law but geometrical independent.

Conclusions: A thumb rule can be formulated to advice physicians in the decision process in the preplanning phase.

IV-08

Dr. Xiance Jin
Chief medical physicist and vice director in the
Department of Radiotherapy and Chemotherapy
of the 1st Affiliated Hospital of Wenzhou Medical University
Wenzhou, China

XianceJin started his career as a medical physicist in China in 2001 after he graduated from Zhejiang University with a BS degree in physics. He went to US in 2007 and studied in the medical physics program of University of Toledo for his Ph. d degree. He went back to China in September 2011 after he got his Ph.D. His Ph. D thesis is " Evaluation of Large Area Polycrystalline CdTe Detector for Diagnostic X-ray Imaging" Dr. XianceJin has been involved in medical physics for more than 12 years. He is a full member of AAPM and is eligible for ABR board certification. He passed the physics part of Part I ABR. Now is working on the remaining ABR certification exams. Dr. Jin had published more than 20 papers and abstracts both in Chinese and international journals. His main research interests are new technologies and devices of radiotherapy for nasopharyngeal cancer and other cancers. Involved research programs on NPC won Chinese national and provincial awards. As a young medical physicist working in China with international education background, Dr. Jin is willing and eager to serve for the international board of certification to do his own contribution to the development of international and China medical physics.

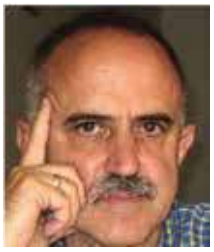
Ultrasound images based radiomics for cervical cancer

Xiance Jin,[1,2] Juebin Jin,[1] Yao Ai,[1]Congying Xie1,[3]

1. Radiotherapy Center, Wenzhou Medical University First Affiliated Hospital, Wenzhou, China, 325000
2. School of Basic Medical Science, Wenzhou Medical University, Wenzhou, China, 325000
3. Radiation and Medical Oncology, Wenzhou Medical University Second Affiliated Hospital, Wenzhou, China, 325000

Cervical cancer is the fourth most common causes of cancer-related death among women in the developed countries, and the second in the developing countries. Ultrasonography is universally recognized as a convenient and reasonable price method to help clinician to detect and diagnosis of cervix cancer in clinically. Only the accuracy and reproducibility of the interpretations of ultrasound images are often relied on the skill of the ultrasonographer, which leads to the limitation of interobserver variability. Therefore, computer aided or objective evaluation markers from radiomics features based on ultrasound images are imperatively needed. The purpose of the series studies is to, on the basis of previous research, with the help of machine learning and deep learning techniques, 1) to explore the big data cleaning standard of ultrasound images to improve the quality and consistency

of ultrasound images. 2) to explore the automatic segmentation technology of cervical cancer tumor target based on ultrasound and the automatic extraction technology of radiological features by using deep learning technology, to improve the quality of radiological features, and 3) to explore the automatic diagnosis and treatment assistant system of cervical cancer based on ultrasound radiological features and related clinical characteristic parameters. to improve the level of individual diagnosis and treatment of cervical cancer and improve the survival and quality of life of patients.



IV-09

Dr. Paweł Kukołowicz
Head of Medical Physicas Department
Maria Sklodowska-Curie National
Research Institute of Oncology
Warsaw, Poland

Born in 1957 in Łodź, Poland. Graduated from Warsaw University, Faculty of Physics, specialized in medical physics in 1981. From 1980 till 1997 medical physicists at Medical Physics Department, Cancer Center-Institute of Oncology in Warsaw. From 1997 till 2010 head of Medical Physics Department in Holycross Cancer Center in Kielce. From 2010 back at Cancer Center-Institute of Oncology in Warsaw. From 2012 head of the Department. In 1997 PhD at the Faculty of Physics at Warsaw University. From 2007 Associate Professor. President of Polish Society of Medical Physics (2012 – 2014 and from 2014 till now). From 2006 specialist in medical physics according to the Polish law (expert in medical physics). Lecturer at the Jan Kochanowski University in Kielce (2009 – 2011), at Warsaw University (2012 – 2017), at European School of Medical Physics, Archamps (2012 – 2014), and also at the ICTP in Trieste. Author of more than 30 articles published in peer-reviewed journals. The co-author of several Polish recommendations in radiotherapy. Father of 4 children and grandfather of 8 grandchildren. Marathon runner.

In-vivo dosimetry for sarcoma patients irradiated with IMRT techniques

AgnieszkaWalewska, PawełKukołowicz

Maria Sklodowska-Curie National Research Institute of Oncology, Warsaw, Poland

Motivation: was to develop a method for in-vivo dosimetry for patients with unresectable sarcomas treated with IMRT techniques.

Materials and Methods: The 21 patients with unresectable sarcomas underwent the short preoperative radiotherapy 5x5Gy. The goal was to evaluate the quality of radiotherapy. The consistency of the dose measured during the therapeutic session and the dose calculated in the treatment planning system (TPS), as well as the repeatability of a dose delivered during the therapeutic sessions, were evaluated.

The validation of Gafchromic films measurement method was performed and its uncertainty was estimated. The uncertainty of determining the reference dose, obtained from the TPS in measurement points, was estimated. In-vivo measurements were performed for 21 patients, each one irradiated with 1 cm bolus. The results obtained in 96 therapeutic sessions were analyzed. The difference between the measured dose and the reference dose was determined. Statistics describing the repeatability of the treatment for 21 patients at each measurement point (4 measurement points for each patient) were calculated.

Results: The results of the study showed that Gafchromic films may be used for in vivo dosimetry for dynamic techniques for patients with unresectable sarcomas who underwent preoperative

hypofractionated radiotherapy. The low uncertainty (≤ 1,1% - one standard deviation) of Gafchromic films measurement provides the detection of errors that are considered dangerous for radiotherapy. In 93% of the cases, the difference between the measured dose and the reference dose did not exceed 7%. The results of the study reviled compliance of the delivered doses with the doses calculated in the TPS and a good repeatability of treatment.
Conclusions: The routine use of in vivo dosimetry with Gafchromic films is possible for patients irradiated with bolus. The repeatability od irradiation of sarcoma patients was good.

IV-10

Prof. Guenther H. Hartmann
Division of Medical Physics in Radiation Oncology
German Cancer Research Center (DKFZ)
Heidelberg, Germany.

Born: April 7,1946 in Herrsching, Bavaria, Germany
Married since 1970 with: Ingrid Hartmann
Three children: Oliver (49), Anne (47), Laurin (42)
1967-1970 Study of Physics at the Technical University, Munich
1970-1972 Study of Physics at the University in Erlangen-Nürnberg
1970-1972 Scholarship of the "Studienstiftung des DeutschenVolkes"
1972 Physics degree
1979 PhD degree
1999 Professorship in Medical Physics
Retired since 2011
2021 most recent publication in Med. Phys. (together with P.Andreo, K. Zink and R.-P. Kapsch): “Cema-based formalism for the determination of absorbed dose for high energy photon beams”

Cema-based formalism for the determination of absorbed dose for high energy photon beams

G. H. Hartmann[1], P. Andreo[2,3,] R.-P. Kapsch[4], K. Zink[5,6,7]

1. German Cancer Research Center (DKFZ), Heidelberg, Germany

2. Department of Medical Radiation Physics and Nuclear Medicine, Karolinska University Hospital, SE-171 76 Stockholm, Sweden

3. Department of Oncology-Pathology, KarolinskaInstitutet, SE-171 76 Stockholm, Sweden

4. Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

5. Institute of Medical Physics and Radiation Protection (IMPS), University of Applied Sciences 5 Giessen, 35390 Giessen, Germany

6. Department for Radiotherapy and Radiooncology, University Medical Center Giessen-Marburg, 35043 Marburg, Germany

7. Frankfurt Institute for Advanced Studies (FIAS), Goethe-University, 60438, Frankfurt, Germany

Purpose: Determination of absorbed dose is well-established in many dosimetry protocols and considered to bble using ionization chambers under reference conditions. If dosimetry is performed under other conditions or using other detectors, however, open questions still remain. Such questions frequently refer to appropriate correction factors. A cema-based approach to formulate such correction factors offers a good understanding of the specific properties of a detector for dosimetry under various measuring conditions and thus an estimate of pros and cons of its application.

Methods: Determination of absorbed dose requires the knowledge of the beam quality correction

factor kQ,Qo, where Q denotes the quality of a user beam and Q0 is the quality of the radiation used for calibration. In modern Monte Carlo (MC) based methods, kQ,Qo is directly derived from the MC calculated dose conversion factor which is the ratio between the absorbed dose at a point of interest in water and the mean absorbed dose in the sensitive volume of an ion chamber. In this work, absorbed dose is approximated by the fundamental quantity cema. This approximation allows the dose conversion factor to be substituted by the cema conversion factor. Subsequently, this factor is decomposed into a product of cema ratios. They are identified as the stopping power ratio water to the material in the sensitive detector volume, and as the correction factor for the fluence perturbation of the secondary charged particles in the detector cavity caused by the presence of the detector. This correction factor is further decomposed with respect to the perturbation caused by the detector cavity and that caused by external detector properties. The cema based formalism was subsequently tested by MC calculations of the spectral fluence of the secondary charged particles (electrons and positrons) under various conditions.

Results: MC calculations demonstrate that considerable fluence perturbation may occur particularly under non reference conditions. Cema based correction factors to be applied in a 6 MV beam were obtained for a number of ionization chambers and for two solid state detectors. Feasibility was shown at a field size of 4 cm x 4 cm and of 0.5 cm x 0.5 cm. Values of the cema ratios resulting from the decomposition of the dose conversion factor can be well correlated with detector properties. Under the small field conditions, the internal fluence correction factor of ionization chambers is considerably dependent on volume averaging and thus on the shape and size of the cavity volume.

Conclusion: The cema based decomposition of the dose conversion factor into stopping power ratio and a fluence perturbation correction factor is applicable under any measuring condition independently of detector type and whether Bragg-Gray conditions are met. The decomposition does not increase the uncertainty of the sub-factors. Both sub-factors can be consistently expressed as cema ratios. The decomposition of the fluence perturbation correction factor into further sub-factors can serve to a better understanding of the specific behavior of a detector at dose measurements, particularly at non-reference conditions.

IV-11

Prof. Khondaker A. Mamun
Professor, Department of Computer Science and Engineering
United International University (UIU)

Khondaker A. Mamun received his Ph.D. in Computer and Biomedical Engineering from University of Southampton, UK. After that he worked as a Postdoctoral Research Fellow in the PRISM Lab with joint appointment from Institute of Biomaterials and Biomedical Engineering (IBBME), University of Toronto, Toronto, Canada and Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada. Since October 2014, he is working as an Associate Professor and then Professor at the Department of Computer Science & Engineering, United International University (UIU), Dhaka, Bangladesh.

Prof. Mamun is the Founder and Director of Advanced Intelligent Multidisciplinary Systems Lab (AIMS Lab) at UIU, where his team actively performs research on the applications of 4IR technologies like, artificial intelligence, big data and internet of things in healthcare, disabilities, brain computer interface (BCI) and education. Prof. Mamun is the founder of CMED Health (www.cmed.com.bd), a startup that commercialized from research of AIMS Lab, UIU and focuses on health inclusion through digital healthcare platform. He is also a national consultant for information system and data

management for health system of MTR of 4th HPNSP, Ministry of Health and Family Welfare, Government of Bangladesh.

Abstract: Healthcare is a basic need of humans. However, it is the biggest challenge in a developing country, where many people are not getting good healthcare due to lack of systems and resources. On the other hand, healthcare is about to enter a period of rapid transformation by utilizing Fourth Industrial Revolution (4IR) technologies. Longevity and the advance of new technologies and discoveries – as well as innovative combinations of existing ones – are among the many factors pushing patient empowerment, which is fundamentally changing how we prevent, diagnose and cure diseases. Rapid growth of digital technology plays a big role in the healthcare system and helps to predict future health consequences and utilize preventive measures to protect it and improve quality of living. The Digital Health Ecosystem triggered by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. The potential for merging physical, digital and biological systems certainly has far-reaching potential for healthcare provision. The talk will discuss the implementation experience of Digital Health that is transforming the healthcare landscape for achieving Health Inclusion (UHC) in the era of 4IR.

IV-12

Major Md. Ashrafuzzaman, Ph.D, EME
Associate Professor
Military Institute of Science and Technology (MIST)

Major Md. Ashrafuzzaman, Ph.D was born in Dec 1980. His B.Sc and M.Sc degree was in Biotechnology and Genetic Engineering, at Khulna University, Bangladesh and awarded his Ph.D in Drug Development and Biomaterials from Korea Institute of Science and Technology (KIST) South Korea. He had served as the Founder Head of the Biomedical Engineering department of Military Institute of Science and Technology (MIST) from 25-11-2014 to 12-04-2016 and now serving as associate professor and guiding the postgraduate and graduate students with active supervision and mentorship. He has published many research articles and book chapters in different international journals and patented his research works. He is the chairman and member several National Committees and Country Collaborator of CED, IFMBE for the successive development of Biomedical Engineering in Bangladesh. He is the Chief Patron of Saudi Bangladesh Institute of Biomedical Engineering & Technology (SBIBMET) to achieve the sustainable development goal (SDG) 2030 in the health sector of Bangladesh.

Augmentation of Heath Technology Management through Effective Implementation and Proper Engagement of Biomedical Engineers at all Level of Hospitals in Bangladesh

Md. Ashrafuzzaman[1]

1. Associate Professor, Department of Biomedical Engineering, Military Institute of Science & Technology, Dhaka-1216, Bangladesh

Bangladesh is now one of the fastest growing economies in the world (41st largest economy in the world, 2019). Compared to the economic growth and global position, Bangladesh is still far away for sustainable healthcare system (Ranked 88 on overall performance of health care system, WHO 2020). Bangladesh government has manifested to facilitate the overall healthcare system to a global standard level within 2041 along with so many visionary plans. Biomedical Engineering (BME) education

plays a crucial role in meeting the grand challenge of healthcare sector. Indeed, the number of Bangladesh undergraduate and graduate degree programs, research institutes, and centers focused on healthcare sustainability has significantly increased in the past 2/3 years a stimulating and optimistic indication which has been possible by the endeavor of Biomedical Engineering experts and professionals. Maintenance and operation of medical devices is heavily reliant on different company's personnel and their technicians, takes a toll on finances allocated for equipping healthcare sector. Absence of the country's own certified CE/CET and solutions related to problems involving medical equipment is a serious challenge. The overall HTM relies on the availability of technicians specific to the equipment from the supplier companies which affects quality control of equipment. Since the population is projected to be 194 million by the year 2030, more than 62,000 BME/CE/CET shall be required to meet the growing demand of healthcare sector. With government's recent initiative, only 6190 CET and a mere 300 BME/CE exist in Bangladesh for its 167 million populations. Further, these CE/CET professionals are yet to certify. The development of new training module and BME/CE certification system to ensure number of certified BME/CE/CET required by government in its creation of BME/CE/BMET posts in the hospitals can only be the potential for achieving the global sustainable development goal in healthcare sector by 2030.

IV-13

Dr. Mala Khan
Director General in Bangladesh Reference Institute
for Chemical Measurements (BRiCM)
Ministry of Science and Technology from 27 October 2020

Until her appointment at the BRiCM, she has been serving as the Chief Scientific Officer in Designated Reference Institute for Chemical Measurements and conducted as Director in several project for establishing the chemical metrology infrastructure in Bangladesh.
She started her journey in Analytical Instrumentation & Laboratory Information System Management LIMS in Bangladesh and was awarded Chancellors´ Gold Medal by The Honourable President of the Peoples´ Republic of Bangladesh for her academic excellence in 2000 from the University of Asia Pacific.

In a very specialized field "Science of Chemical Measurements, namely, Chemical Metrology", she have been keeping herself strict to her mission to identify scientifically the national challenges in laboratory quality management system (LQMS), laboratory accreditation and science of measurements i.e. metrology, and formulated the "National Strategy (2009-2021) for establishing scientific infrastructure in Chemical Metrology in Bangladesh" to meet the international requirements and norms.

By the year 2007 she got a breakthrough success in attracting the academia-industries-scientific communities including Bangladesh Academy of Sciences BAS, European Commission, UNIDO and other concerned international communities and national policy makers in chemical metrology area. She have been successful in designing and establishing Designated Reference Institute for Chemical Measurements DRiCM which has been mandated to be the reference measurement infrastructure for Chemical Metrology and it was inaugurated by the Honorable Prime Minister Sheikh Hasina on 10 June 2012.

She have successfully deployed the system of DRiCM to meet acceptable international standards defined by Bureau International des Poids et Mesures (International Bureau of Weights and Measures) BIPM, to achieve recognitions from the regional level by Asia Pacific Metrology Programme APMP and BIPM, Paris in 2012 DRiCM earned membership of BIPM and APMP. For her this outstanding work APMP gave her award "APMP DEN Award" in 2015. Through her activities DRiCM recognized as Designated Institute in National Quality Policy and became the scientific partner of The

Netherlands based UN Organization for the Prohibition of Chemical Weapons (OPCW) and Portuguese national standards and metrology body IPQ and COMSATS.

Under her leadership BRiCM became not only a national asset but also a regional and international hub for Chemical Metrology. Her dedication brought success in turning BRiCM to be an essential science, technology and innovation infrastructure for Bangladesh underpinning the national.

She holds a PhD degree in "Chemical Metrology"

Necessity of Implementation of Metrology for Medical Devices in Bangladesh

Mala Khan

Bangladesh Reference Institute for Chemical Measurements, Dhaka, Bangladesh

Bangladesh suffers from both a shortage and geographic misdistribution of healthcare resources (Equipment, Personnel, etc.). This scenario can be analogous to pouring water on a drowned mouse when the available patient care equipment's malfunctioning causes a delay in treatment or cause any fatality. In health sector, besides the knowledge and experience of doctors, actual diagnosis and appropriate patient treatment largely depends on numerous medical devices. In enormous number of serious health conditions, proper functionality of medical devices is essential and crucial for patients. Medical measurements are present in everyday life of people and are fundamental in the prevention, diagnosis, and treatment of disease. Because of the sensitivity of the field and direct link of measurements in support of health, a high interest lies in the role of metrological decisions and conformity assessment. Medical device calibration and tests are some of the surging and critical issues in the field of metrology. Patient safety is a must for the medical device industry and applications in the health sector. Therefore, all measurement devices used in the medical field must be controlled periodically, and all measurements must be standardized as a quality control regimen that guarantees the reliability of medical devices. It is high time that a new regulatory approach is introduced for the medical devices in use, facing the convergence between international policy enforcement and metrological regulations. Therefore, it is necessary to carry out a strict and independent testing of medical devices functionalities to attain an accurate and viable diagnosis and patient treatment.

IV-14

Prof. Sunil Dutt Sharma
Senior Scientist and Head
Medical Physics Section of Radiological Physics & Advisory Division,
Bhabha Atomic Research Centre, Mumbai, India

Prof. Sunil Dutt Sharma is a well-known researcher, renowned teacher and popular guide for many medical physicists of India and abroad. He is working in the field of medical physics and radiation safety from more than 28 years. His research interest is design & development of radiotherapy equipments and treatment accessories; dosimeters, phantoms, QA/QC tools and quality audit methods. He has authored 120 papers in peer reviewed high impact international journals. Prof. Sharma contributed significantly in medical physics education and training and he is the coordinator of prestigious Post MSc Diploma in Radiological Physics course. He is serving as Associate Editor of Journal of Medical Physics since 2006 and is currently he is the President of Association of Medical Physicists of India (AMPI).

Technological Advances in Radiation Therapy

Sunil Dutt Sharma, PhD

Radiological Physics & Advisory Division, Bhabha Atomic Research Centre, Mumbai, India

A variety of beam delivery devices are used in radiation therapy for treatment of different types of

cancer cases. Initially, Teleisotope Machines (Telecaesium and Telecobalt) were in use but now electron accelerator based systems has become mainstay treatment devices. Considering the need of conformal therapy and sparing of normal tissues and critical organs, a number of technological improvements have been made in Teleisotope as well as electron accelerator based beam delivery devices. Standard Telecobalt machines have been equipped with multileaf collimators to be used as a conformal treatment device and further technological improvements have been brought in specialized Telecobalt machines (gamma knife, view-ray) as well.

The technology of standard medical electron accelerator have been further improved with the addition of flattening filter free photon beams (a few fold enhancement in dose rates), multileaf collimators of improved spatial resolution, and magnetic reasonance imaging systems for onboard imaging (relatively better soft tissue contrast). The specialized medical electron accelerators (tomotherapy and cyber knife) have also been upgraded in the recent past to cover different types of cancer cases. The collimator system of cyber knife now contain adjustable collimator systems which eliminates the need of changing the cones during treatment of a patient. These technological advances has brought versatility in the treatment delivery systems and convenience in clinical use while treating different types of cancer cases.

In addition, particle therapy and heavy ion therapy (proton beam therapy, carbon ion therapy) facilities have also been added in many countries. Though the cost of installation and operation of proton and carbon ion therapy equipment are many fold higher than the cost of installation and operation of electron beam accelerators, the particle therapy systems have unique advantages in a few cancer cases. In addition, other mode of therapies (neutron capture therapy and nanoparticle assisted therapy) are also being explored.

All these systems have their own merits and demerits which need to be analyzed from the perspective of their clinical use. Now, it is the duty of the technical and clinical experts to select most useful treatment delivery systems for their institution/region/country. This selection should solely be based on the clinical requirements.

IV-15

Dr. K Siddique-e Rabbani
Honorary Professor (Post retirement, since 2016)
Founding Chairperson, (2008-2015)
Department of Biomedical Physics & Technology (BMPT), University of Dhaka
Director, Dhaka University Telemedicine Programme (run by BMPT)

Born in 1950, Professor K Siddique-e Rabbani did his Bachelors and Masters in Physics and PhD in Microelectronics. Joining the Physics Department of Dhaka University as an Assistant Professor in 1978 he chose research areas in Solar Energy and Biomedical Physics. In 2008 he became the first Chairperson of a new Department of Biomedical Physics & Technology, continuing till his retirement in 2015. He has been an Honorary Professor since 2016. Focusing on PhD level research, he steered the department to produce some world class research innovations which are acclaimed internationally. Side by side he established organisations to take the research outcomes to the people. He supervised more than 100 thesis students at Masters and PhD levels, wrote two books on Electronics, 10 book chapters - two of which were on one of his innovations, published more than 120 peer reviewed papers, and gave more than 140 invited lectures at home and abroad.

Rethinking some issues pertaining to Medical Physics

K Siddique-e Rabbani

Honorary Professor, Department of Biomedical Physics & Technology, University of Dhaka, Dhaka, Bangladesh

'Medical Physics' literally means physics as applied to medicine. However, due to historical reasons,

the name has been kept limited to the arena of ionising radiation only, which were the dominant topics in the early twentieth century, while other areas of Physics such as electricity, ultrasound, optics, etc., that have flourished subsequently in medicine and no less important than ionising radiation, are still out of the jurisdiction of 'Medical Physics', which is rather unfortunate. Bundling these later topics under 'Biomedical Engineering' has not done justice. 'Medical Physics' is the science behind 'Biomedical Engineering' and the distinction has to be appropriately defined.

The second point I want to raise is the level of education at which Medical Physics and Biomedical Engineering should be introduced. In radiation oncology, treatment planning of each patient is a research in itself. Unless 'Physics' as a science is well rooted in the 'Medical Physicist', it is not possible for that person to provide a proper treatment plan. I feel a student needs to have a thorough study of Physics in the undergraduate level and take up Medical Physics only at the post-graduate level. This is because Physics poses conceptual and analytical challenges requiring extreme concentration and practice which only can be acquired at the undergraduate level, and which cannot be done as one ages. On the other hand, medical concepts can be acquired by the brain later. Now having 'Medical Physics' at undergraduate level On the other hand putting in a lot of medical courses within the undergraduate courses, as is being done now in many universities of the world, clearly takes out the time necessary to master Physics, so we end up in having 'Medical Physicists' without adequate preparation. Once I was asked by a professional to think of posting a 'Physicist' side by side with a 'Medical Physicist' in order to do proper treatment planning. I find the same problem in Biomedical Engineering too, lack of adequate preparation in Physics. Therefore, this point needs to be thrashed out and corrected, if necessary at the earliest.

IV-16

Dr. Pratik Kumar
Professor & Head, Medical Physics Unit
Institute Rotary Cancer Hospital (IRCH)
All India Institute of Medical Sciences (AIIMS)
New Delhi, India

Publications of papers in national and international journals: 81

Chapter in Books: 5

Invited Talks / Presentations at conferences: 83

Proffered Papers in conferences as presenter / co-presenter: 160

Guide / co-guide in projects & research thesis: 34

AIIMS Excellence Research Award 2017 & 2019

Dr. Cyril Albert Jayachandran Endowment Oration 2019, Tamilnadu& Puducherry Chapter of Association of Medical Physicists of India (TN&PY AMPI) at Kanyakumari

Book Review & News Editor, Journal of Medical Physics and Member, Editorial Board, Indian Journal of Radiology & Imaging; Founding Editor, Medical Physics Gazette

Referee for Journal of Medical Physics, European J of Medical Physics, J of Luminescence, Radiation Measurement, Radiation Protection Dosimetry, Applied Radiation & Isotopes, Journal of Synchrotron Radiation, ThermochimicaActa, Radiation and Environmental Biophysics, Radiation Physics Chemistry, Australasian Physical and Engineering Sciences in Medicine, etc.

Properties Optimization of KCl:Sm3+ using TA-OSL for radiation dosimetry

Mini Agarwal, Sahil, Pratik Kumar

Medical Physics Unit, IRCH, AIIMS, New Delhi- 110 029, India

This paper reports the temperature dependence optically stimulated luminescence (TA-OSL)

properties of KCl:Sm in the temperature range of 40-310◦C. This nano phosphor was synthesized by the method of high-temperature solid-state reaction with optimum dopant (Sm) concentration. KCl:Sm is found to be polycrystalline in nature with average grain size 30-70 nm and has been confirmed from XRD. KCl:Sm showed good TA-OSL intensity at 100◦C (at a fixed dose of 10 Gy of gamma photons). KCl:Sm showed linearity till 500Gy (at a fixed temperature of 100◦C) after that it got saturated. The Arrhenius analysis estimated the activation energy of traps are Ea = 0.2 ± 0.05 eV. In this work the TA-OSL properties confirms the presence of continuous distribution of deep level defects of nanophosphor KCl:Sm. The temperature dependence characteristics of KCl:Sm with respect to gamma photons have been discussed with reference to medical as well as high radiation dosimetry.
Keywords:KCl:Sm, Temperature dependence OSL (TA-OSL), Deep traps, and Thermal activation energy.

IV-17

Prof Martin Ebert
Director of Physics Research, Radiation Oncology
Sir Charles Gairdner Hospital, Perth, Western Australia
School of Physics, Mathematics and Computing
University of Western Australia
Western Australia

After becoming a certified clinical physicist and working clinically for approximately 10 years, Prof Ebert became a full-time researcher, coordinating research activity in Radiation Oncology at the Sir Charles Gairdner Hospital and University of Western Australia in Perth, Australia. His work has focused on extraction of information from clinical trial data to predict the impact of clinical technologies and to identify safer, more effective methods of radiotherapy treatment. This work now includes support for imaging and theranostics clinical trials, particularly in the context of systemic disease. Prof Ebert also has a long-term interest in radiobiology and the importance of tumour microenvironment for treatment response, and he now works with medical oncologists and immunologists to discover how the effect of combined radiotherapy and immunotherapy can be optimised.

Remembering the importance of biology in radiotherapy

Dr. Martin A Ebert

Sir Charles Gairdner Hospital, Perth, Western Australia

Abstract: Physics has contributed much to the development of radiotherapy. The last 30 years have seen physics lead expansive technological developments ranging from CT-based planning to beam intensity-modulation driven by inverse optimization, and the high-accuracy delivery of potentially-lethal radiation doses guided by advanced imaging methods. Amidst the frenzy of technological advancement, which is currently embracing the coming age of artificial intelligence, it is easy for physicists to lose sight of some of the biological factors that underpin the radiotherapy process. And yet, it is an understanding of the biology that provides the largest potential impact on treatment efficacy. An example is the excitement associated with radiotherapy at extremely-high dose rates (i.e. “flash” radiotherapy) which was originally identified over 50 years ago, though which represents a departure from the technological norm. In this presentation, the current status of radiotherapy will be assessed relative to an understanding of radiobiology. Opportunities for improving treatment outcomes, which benefit from a clearer biological understanding, will be identified. This will focus on two main examples - 1) the opportunities to use systemic approaches (e.g. immune response) to improve efficacy, and 2) the need to collect data on patients after treatment to build a population-level understanding of response.

IV-18

Dr Pradip Deb
Senior researcher in Medical Radiations
Radiation Safety Officer
School of Health and Biomedical Sciences
RMIT University, Melbourne, Australia

Dr. Pradip Deb obtained BSc Honours and MSc in Physics from the University of Chittagong, MAppSc in Medical Physics from Queensland University of Technology, and PhD in Nuclear Physics from the University of Melbourne, Australia. He was a Melbourne University Research Scholarship recipient. Previously he worked in the University of Melbourne, the Ohio State University, and the University of Tasmania. His research interest includes physics education, radiation dosimetry, radiation safety and protection.

Misconceptions of radiation: what can be done

Pradip Deb

Discipline of Medical Radiation, School of Health and Biomedical Sciences, RMIT University, Melbourne, Australia

Introduction: Radiation is an important aspect of human life. We interact with radiation from several sources, both natural and manmade. On average more than 6 mSv of radiation dose are exposed on us annually of which 3 mSv are from natural sources and 3.2 mSv come from manmade ionizing radiations. Ionizing radiations are widely used for diagnostic and therapeutic purposes and hence saving millions of lives every year. About 14% of the world's electric powers are generated by using radioactive materials from over 440 commercial nuclear power reactors in 30 countries around the world. Although the radiation is so useful, the radiation issue is a long-time global taboo. General public do not understand clearly the concept of radiation energy, effective dose and the effects of radiation on life and environment. The concept of radiation is mainly transmitted by media especially after the occurrence of radiation accidents like Chernobyl or Fukushima.

Material and Method: In this paper conceptions and misconceptions about radiations among health professionals, university level students, and general public will be discussed. Results of conception surveys among nurses, medical radiations and pharmacy students will be presented and analysed.
Results and Discussion: The information transmitted via media is often biased and sensational which increases the public's fear of radiation. Encouraged by the media, general public portray any nuclear accident as extremely dangerous event which can undermine human civilization causing millions of deaths, which is far from the truth. Nuclear energy is environmentally clean and hence not responsible for global warming. But many people are reluctant to trust nuclear energy.

Conclusion: Public awareness needed to be increased and radiation facts should be available from reliable sources. Medical physics associations can play active role. In this talk the issues will be explained and some examples and suggestions will be presented.

IV-19

Franco Milano
Prof. of Medical Physics (Italy)

Franco Milano is a Professor of Medical Physics at the University of Florence, Italy. In addition to serving as a Research fellow for the Italian National Research Council, he is an appointed expert on behalf of the International Atomic Energy Agency (IAEA) in the areas of radiotherapy and diagnostic imaging. He has complete his M.Sc. in Physics (Nuclear Physics) from the University of Florence and Post-Graduation in Medical Physics from the University of Pisa. He is involved in a number of International activity in medical Physics training. He was the Director of the EFOMP Summer School on Medical Physics, Trieste 1998, Lecturer in ESTRO training course "Physics of Radiotherapy" from 2000 to 2006, Co-director and lecturer at the Medical Physics College organized by International Centre for Theoretical Physics (ICTP). He has also worked as a Visiting professor in many Universities.

Dose Limit and Dose Constraints in Shielding Planning of a MV Radiotherapy Facility

Franco Milano

University of Florence, Italy

ICRP Publication 103 and IAEA Basic Safety Standards (IAEA SSS No.GSR Part 3, 2014) emphasize the key role of the principle of optimization and retains the term 'Dose Constraint' for an individual level of dose in planned exposure situations. The ICRP Publication 103 definition of Dose Constraints is "a prospective and source-related restriction on the individual dose from a source in planned exposure situations (except in medical exposure of patients), which serves as an upper bound on the predicted dose in the optimisation of protection for that source. It is a level of dose above which it is unlikely that protection is optimised for a given source of exposure, and for which, therefore, action must almost always be taken. Dose constraints for planned situations represent a basic level of protection and will always be lower than the pertinent dose limit. During planning it must be ensured that the source concerned does not imply doses exceeding the constraint. Optimisation of protection will establish an acceptable level of dose below the constraint. This optimised level then becomes the expected outcome of the planned protective actions." In the preentation the Author discusses the practical application of the optimization principle with particular regard to compliance with the Dose Constraints during the design phase of the shielding of a bunker complex for radiotherapy treatments with modern external beams irradiation techniques.

IV-20

Dr. Karthick Raj Mani
Consultant & Chief Medical Physicist
Radiation Oncology Unit, United Hospital Ltd

Dr. Karthick Raj Mani was born on 19th November 1981 in Coimbatore, India. He is currently working as a Consultant & Chief Medical Physicist in the Radiation Oncology Unit, United Hospital, Dhaka, Bangladesh. He has 16 years of clinical experience as a Radiation Oncology Medical Physicist. He has done Doctor of Philosophy from the Department of Medical Physics, Bharathiar University,

Coimbatore, India. He has 21 Peer-Reviewed International Publications & several Conference presentations. He has the Radiological Safety Officer (RSO) Certification from BARC, Mumbai, India in 2005 and the Board Certification in Radiation Oncology from the College of Medical Physics of India (CMPI) in 2010. He Supervised various postgraduate and graduate Medical Physics Thesis in India and Bangladesh. Worked as a part-time teaching faculty for M.S (Medical Physics) students in the Department of Biomedical Physics & Technology, University of Dhaka, Bangladesh from 2015 to 2017.

Single institutional experience of testing IAEA - AAPM Code of practice for small static fields used in external beam radiotherapy

Karthick Raj Mani

Department of Radiation Oncology, United Hospital, Gulshan, Dhaka -1212, Bangladesh

Aim: To test the Technical Report Series (TRS) 483, jointly developed by International Atomic Energy Agency (IAEA) and The American Association of Physicists in Medicine (AAPM), for the dosimetry of small static photon fields used in external beam radiotherapy.

Materials and Methods: We tested the code of practice (CoP) through determination of beam quality index of the reference field [TPR20,10(10) and %dd (10) X] from the small fields using Palman's equation, cross calibration and reference dosimetry using a machine-specific reference (msr) fields and field output factors for field size ranging from 0.5 x 0.5 to 10 x 10 cm2. 6 MV and 10 MV with flattening filter (WFF) and flattening free filter (FFF) photon beams were tested using the CoP. The cross calibration for the msr field were carried out between the FC65-G farmer type chamber with CC-13 and CC-01 chambers. The output factors were measured using the photon field diodes, electron field diodes, CC-01 & CC13 for all the 6 WFF, 6FFF, 10WFF and 10FFF.

Results & Discussion: Measurements were made with two linear accelerators True Beam and Clinac 2100 DMX (M/S Varian Medical systems, USA). There were two diodes and three ionization chambers were used in the testing of the CoP. The beam quality index TPR20,10(10) and %dd(10)X determined using the Palman's equation from the small msr fields were with ± 0.1% from the measured values. The cross calibration in the msr fields between the chambers were resulted with ± 0.3%. The output factors measured using various detectors and corrected according to the CoP were resulted with ± 1%. The preliminary results of the CoP were consistent and improve the variations between the detectors. The CoP has no issues in putting into clinical practice for reference and relative dosimetry in small static photon beams.

Acknowledgement: The authors would like to acknowledge assistance received from the International Atomic Energy Agency through Coordinated Research Projects on Testing of Small Field Dosimetry (code E24021, Contract No: 19185/R1).

IV-21

Dr. Raju Prasad Srivastava
Medical Physicist
Department of Radiation therapy
Ghent University Hospital Gent, Belgium

Dr. Raju Prasad Srivastava is a Medical Physicist at Department of Radiation therapy, University Hospital Ghent, CorneelHeymanslaan 10, 9000 Gent, Belgium. He is also a Medical Physicist at Department of Radiotherapy, Centre Hospitalier de Mouscron Avenue de Fécamp, 49 B-7700 Mouscron, Belgium. He achieved his MS in Physics from Tribhuvan University, Kathmandu, Nepal (1994-1997). He achieved diploma in Radiological Physics, BARC, Mumbai, India (1999-2000) and

"Master of Science in de medischestrlingsfysica" NARIC, Belgium. In 2012, he completes his PhD in Medical Physics from Ghent University Hospital, Ghent University, Belgium.

Stereotactic radiotherapy (SRT) with Rapid Arc: Challenge and Implementation into Routine Clinical Work

Raju Srivastava[1, 2]

1. Ghent University Hospital, Department of Radiation Oncology, CorneelHeymanslaan 10, 9000 Gent
2. Centre Hospitalier de Mouscron, Radiothérapie département, Avenue de Fécamp, 49 B-7700 Mouscron

Introduction: Intracranial brain lesions have been treated with stereotactic radiosurgery (SRS) or stereotactic radiotherapy (SRT) dedicated to the high dose and high precision technique. High doses delivering to the tumor per fraction needs high conformity and steep dose fall-off to avoid or minimize organs at risk (OAR). Currently, linear accelerators have improved in geometric and dosimetric accuracy and approve more advanced treatment optimization and delivery techniques like SRS and SRT, SBRT, etc. The purpose of the work to help medical physicists to start stereotactic radiotherapy treatments (SRS, SRT, SBRT) into routine clinical work.

Material and Methods: Twenty-five patients SRT of intracranial brain with single or multiple lesions have been included in this study. The work was done with 6 MV photon beams on Varian ClinaciX accelerators equipped with a Millennium 120 multileaf collimator (MLC). The RapidArc plan was generated in the Eclipse TPS (v15.4), having Acuros XB algorithm, in the dose-to-medium dose reporting mode, with 1-mm calculation grid size. Ruby phantom with microDiamond detector was used to measure point dose. Portal dosimetry and volumetric Octavius 4D with 1000SRS detector has been used for patient specific QA.

Results and Discussion: The microDiamond measurements with Ruby phantom were ± 3% agreement with TPS. The results demonstrated that the gamma pass rates for all the plans were higher than ≤ 98.6 % ± 0.8 by volumetric 3D analysis, where a 10% low-dose threshold was fixed. The standard of our department has been established 97% or greater for the γ-index for all SRT plans. Portal dosimetry results showed γ-index 99.5 % ± 0.3 in 2D. The analysis was done with 5% threshold of reason of interest.

Conclusion: The study confirmed that measurements with microDiamond and patient specific QA provided a clear and practical overview regarding the expected accuracy and their possible application for SRT treatment in clinical routine work.

IV-22

Md Akhtaruzzaman, PhD
Senior Medical Physicist
Labaid Cancer Hospital and Super Speciality Center
Dhaka, Bangladesh

Dr. Md Akhtaruzzaman (Akhtar) has completed his graduation in Medical Physics in 2009 from the Department of Medical Physics and Biomedical Engineering of Gono Bishwabidyalay (University), Dhaka. In the same year, he got the opportunity to start his professional career as a faculty member of medical physics at the same university because of his academic excellence. Later on, he moved to Ahsania Mission Cancer and General Hospital, Dhaka to enrich his professional skills in Radiation Oncology Physics and to work directly with the patients suffering from a deadly disease called cancer. Dr. Akhtaruzzaman is currently working as Head of Medical Physics at the Labaid Cancer Hospital with his dedication and sincerity since November 2018. However, in the meantime, he has been

awarded as a Doctor of Philosophy (PhD) in Medical Physics from the Maria Sklodowska-Curie National Research Institute of Oncology, Warsaw, Poland.
He also has published his research works in the national and international journals. Moreover, he has co-supervised over 10 B.Sc./M.Sc.projects Thesis. Dr. Akhtaruzzaman, is currently contributing to BMPS as General Secretary and always actively work for any conference or workshop organized by BMPS. He is also a member of the Science Committee of the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP).

Delivery of VMAT technique for whole breast irradiation with five fractions (FAST-Forward trial)- an initial experience in Bangladesh

M. Akhtaruzzaman[1], S. K. Farid, M. A. Sumon[1,2], M. J. Islam[1], N. Islam[1], M. A. Mannan[1], A. P. Chowdhury[1], A.F.M.K Uddin[1,3]

1. Labaid Cancer Hospital and Superspecialty Centre, Dhaka, Bangladesh
2. Kurmitola General Hospital, Dhaka, Bangladesh
3. National Institute of ENT, Dhaka, Bangladesh

Purpose: To investigate the dosimetric properties of volumetric modulated arc therapy (VMAT) in compare to three dimensional radiotherapy (3DCRT) treatment techniques for whole breast irradiation with five fractions regimen according to Fast-Forward trial.

Materials and Methods: Recently, we treated 9 patients with carcinoma of breast after breast conserving surgery. The dose prescription to the PTV was 26 Gy in five fractions. Treatment plans were performed using volumetric modulated arc therapy (VMAT) technique by Eclipse treatment planning system. Dose volume histograms (DVH) for the PTV and the organs at risk (OARs)-ipsilateral lung and heart were compared with three dimensional radiation therapy (3DCRT) technique as stated in FAST-Forward trial (PTV, D95 >95%, D5<105%, D2<107% and Dmax<110%; ipsilateral lung, D15<8Gy; Heart, D30<1.5Gy and D5<7Gy). Conformity index (CI), homogeneity index (HI) and dose to the other OARs- contralateral lungs, contralateral breast, left anterior descending artery (LAD), Liver and brachial plexus were also investigated.

Results: D95, D5, D2 and Dmax for PTV were 97.75±1.12, 105.2±0.82, 105.90±0.89 and 109.36±1.00 respectively in compare to 95.0%, 105.0%, 107.0% and 110.0%. We investigated the CI as 1.07±0.05 and HI as 0.11±0.02. For ipsilateral lung D15, D35 and D50 were 7.36Gy±0.93, 3.60Gy±0.83 and 2.70Gy±0.72. For Heart, D30 and D5 and Dmeanwere 1.58Gy±0.31, 3.53Gy±1.40 and 1.53±0.40. Dose to the contralateral lungs (D10), contralateral breast (D5) were 2.85Gy±0.85 and 3.90Gy±1.00 respectively. Mean dose for LAD and Liver were 4.57Gy±2.00 and 3.15Gy±1.75 respectively. Maximum dose for brachial plexus was 2.74Gy±1.68.

Conclusions: With VMAT technique, the treatment plans were highly conform with better PTV coverage as well as lower dose to the OARs.

Mini-Symposium

Mini symposium – I: Education & Training in AFOMP Region

Course Objectives: In the modern profession of medical physicists, their training and education is extremely important. This is because the impact on their skills on MP's competences is certainly comparable if not greater than their ability to do research. It should also be emphasized that, due to the technological advancements of equipment, software and methods, long life training is also of great importance to allow all Medical Physicists to maintain their professionalism.

MS-01

Franco Milano
Prof. of Medical Physics (Italy)

Franco Milano is a Professor of Medical Physics at the University of Florence, Italy. In addition to serving as a Research fellow for the Italian National Research Council, he is an appointed expert on behalf of the International Atomic Energy Agency (IAEA) in the areas of radiotherapy and diagnostic imaging. He has complete his M.Sc. in Physics (Nuclear Physics) from the University of Florence and Post-Graduation in Medical Physics from the University of Pisa. He is involved in a number of International activity in medical Physics training. He was the Director of the EFOMP Summer School on Medical Physics, Trieste 1998, Lecturer in ESTRO training course "Physics of Radiotherapy" from 2000 to 2006, Co-director and lecturer at the Medical Physics College organized by International Centre for Theoretical Physics (ICTP). He has also worked as a Visiting professor in many Universities.

Work in Progress for AFOMP Syllabus

Milano F.

University of Florence, Florence, Italy

Introduction: Merriam-Webster gives this definition of a Syllabus: a summary outline of a discourse, treatise, or course of study or of examination requirements. A syllabus is therefore an indispensable tool that allows teachers to be efficient in training each of their students regardless of the discipline taught. Many medical physics Organizations have issued their own syllabus which obviously takes into account National, or Federation of Organization's needs. AFOMP due to the complexity of its structure linked to the heterogeneity of the Organizations within it and to the high number of medical physicists has deemed it essential to provide itself with this tool focused on its needs.

Methods: A working group (WG) has been formed to draft an AFOMP Syllabus which will then be submitted to the observations of each individual AFOMP member.

Conclusion: The presentation will briefly illustrate the problems faced by the WG and at the same time wants to inform the AFOMP Medical Physicists about this initiative

MS-02

Prof. Dr. Golam Abu Zakaria
Prof. of Clinical Engineering,
Anhalt University of Applied Sciences,
Koethen, Germany (EFOMP)

Dr. Golam Zakaria is currently the Prof. of Clinical Engineering in the Anhalt University of Applied Sciences, Koethen, Germany.After his post-graduate studies on medical physics at the University of Goettingen, he received his doctorate in medical physics at the University of Heidelberg in 1986. From 1987, Prof. Dr. Zakaria was chairman and chief medical physicist of the independent Department of Medical Radiation Physics at Gummersbach Hospital, an academic teaching hospital of the University of Cologne. In 1990 Dr. Zakaria was recognized as a qualified expert in medical physics (radio-oncology, nuclear medicine and radiological diagnostic) by the German Society for Medical Physics (DGMP). Prof. Zakaria has been invited as Guest/honorary/adjunct professor in many institutes or universities in Germany, Italy, China, India and Bangladesh. Furthermore, he set up cooperation with various institutes, hospitals and universities in all those countries for teacher- student- exchange programs and medical physicists training.

Prof. Dr. Zakaria is also the founder chairman of the "South Asia Centre for Medical Physics and Cancer Research" in Dhaka, Bangladesh (was founded July 2018). Dr. Zakaria is nominated as the Accreditation Committee-2 Chair (Radio-Oncology Physics) of the International Medical Physics Certification Board (IMPCB) since January 2018 and Vice Chair of the International Organization Medical Physics (IOMP) Accreditation Board since October 2018. He is one of the member of EFOMP Working Group on "Artificial Intelligence"

South Asia Centre for Medical Physics and Cancer Research: A Good Example of Regional Cooperation

G. A. Zakaria[1,2,] H.A. Azhari1[3], M. Shemanto[1], V. Steil[4], F. Hensley[5]

. 1 South Asia Centre for Medical Physics and Cancer Research, Bangladesh
. 2 Anhalt University of Applied Sciences, Germany
. 3 United International University, Bangladesh
. 4 University Medical Center Mannheim, Germany
. 5 Heidelberg University, Germany

Purpose: Cancer is a leading cause of death worldwide. South Asian countries face a big challenge in all key components of cancer control such as prevention, early detection, diagnosis, treatment and rehabilitation. This well-known fact indicates that this region needs strategies to improve cancer management.

Material and Methods: In Bengali-German cooperation with the support of the German Academic Exchange Service, the education, training and research on medical physics in Bangladesh are continuing its development since 1996. The South Asia Centre for Medical Physics and Cancer Research (SCMPCR) has started its journey in 2018 with a mission to advance cancer care practice in Bangladesh and in other countries in South Asia by disseminating scientific information, fostering the educational and professional development and promoting the highest quality medical services for patients.

Results: The SCMPCR frequently organizes programs like cancer awareness, screening, and training of all cancer care professionals, especially medical physicists and radiation oncologists. SCMPCR also supports groups of cancer patients through self-help group, to expand the communication between

them for their own health aids and to alleviate symptoms. Until August 2021, SCMPCR arranged five IOMP and EBAMP accredited hands-on workshop, three in-service training, and four e-learning programs for the cancer care related professionals of the South Asia region with qualified experts. Besides, SCMPCR publishes newsletters bi-annually to represent its activities and the landscape of cancer care in the region.

Conclusion: SCMPCR has a long way to go to reach the motto "Quality Education and Health Science for Patient Benefit". It could play an important role to produce manpower to meet the challenge of 21 century's medicine especially for an advanced cancer treatment in South Asian region and beyond specially in Africa.

Keywords: South Asia, Medical Physics, Hands-on Training, E-learning, Awareness, Screening

MS-03

Prof. Dr. Arun Chougule
President, AFOMP

Dr. Arun Chougule is the Senior Professor and Head of Department of Radiological Physics, SMS Medical College & Hospitals, Jaipur, Ex. Pro Vice Chancellor, Rajasthan University of Health Sciences and Dean Faculty of Paramedical Science, Jaipur India. He has 37 years of professional and teaching experience in medical physics. He is considered as one of the pioneers in radiation experiment dosimetry and radiobiology in India. He has been on many significant positions and member to countless committee and organizations. He is the past President of Association of Medical Physicist of India (AMPI) and currently he is President of Asia-Oceania Federation of Organization for Medical Physics (AFOMP) and Chair of education and training committee of International Organization of Medical Physics (IOMP), Chairman IOMP Accreditation Board. He is member of Board of Directors of International Medical Physics Certification Board [IMPCB]. He has more than 120 publications in national and international journals and presented more than 350 papers in national and international conferences. He has been authoring to two books. His research interest includes radiation biology, experimental dosimetry in teletherapy, radiation safety and protection in radiology and radiotherapy, QA-QC in Radiology.

He has served as an expert to IAEA and has been regular associate to ICTP for 8 years. He has done a significant work for radiation safety Training programs of VLIR, Belgium, for many years as key resource person. He has been awarded with numerous fellowships and awards mainly IOMP-IDMP 2016 for contribution of Medical Physics, AFOMP Member Excellent Presentation Awards, Outstanding Faculty award 2019 SMS Medical College, Govt. of Rajasthan, Dr. Farukh Abdulla Sher – e- Kashmir best researcher award for 2011-12. Recently he has been awarded as AFOMP outstanding medical physicists 2020 for his contribution to Medical Physics education, research and professional development. His contribution to health sciences and awarded prestigious fellow National Academy of Medical Sciences- FAMS in 2021. He is associated with over 27 national and international scientific organizations, Associate editor of 4 international journals and editorial board member of many journals. He is associate with many NGO's working in the field of cancer awareness. He is very widely travelled across the world.

Education and Training of Medical Physicists - AFOMP Initiatives

Arun Chougule

President AFOMP

Clinical Medical physicists are health professionals and therefore medical physicists working in clinical environment should have required competency and therefore undergo structured clinical training program and residency under experienced medical physicist in recognized institution. Further medical physics is a fast-growing area needing high degree of knowledgeand professional competency due to the rise in complexity of treatment procedures,increasing access to medical technology and the requirement of coordination betweenmedicine, physics, and biomedical engineering areas. The unprecedented surge in medicalphysics competency in the last 2- 3 decades is due to implementation of specialized physicsintensive procedures such as particle therapy, image guided and intra operative radiotherapy, advanced imaging, and nuclear medicine techniques. In this scenario to handle this new technology era the quantity of qualified medical physicist needs to be in consonance with the competency needed. There is a special requirement for education and training of medicalphysicists which lead to opening of numerous educational programs around the world and soin AFOMP region. However, if we look at socio-economic & educational status of AFOMPcountries we find huge diversity, further there are no unified guidelines as Euratom forEuropean region/EU and therefore task of AFOMP to homogenise the medical Physicseducation and profession is quite challenging. We have conducted a survey to access themedical physics and education status in AFOMP region and found that out 21 countries, 14 countries have the structured medical physics education program and only 07 countries have the mandatory residency program and accreditation. Further there is huge gap in availability of CQMP in AFOMP region, 20 MP/ million populations to 0.5 MP/ million populationwhereas compared to US- Canada [25 MP/ million] and Europe [13 MP/ million] the numberof medical physicists for one million populations is in AFOMP region is only 2.7, that showshuge potential to ramp up the structured education and training of medical physicists inAFOMP region to cope up the need. To cater to the needs of the medical physicists and their education, AFOMP has created Professional development committee (PDC), Education and training Committee (ETC), Scientific Committee (SC) to work on number of important tasks. These committees have drafted policy statements to deal with minimum level of education and training of medical physics, continuous professional development, and career progression for clinical medical physicist in AFOMP countries. However, the situation in AFOMP region is veryheterogenous and therefore AFOMP has form a task group under Chairmanship of Prof.Franco Milano to draft a model syllabus for Master's in Medical Physics. Task group hasalready conducted two web-based meetings to frame out the syllabus considering existingsyllabuses being followed in AFOMP countries to harmonise a basic minimum syllabusencompassing the recommendations of IAEA/IOMP. The details of the initiative will bepresented in the communication.

- MS-04

Dr. Frank William Hensley
Medical Physicist and Researcher
Dept. of Radiation Oncology
University Hospital Heidelberg, Germany

Physicist, since 1978 specialization in Medical Physics
Studies: 1974 Diploma in Physics (Nuclear Physics, University of Heidelberg)
Ph.D.: 1979 Dr.rer.nat. (Nuclear Physics & Astrophysics, University of Heidelberg)
Professional: Since 1978 specialization in Medical Physics

1990 to 11.2014: Medical Physicist and researcher at Dept. of Radiation Oncology/ University Hospital Heidelberg

Main focus: Dosimetry, Brachytherapy, Intraoperative Radiotherapy, Total Body and Total Skin Radiotherapy, general Radiotherapy Physics with Photons and Electrons

Teaching: Lecturer in Radiation Physics and Radiation Protection at:
Heidelberg University Medical School
Karlsruhe Institut für Technologie (KIT)
Forschungszentrum für Technik und Umwelt (FTU)
European School of Medical Physics (ESMP), Archamps
Summer Schools in Medical Physics, Santiago, Chile
Gono University, Dhaka, Bangladesh

Organisation of Practical Training in Medical Physics

F. Hensley[1],V. Steil[2], H. A. Azhari[3,4], G. A. Zakaria[3,5]

1. University of Heidelberg, Heidelberg, Germany
2. Radiooncology, University Medical Center Mannheim, Mannheim, Germany
3. South Asia Centre for Medical Physics and Cancer Research, Dhaka, Bangladesh
4. Centre for Biomedical Science and Engineering, United International University (UIU), United City, Madani Avenue, Badda, Dhaka - 1212, Bangladesh
5. Ex-Gummersbach Hospital of Klinikum Oberberg, Medical Radiation Physics, Teaching Hospital of the University Cologne, Gummersbach, Germany

Practical training is an essential part of medical physics education which must be provided by hospitals within their patient services. Such training cannot efficiently be offered by universities as these usually do not have the necessary full range of active diagnostic and therapeutic equipment to teach their handling and quality assurance. Additionally, practical training must provide sufficient experience in therapy planning, application of diagnostic equipment, and realistic decisions in real-life patient situations. Therefore, accreditation programs of medical physics professional societies such as IOMP (International Organisation for Medical Physics), EFOMP (European Federation of Organisations for Medical Physics) und AAPM (American Association of Physicists in Medicine) require a minimum of two years of structured practical clinical training in form of hospital-based residencies. Most countries worldwide do not meet these requirements, largely due to lack of interest of hospitals to improve their own quality by installing adequately payed trainee positions.

IAEA (International Atomic Energy Agency) recommendations [1,2,3] give guidance to implement clinical training programs for medical physicists. Important first steps are the installation of steering committees and supervisors which design and coordinate a curriculum and a structured training program leading to professional accreditation of medical physicists.

Many countries have yet failed to install regulations on topics such as medical radiation protection, definition of professional qualification standards, and obligatory professional participation of medical physicists in fields of radiation medicine requiring this collaboration. In such countries, medical physicists can and should take the initiative, and develop and implement structured training programs in medical physics themselves, in collaboration with the respective professional societies, with national and educational institutions, and with the hospitals.

1. IAEA TCS 37: Clinical training of medical physicists specializing in radiation oncology. IAEA, Vienna, 2009
2. IAEA TCS 47: Clinical training of medical physicists specializing in diagnostic radiology. IAEA, Vienna, 2010
3. IAEA TCS 50: Clinical training of medical physicists specializing in nuclear medicine. IAEA, Vienna, 2011

MS-03
MS-05

Dr. Kanchan P. Adhikari
Associate Professor Medical Physics
National Academy of Medical Sciences
Bir Hospital, Kathmandu, Nepal

Dr. Adhikari also involved in academic and research activities in radiation used in medicine. Dr. Adhikari has been Involved in developing the Nuclear Law, monitoring, licensing and radiation survey of the facilities, preparation of inventory of radioisotopes, outreach and other relevant nuclear activities for the Ministry of Education, Science & Technology and Ministry of Health & Population of Nepal. Right now, he has been working as a committee member for developing Radiation Regulation. Dr. Adhikari has designed various national projects for International Atomic Energy Agency and also working as a National Project Counterpart (NPC) for different IAEA Technical Cooperation projects. Dr. Adhikari had presented papers at various forums & published papers in different journals. Dr. Adhikari is also affilated as a committeee member in different national and international societies.

Development of Medical physics in Nepal

Kanchan P Adhikari, PhD

Associate Professor Medical Physics, National Academy of Medical Sciences, Bir Hospital, General Secretary, Nepalese Association of Medical Physicist (NAMP)

Since 2008, after obtaining a membership of IAEA, the turning point of recognition of role and responsibilities of medical physicists ensued in Nepal. The main accomplishments include Radioactive Substances (Utilization & Regulation) Act has materialized effective as of July 2020. The finalized draft of regulations for safety and security of radiation sources required for operating radiation therapy, diagnostic radiology and nuclear medicine facility has already been completed through Ministry of Education Science & Technology with an active participation of medical physicist. Once it is carried out, role and responsibilities of medical physicists will be increased. Since 2012, Nepal has been involved in various Technical Cooperation projects associated with the IAEA with an active involvement of medical physicist from project designing to successful implementation of project as a national project counterpart. Therefore, the future of role and responsibilities of medical physicist in Nepal mainly depends on the infrastructure of a strong regulatory system and sustainable safety culture of radiation users. Despite all the challenges inherent, we are confident that recognition, role and responsibilities of medical physicists in Nepal will be enhanced and Nepalese Association of Medical Physicists could play its active role in promoting this field.

Key words: Medical Physicist, Radiation, Radioactive substances, Regulations, Safety

Mini Symposium –II: Medical physics challenges in the Middle East region

Course Objectives: The proposed mini-symposium on Medical physics challenges in the Middle East region is aimed to highlight the status of medical physics in the Middle East countries, with some focus on challenges related to education, training, equipment and number of Medical physicists (male/female). The economic diversity and the instability and conflicts in many countries in the MEFOMP region resulted in different tracks of development for medical physics in each country. This implies that enormous efforts must be exerted in order to support the development of the medical physics profession in some of the countries in the region. Medical Physics educational programs offering MSc degrees are currently available in some countries.

MS-06

Dr. Huda AL Naemi
MEFOMP President

Dr. Huda is Asst. Professor of medical biophysics research in radiology at Weill Cornell Medicine, Qatar. She is president of Middle East Federation of Organizations of Medical Physics (MEFOMP). She represents Qatar in several international meetings and conferences and work closely with global organizations such as International Atomic Energy Agency (IAEA).She is member of Awards & Honors and Accreditation committee of the International Organization for Medical Physics (IOMP). In 2017 she was awarded IOMP IDMP award.

Dr. Al Naemi was also awarded "The Healthcare Gold Medal" by The Institute of Physics and Engineering in Medicine (IPEM) on 23rd September 2019. In December 2017, she was awarded "The State Encouragement Award" for Medical Sciences Category, Doha Qatar.

Medical Physics in the Mefomp Region: Current Status 2021

Huda Al Naemi and Mohammad Hassan Kharita

Middle East Federation of Organizations of Medical Physics (MEFOMP) was established in 2009 with 12 participating countries: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen. This wok aims to update the information about medical physics in MEFOMP countries, with limited scope covering education, training, equipment and number of Medical physicists (male/female). The economic diversity and the instability and conflicts in many countries in the MEFOMP region resulted in different tracks of development for medical physics in each country. This implies that enormous efforts must be exerted in order to support the development of the medical physics profession in some of the countries in the region. Medical Physics educational programs offering MSc degrees are currently available in five countries: Iraq, Jordan, Lebanon, Saudi Arabia and Syria. Since, a national or regional certification system does not exist, as interim solution, MEFOMP in collaboration with the International Medical Physics Certification Board (IMPCB) performed certification exams, as some countries in the region started to accept IMCPB certification. The number of Medical Physicists per million ranges between 0.5 in Yemen to over 23 in Bahrain, while the average number for the MEFOMP countries is about 8 medical physicists per million. In MEFOMP countries, the average number of Teletherapy, CT and Nuclear Medicine units are 1, 13.4 and 2.8 units per million populations, respectively. MEFOMP has contributed a chapter to a recently published scientific book about medical physics during the COVID-19 pandemic, summarizing the different challenges faced during the outbreak of COVID-19 in MEFOMP countries.

MS-07

RabihHammoud
Chief Medical Physicist
Hamad Medical Corporation -Doha - Qatar
Assistant Professor of Medical Physics Research in Radiation Oncology,
Weill Cornell Medicine, Qatar

Dr. RabihHammoud is an American Board Certified Medical Physicist since 2004. He obtained his Master of Sciences Degree in Medical Physics from Wayne State University in US and completed his PhD at Universite De Bretagne Occidentale, in France in the same field.

He is an active member of several Medical Physics Societies locally and internationally like ASTRO, AAPM & ESTRO and an elected treasurer of Middle East Federation of Medical Physicist (MEFOMP). He has been invited as Faculty & Speaker of various activities of the medical and scientific societies as well as within HMC. He has also published numerous papers, book chapters & abstracts. Further, he is actively involved in IAEA activities as a participant to regional workshops and scientific meetings and an auditor for QUATRO expert mission. He hosted more than one IAEA Radiotherapy Courses. In addition, Dr. Hammoud is an examiner for the International Medical Physics Certification Board (IMPCB).

Impact of Covid-19 on Medical Physics in Qatar

RabihHammoud, Mohammad Hassan Kharita and Huda AlNaemi

The history of Medical physics started in Qatar as Hamad Medical Corporation (HMC) grew from three hospitals in the early 1980's, to 15 hospitals in 2021. Qatar Medical Physics Society (QaMPS) started in 2009 as a small group of medical physicists in Hamad Medical Corporation (HMC). The mission of QaMPS is to advance medical physics practice in Qatar and to promote and support the medical physics profession. QaMPS is one of the founding members of the Middle East Federation of Organization of Medical Physics (MEFOMP). The number of Medical physicists grew from 9 in 2009 to 38 in 2021. The number of Medical Physicists per million is about 13. The average number of Linacs, CT and Nuclear Medicine units are 1.9, 22.2 and 4.4 units per million populations, respectively. Medical Physicists in Qatar played a significant role during this unprecedented COVID-19 pandemic, both in sustaining its essential role to the healthcare system and in optimizing the preventive effort of humankind in the control of this pandemic.

MS-08

Dr. Huda AL Naemi
President of Kuwait Association of Medical (KAMP)
Vice President of middle east federation of medical physics (MEFOMP)
Lead Radiation Physics in Kuwait Cancer Control Centre

Dr. Meshari Al-Nuaimi has made outstanding contributions in the field of medical physics and radiation protection in medicine by his actions in establishing the first dedicated medical physics unit in Kuwait.He studied nuclear medicine science at Kuwait University and received Master degree and PhD in medical physics and biomedical engineering form University College London (UCL).
Dr. Al-Nuaimi is an autonomous worker committed to providing high quality medical physics and radiation safety services by utilizing the organizational, teaching and communication skills developed through my involvement as an expert in nuclear medicine, radiation protection, quality management and medical physics locally and regionally for the IAEA.
Dr. Al-Nuaimi has extensive experience in education and in providing training as a clinical instructor for allied health BSc students, medical physics tutor for Kuwait nuclear medicine residency program and key coordinator of many conferences, workshops and training courses in the region.
MEFOMP 2021 Virtual Conference: Expanding Knowledge and Meeting Challenges
MeshariAlNaaimi, Mohammad Hassan Kharita, RabihHammoud, RefaatAlMazrou, Abdalla Al-Haj and Huda AlNaemi
Virtual conferences in light of COVID-19 pandemic raise challenges for organizers, attendees and speakers. Nevertheless, they offer several advantages and have revolutionized the way professionals interact and how conferences of the future might look, even after the pandemic. The Middle East Federation of Organizations of Medical Physics (MEFOMP) in cooperation with the International Atomic Energy Agency (IAEA) organized a virtual medical physics conference that took place

between 5 and 7 of April 2021. The conference was endorsed by leading international medical physics organizations and accredited with continuous medical education credits.
The conference enabled attendees to have interactive free access to an in-depth view of future directions, latest advancements and lessons learned from COVID-19 pandemic delivered by internationally renowned leading experts in the field. To facilitate the conference technological demands and connect effectively with the remote audience, a special dedicated website was designed and developed with Zoom Webinar as a virtual platform and an experienced IT technical support team to manage the whole event. The virtual conference opened new possibilities in panel discussion and Q&A sessions. Attendees were asked to answer real time MCQ questions submitted at the end of each lecture. This resulted in a better quality of question and interaction with the attendees. In addition, recordings of presentations were available for download on the conference website. While the in person MEFOMP conference that took place in January 2020 just before the pandemic attracted just about 200 local participants, the virtual 2021 MEFOMP conference registered over 2,900 individuals from 81 countries. This indicated that MEFOMP virtual conference has succeeded to spread knowledge and updates, and made them accessible to a larger and more diverse audience. Some of the MEFOMP first virtual conference experiences, results and lessons learned are shared in this article.

Mini-Symposium -III: Setting up a certification board

COURSE OBJECTIVES: As many AFOMP colleagues are working on forming their own certification boards, several important questions deserve in depth exploration. This symposium is the forum for Asia Oceania medical physicists to revisit the recommendations of the IAEA TCS-71, starting from the IOMP point of view when the IMPCB was formed. The method and model used by IMPCB in the subsequent eleven years should be reviewed in detail. The IMPCB leadership will be ready to answer questions. The state of the art of diagnosis and treatments helped boost the demand of certified medical physicists. The solution to balance the demand is to improve the supply of highly qualified medical physicists. This should be done before the situation becomes critical. How to achieve this goal in the region and overcome the obstacles will be proposed by the speakers?

MS-09

Colin G. Orton, PhD
President - IMPCB, Past President – IOMP

Dr. Orton graduated with a Ph.D. in Radiation Physics from the University of London, England in 1966. He has worked as Director of Medical Physics at New York University School of Medicine (Assistant Professor 1966-1975), at Rhode Island Hospital and Brown University (Associate Professor 1975-1981), and at the Detroit Medical Center/Karmanos Cancer Institute and Wayne State University (Professor 1981-2003. While at Wayne State he directed of one of the first accredited medical physics graduate programs, with over 150 M.S. and Ph.D. graduates. He has served as President of the American Association of Physicists in Medicine (AAPM), Chairman of the American College of Medical Physics (ACMP), President of the International Organization for Medical Physics, the American Brachytherapy Society (ABS), and the International Union for Physical and Engineering Sciences in Medicine (IUPESM) and is currently President of the International Medical Physics Certification Board.

The Importance of Certification

Colin Orton

Wayne State University, Detroit, Michigan, USA

Topics to be addressed include:

- Why do we have certification of medical physicists?
- What are the educational and clinical training requirements to become a certified medical physicist?
- What are the requirements for maintenance of certification?
- What are the incentives for a medical physicist to become certified?
- How can Medical Physicists become certified?

MS-10

Raymond Wu, PhD
Chief Executive Officer – IMPCB

Raymond K. Wu, DABR, DABMP, FACMP, FAAPM, FIOMP earned his PhD degree in Physics in 1974. He completed his postdoctoral training in the Department of Radiation Therapy and Nuclear Medicine at Thomas Jefferson University Hospital in Philadelphia. He then joined Temple University Medical School in Philadelphia with joint appointments in the Radiotherapy and the Nuclear Medicine Departments. Since 1985, he was appointed Professor of Radiation Oncology at the Eastern Virginia Medical School in Virginia and served as the chief physicist in its affiliated hospitals. From 2002 to 2008 he was Chief of Physics in the Radiation Oncology Department of the OhioHealth Medical System in Ohio. From 2008 to 2015 he was the Chief of Physics in the Department of Radiation Oncology & CyberKnife of the University of Arizona Cancer Center, and of the Gamma Knife section of the Barrow Neurological Institute in Phoenix. Dr. Wu is currently the Chief Executive Officer of the International Medical Physics Certification Board.

Credential Verifications and Academic Course Work Requirements

Raymond Wu

CEO, International Medical Physics Certification Board, Pismo Beach, California, USA

It has been challenging under Covid-19 during the past two years. But IMPCB was able to overcome the problem and created the Zoom-based model for the Part III examinations. The speaker will show how the IMPCB volunteer committee members and staff review the credentials and academic course work records. He will show that financial resources are not the key element of success. Persistence and long-term commitments are the crucial elements to produce a credible system. The IAEA Report 71 provided the guidelines for certification of clinically qualified medical physicists. Following the paths outlined in the report, professional medical physics organizations in all countries can proceed with establishing the national certification boards. Such boards, if run by volunteer medical physicists meeting ethical standards who are interested in helping with identifying the most clinically qualified colleagues, will be able to create a base to build upon. The goal is to become trustworthy institutions in a few years that in the perspective of employers and clinical colleagues the medical physicists identified by the certification programs are indeed qualified and continue to be qualified. The symposium will focus on the AFOMP region towards achieving the goal.

MS-11

Adel Mustafa
Chief Examiner and Chair of Accreditation Committee, IMPCB
Email: adel.mustafa@yale.edu
Associate Professor of Clinical Radiology and Biomedical Imaging Yale University School of Medicine Director of Diagnostic Radiology Medical Physics Yale New Haven Hospital New Haven, Connecticut USA.

Career: More than 25 years of clinical and academic diagnostic medical physics covering radiology and nuclear medicine. Currently director of diagnostic medical physics at Yale University hospital and director of radiology resident's physics curriculum at Yale Medical School. Have had more than 16 years as chief physicist, radiation safety officer and academic faculty at the teaching hospital of New York Medical College in Manhattan, New York. Main interest in Image quality optimization and radiation dose management from all imaging modalities. Teaching faculty at several radiology residency programs in New York, New Jersey and Connecticut. Invited speaker at international radiology and medical physics conferences. Gave more than 70 presentations in 12 countries from 2004-2016. For 10 years I was committee member then Chief Editor of the nationally known RAPHEX physics preparation annual exam taken by residents in radiology and radiation oncology programs in the US. Also serving as oral examiner for diagnostic physics with the American Board of Radiology since 2004. Served and still serving as chair, co-chair and member of many professional AAPM committees. Organized and gave presentations at more than 12 international medical physics conferences sponsored by the AAPM in developing countries. Served as IAEA consultant. Very much interested in the IMPCB project and currently chairing accreditation committee 3 responsible for the Oral examination part.

The International Medical Physics Certification Board (IMPCB) Examination Delivery

Adel Mustafa

Chief Examiner and Accreditation Committee Chair, IMPCB
Yale School of Medicine, New Haven, CT, USA

Background: This is an introduction to IMPCB accreditation and examination processes. Will outline the accreditation requirements, application submission and approval process. Will also present the examination process for all three parts on both therapy and diagnostic physics tracks.

IMPCB Accreditation: The accreditation committee will review applications from recognized national organizations with professional structure seeking IMPCB guidance and recognition to start local certification programs accredited by IMPCB. A model program is available on IMPCB website under document V10a pdf. The program review would verify the application alignment with international professional training guidelines for medical physicists with emphasis on the applicant's education, professional training and the organization professional structure.

IMPCB exams: offered to medical physicists with no access to national or regional certification. The examination sub-committee will establish candidate's eligibility few months before the exams dates. Written part I covers general physics and introductory health sciences with radiobiology. Written part II covers medical physics specialty with specific knowledge across the discipline and Part III is an oral exam on the candidate clinical competences, professional judgment and communications skills. Each exam is three hours long. Current medical physics speciality examinations are on radiation oncology, Medical Imaging with Interventional Radiology Physics and Nuclear Medicine Physics. There are five different exam categories in the different specialties.

MS-12

Prof Tomas Kron, PhD, OAM
FIOMP, FCOMP, FCCPM, FACPSEM, FIUPSEM
Director of Physical Sciences
Peter MacCallum Cancer Centre
Department of Physical Sciences
e-mail: Tomas.Kron@petermac.org

Tomas Kron was born and educated in Germany. After his PhD he migrated to Australia in 1989 where he commenced his career in radiotherapy physics. From 2001 to 2005 he moved to Canada where he worked at the London Regional Cancer Centre on the commissioning of one of the first tomotherapy units. In 2005, Tomas became principal research physicist at Peter MacCallum Cancer Centre in Melbourne, Australia where he now is Director of Physical Sciences. Tomas holds academic appointments at Wollongong, RMIT and Melbourne Universities. He has an interest in education of medical physicists, dosimetry of ionising radiation, image guidance and clinical trials demonstrated by more than 90 invited conference presentations and 300 papers in refereed refereed journals.

The Alumni Program and Thoughts about CPD

Kron T[1], Wu R [2], Cheung KY[3], Mustafa A[4], Orton, C[5]

. 1 Peter MacCallum Cancer Centre, Melbourne, Australia
. 2 Chief Executive Officer – IMPCB, Eastern Virginia Medical School, Norfolk, VA, USA
. 3 Hong Kong Sanatorium & Hospital, Hong Kong SAR
. 4 Yale School of Medicine, Yale New Haven Hospital, New Haven, CT, USA
. 5 President – IMPCB, Wayne State University, Detroit, MI, USA

After more than 10 years the International Medical Physics Certification Board (IMPCB) has successfully established a program of certification of medical physicists in jurisdictions where no other certification board exists. By now 43 medical physicists in radiation oncology and imaging have become certified. In order to provide a forum for these Diplomates of IMPCB (DIMPCB) an informal organisation of alumni was formed in 2020. The group communicates mostly by email and exchanges information amongst its members with the objective to provide a forum for discussion of problems and 'staying in touch'. An important additional goal is to support medical physics colleagues who are intending to set up a local certification program in the future.

The alumni program also presents an opportunity to reach out to DIMPCBs in respect to Continuing Professional Development (CPD). Medical physics is a fast developing field and practitioners are expected to participate in regular CPD activities in order to maintain their competence. We have commenced to distribute literature links and communicate relevant webinars to alumni and it is hoped that this informal network can provide feedback to IMPCB as to how best to reach out to certified colleagues and document their participation in CPD.

MS-13

K Y Cheung
Past President IUPESM, Past President IOMP
Founding President of AFOMP
Hong Kong Sanatorium & Hospital
Hong Kong SAR

Professor Kin Yin Cheung is a Senior Medical Physicist at the Hong Kong Sanatorium & Hospital and Adjunct Associate Professor at the Department of Clinical Oncology at both University of Hong Kong

and Chinese University of Hong Kong. Throughout his 30 years of practice in the field of radiation oncology physics, he has experienced the transition from 2D to 3D radiotherapy treatment and contributed to the clinical implementation of more sophisticated treatment modalities, including SRS, IMRT, IGRT, motion compensated radiotherapy, Tomotherapy, and Linac-based and Cyberknife-based SBRT in Hong Kong. He has also contributed to the development and implementation of the physical aspect of quality assurance methodologies in support of these radiotherapy services. Currently, he is planning the installation and commissioning of the first proton therapy facility in Hong Kong. He has a keen interest in research and development in radiotherapy physics. He has published and presented more than 200 peer-reviewed papers, book chapters, and conference abstracts. He is the Founding President of AFOMP, former President of IOMP, and currently President of IUPESM.

Importance of International Accreditation of Local Certification Board- Hong Kong Experience

K Y Cheung,

Hong Kong Sanatorium & Hospital, Hong Kong SAR

Medical physicists practicing in healthcare should be trained and qualified to practice in a similar manner as other healthcare professionals. Professional certification and/or registration are accreditation processes recommended by international organizations such as IAEA and IOMP for qualifying clinical medical physicists. The HKIPM Medical Physicist Certification Board was established in 2013 to conduct professional certification of medical physicists practicing in Hong Kong. The standard and procedures used by the Certification Board and quality audit on the certification scheme as conducted by an independent competent body are important metrics implemented to ensure a high standard of practice of the certified medical physicists. The HKIPM Board was accredited by IMPCB in 2015. Being an independent international certification body, IMPCB accreditation effectively fills the gap of external quality audit in the medical physics profession in Hong Kong. This is one of the important considerations of the local healthcare authorities and medical institutions in recognition of the professional qualification and status of certified medical physicists. It also helps addressing the issue on quality standard in training and practice of medical physicists in our application for official registration of the profession in Hong Kong. IMPCB accreditation also provides the basis for establishing mutual recognition schemes between IMPCB accredited certification boards. The HKIPM Certification Board and the Korean Medical Physics Certification Board (KMPCB) have signed an MOU, which is effective from 1 January 2020, on a scheme of mutual recognition on professional certification granted by the two Boards to medical physicists practicing in the specialty of Radiation Oncology Physics in Hong Kong and Korea. The arrangement can potentially help promote development of the profession and the related clinical services.

MS-14

Professor Dr. Hasin Anupama Azhari
Director
Centre for Biomedical Science and Engineering
United International University (UIU)
Dhaka, Bangladesh

Dr. Hasin Anupama Azhari has academic experience more than 15 years in academic field and got many clinical trainings in radiation oncology and diagnostic radiology from India, Germany, Italy.

She has been awarded PhD in Medical Physics through a sandwich program between OWSD (Organization for Women in Science for the developing world ICTP, Trieste, Italy) and National University, Bangladesh. She has organized many national and international conferences and workshops. She acts as a reviewer for different national and international Journals and supervised many BSc projects, MSc thesis and PhD thesis. She has organized many national and international conferences in Medical Physics.

Prof. Dr. Azhari received the "International Day of Medical Physics award 2018" for AFOMP. She has collaborated different countries for development of Medical Physics education in international standard. She was a project coordinator for Bengal translation at EMITEL e-Encyclopedia of Medical Physics and Multilingual Dictionary and terms, a project of International Organization of Medical Physics (IOMP) from 2000-2015. She received best Paper publication award in Journal of Bangladesh physical Society and her another publication was in the top listed publication in the Zeitschrift for Medical Physics, Germany

Currently she is the executive member for Asia and Pacific Region, Organization for Women in Science for the Developing World (OWSDW), Italy; Secretary- General Asia–Oceania Federation of Organizations for Medical Physics, (AFOMP); CEO, South Asia centre for Medical Physics and Cancer Research (SCMPCR).

Experiance of Creating a New Board BMPCB

According to IOMP, Individual certification of medical physicists is mandatory to practice medical Physics profession. In this regard the International Medical Physics Certification Board (IMPCB) was formed on May 23rd 2010 by eleven charter member organizations in medical physics.

At the IOMP Council meeting during the World Congress 2015 in Toronto, the IOMP-IMPCB Memorandum of Understanding on Professional Certification of Medical Physicists was adopted. The International Organisation for Medical Physics (IOMP) has been designated the Principal Supporting Organization.

Developing countries like Bangladesh do not have the process of certification of Medical Physicists. IMPCB is assisting to develop certified Medical Physicists through a process including examination. Also IMPCB encourages to form own national certification board in each countries.

Bangladesh Medical Physics Society (BMPS) in the meantime has prepared constitution of Bangladesh Medical Physics Certification Board (BMPCB) as per guidelines of IMPCB. BMPCB is now one of the supporting organizations of IMPCB;

https://www.impcbdb.org/supporting-organizations/. We would like to develop experts of medical physicists who can capable to be an future examiners in BMPCB. In the constitution of BMPCB we have defined that for certain years we need help from IMPCB for recognition of independent activity of BMPCB.

Bangladesh has approached an enormous development in education, training in Medical Physics. Now it is the appropriate time for certification. BMPCB will be able to certify Medical Physicists in near future with national and international support.

Mini-Symposium -IV:Women for Women – connecting women health scientists for the benefit of women in the AFOMP region

COURSE OBJECTIVES: Networking of women Medical Physicists, Radiation and Health Scientists to share how to overcome challenges during pandemic, how to be entrepreneurial and even how to provide health services to women in low resource settings in remote and rural areas. Our objective, in addition to some senior presenters, is to give voice to younger female medical physicists from PhD students to early career researchers from a variety of countries in the AFOMP region.

MS-15

Prof. Eva Bezak, PhD, FACPSEM
Professor in Medical Radiation
University of South Australia
Director, Centre for Translational Cancer Research
UniSA Cancer Research Institute

Eva is Professor in Medical Radiations and Centre Director for Translational Cancer Research at the University of South Australia. Previously she was Chief Physicist at the Department of Medical Physics, Royal Adelaide Hospital. She has co-authored over 170 papers, 280 conference presentations and co-authored books on medical physics and supervised over 35 PhD/MSc students, specialising on computational radiation biology.
She is the vice-president of the Asia-Oceania Federation of Medical Physics, the Secretary General of IOMP, and a member of AC4: International Commission on Medical Physics of the International Union of Pure and Applied Physics. She is the past Chair of the International Union of Physical and Engineering Scientists in Medicine's Women in Medical Physics and Biomedical Engineering task group.

The Biggest Challenges Resulting from COVID-19 Pandemic on Gender-Related Work from Home in Biomedical Fields – World-Wide Qualitative Survey Analysis

E Bezak[1], KV Carson-Chahhoud1,[2,3], LG Marcu[1,4], M Stoeva[5], L Lhotska[6], G Barabino[7], F Ibrahim[8], S Lim[9], E Kaldoudi[10], AM Marques da Silva[11], P Tan[12], V Tsapaki[13], and M Frize[14]

1 Cancer Research Institute, University of South Australia, Adelaide SA 5001, Australia
2 Australian Centre for Precision Health, University of South Australia, Adelaide SA 5001, Australia
3 School of Medicine, University of Adelaide, Adelaide SA 5001, Australia
4 Faculty of Science, University of Oradea, 1 Universitatiistr, 410087 Oradea, Romania
5 Department of Diagnostic Imaging, Medical University of Plovdiv, Plovdiv, Bulgaria
6 Faculty of Biomedical Engineering, Czech Technical University in Prague, Prague 6, Czech Republic
7 Olin College of Engineering, Needham, MA 02492, USA
8 Department of Biomedical Engineering and Centre for Innovation in Medical Engineering, Faculty of Engineering, Universiti Malaya, 50603 Kuala Lumpur, Malaysia
9 School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore 637457
10 School of Medicine, Democritus University of Thrace, Alexandroupoli, Greece
11 School of Technology, Pontifical Catholic University of Rio Grande do Sul, PUCRS, Porto Alegre, Brazil
12 School of Engineering, Ngee Ann Polytechnic, Singapore
13 Medical Physics Dpt, Konstantopoulio General Hospitals, Athens, Greece
14 Dept of Systems and Computer Engineering, Carleton University, Ottawa, ON, Canada K1S 5B6

Background: This paper aims to present and discuss the most significant challenges encountered by

STEM professionals associated with remote working during the COVID-19 lockdown.

Methods: We performed a qualitative analysis of 921 responses from professionals from 76 countries to the open-ended question: "What has been most challenging during the lockdown for you, and/or your family?".

Findings: Participants reported challenges within the immediate family to include responsibilities for school, childcare, and children's wellbeing; and the loss of social interactions with family and friends. Participants reported increased domestic duties, blurred lines between home and work, and long workdays. Finding adequate workspace was a problem, and adaptations were necessary, especially when adults shared the same setting for working and children. Connectivity issues and concentration difficulties emerged. While some participants reported employers' expectations did not change, others revealed concerns about efficiency. Mental health issues were expressed as anxiety and depression symptoms, exhaustion and burnout, and no outlets for stress. Fear of becoming infected with COVID-19 and uncertainties about the future also emerged. Pressure points related to gender, relationship status and ethnicities were also evaluated. Public policies differed substantially across countries, raising concerns about the adherence to unnecessary restrictions, and similarly, not tight enough restrictions. Beyond challenges, some benefits emerged, such as increased productivity and less time spent getting ready for work and commuting. Confinement resulted in more quality time and stronger relationships with family.

Interpretation: Viewpoints on positive and negative aspects of remote working differed by gender. Females were more affected professionally, socially, and personally than males. Mental stress and the feeling of inadequate work efficiency in women was caused by employers' expectations and lack of flexibility. Working from home turned out to be challenging, primarily due to lack of preparedness, limited access to dedicated home-office, and lack of previous experience in multi-layer/multi-scale environments.

MS-16

Associate Professor NayanaParange
MBBS MS(Medical Sonography)
FICOG FASA FAMEE SFHEA AFHERDSA GradCertEd(Univ Teaching) PhD
Professorial Lead, Associate Professor: Medical Sonography
BJ1-24, Allied Health and Human Performance
City East Campus, University of South Australia

Associate Professor NayanaParangeis currently a Professorial Lead and Assoc Prof of medical sonography in Uni SA Allied Health and Human Performance. Her academic and professional background includes qualifications in medicine, specialist training in obstetrics and Gynecology, ultrasound and education. She has over 20 years of clinical ultrasound experience in diverse settings, ranging from primary health care to tertiary maternal fetal medicine setting. She has been instrumental in developing and delivering antenatal ultrasound training and education for many years to various health professional groups including outreach efforts. The aim of these educational initiatives is to facilitate adoption of evidence based practice and improve antenatal care in regional and remote communities to help reduce adverse pregnancy outcomes and thereby reduce maternal fetal mortality in regional, remote communities within Australia and developing countries.

Point of Care Ultrasound (POCUS) - a feasible solution to reduce inequities in antenatal care in low resourced settings

NayanaParange

City East Campus, University of South Australia

Inaccessibility of health services, inadequate or infrequent antenatal care are reported risk factors for infant and maternal mortality and morbidity. By 2030, WHO SDG 3 aim is to reduce the global

maternal mortality ratio to less than 70 per 100 000 live births, end preventable deaths of newborns and children under 5 years of age, and reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortalities to at least as low as 25 per 1000 live births.
A clear majority of many life-threatening problems for the mother and her baby's problems can be recognised on antenatal ultrasound, and most often, interventions can be applied to prevent mortality and morbidity. However, fewer pregnant women even in developed countries such as Australia have access to timely ultrasound services compared to women in metropolitan and regional areas. This problem is amplified in developing countries due to various barriers such as lack of trained specialists, cultural, geographical, economic as well as issues with infrastructure, technology and logistics.
This presentation will illustrate how Point of care ultrasound (POCUS) training of health care providers is one solution and can be an efficient way of upskilling health professionals in a short period of time to enable them to learn life-saving skills and provide equitable healthcare. Various examples of the author's community work across many disadvantaged regions in the world, as well as the research conducted by the author's team in this area will be shared.

MS-17

Assoc. Prof. Dr. Chai Hong Yeong, PhD, MIPM
School of Medicine
Faculty of Health and Medical Sciences
Taylor's University, Malaysia

Dr. Chai Hong Yeong is a medical physicist, a certified Radiation Protection Officer and an Associate Professor at the Taylor's University, Malaysia. She completed the IAEA Clinical Training of Medical Physicists Specialising in Diagnostic Radiology (DRMP) in 2014. Dr. Yeong is currently chairing the Professional Relations Committee of the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) 2019-2021. She is also the elected Vice President of the South-East Asia Federation of Organizations for Medical Physics (SEAFOMP) 2019-2021 and Vice President of the Malaysian Association of Medical Physics (MAMP). She is the recent awardee of the prestigious IUPAP Young Scientist Award 2021. She has also been awarded the SEAFOMP Young Leader Awards in 2017. Her research areas focus on theranostics, minimally invasive cancer therapies, 3D printing in medicine and radiomics. She has published more than 70 peer-reviewed journal articles, 2 academic books and 2 book chapters.

Women Entrepreneurship in Medical Physics

CH Yeong

School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, 47500 Subang Jaya, Malaysia

"I want every little girl who's been told she's bossy to be told again she has leadership skills" – this is a popular quote from Sherly Sandberg, the Chief Operating Officer of Meta Platforms (formerly "Facebook"), and the author of "Lean in". According to Sherly, while men are continually applauded for being ambitious and powerful and successful, women who display these same traits often pay a social penalty, or told that they are too aggressive. Gender bias is not new to everyone, but more often, the biases are engendered by the women themselves, primarily due to the lack of confidence and the culture of self-sacrificing for family or the loved ones. In this talk, the author is going to share about her experiences in starting up a business (a passion, to be exact) and what drove her to pursue the entrepreneurial journey. She will also share some tips on managing stresses and balancing between work and life from a woman's perspective.

MS-18

Mikaela Dell'Oro
Allied Health & Human Performance
University of South Australia
Adelaide, SA 5001, Australia

Mikaela Dell'Oro works clinically as a radiation therapist at the Royal Adelaide Hospital whilst completing her PhD at the University of South Australia. She works closely with international research teams such as St. Jude Children's Research Hospital, Memphis, USA to improve knowledge in proton and photon normal tissue modelling aiming to achieve optimal patient outcomes. Her current research surrounds modelling the long-term side effects such as normal tissue complication probability and second primary cancer induction for paediatric patients undergoing proton beam therapy for CNS cancer. Higher degree by research has inspired a strong interest in the development of current radiotherapy protocols.

Navigating a PhD during a pandemic Navigating a PhD during a pandemic

Mikaela Dell'Oro

Allied Health & Human Performance, University of South Australia, Adelaide, SA 5001, Australia
Department of Radiation Oncology, Royal Adelaide Hospital, Adelaide, SA 5000, Australia

Reflecting over the last two years the research and clinical space in radiation oncology has vastly changed. Completing my PhD during the pandemic was not what I had anticipated. Adjusting my expectations; I quickly needed to navigate Australian state-wide lockdowns and experiment setbacks all whilst working from home. This presentation aims to provide advice for early career researchers on goal setting and perseverance. In a time where face-to-face conferences and meetings are not feasible, I discuss adaptation techniques for building collaborations, taking opportunities, and pushing age/gender gap limits.

MS-19

Difficulties encountered in my postgraduate work during the COVID-19 pandemic and how I am managing to overcome them.

JivendraWickramasinghe
Department of Nuclear Science, Faculty of Science, University of Colombo, Sri Lanka

The Covid 19 pandemic has affected different categories of people's lives such as personal, professional, and educational aspects, in varying degrees. My postgraduate studies took a drastic turn during these two years. The PhD research I am working on is an experimental study on radio protectors. It included patient recruitment, deriving and maintaining primary human cell cultures, irradiation of cell cultures, and many other laboratory experiments. More than eighteen months were spent amongst intermittent lockdowns and fluctuating Covid waves. All education systems including universities and laboratories were closed and had adapted the online working system. Everyone except for the emergency services was home bound which affected their mental status as well as the financial status. Particularly in the research laboratories, procurement of chemicals and consumables were delayed indefinitely. Even the administrative work such as releasing of funding instalments and biannual progress reports were stagnated. In order to overcome these difficulties encountered, several actions were taken. An appeal was submitted to the university explaining the delays in the research work. With special permission from the university, laboratory work was resumed even under the

lockdown. Appropriate measures were taken to manage the affairs concerning personal and mental aspects; reviving the reading habit, connecting with friends online, and enjoying the time spent with the family. Even though there were setbacks in laboratory experiments, manuscripts submissions, and compiling the thesis, I tried my best to come up with alternative plans to complete the experiments and the research. Eventually, what would matter most is the fact that we survived a deadly virus when many of our loved ones did not. And as everything, this shall come to end. Life will move forward. And a PhD would have been finished successfully amidst a pandemic.

MS-20

Experience of completing MSc. thesis work during Covid Pandemic

Jannatul Ferdusy Soma[1], Dr.Hasin Anupama Azhari[2]

1. Department of Medical Physics and Biomedical Engineering, Gono Bishwabidyalay, Savar, Dhaka, Bangladesh.
2. Director, Centre for Biomedical Science and Engineering, United International University, Bangladesh

Bangladesh, like the rest of the world, continues to learn from COVID-19. The country was placed on complete alert for the COVID-19 pandemic, and preparations were made to raise awareness and prevent the spread of the syndrome. Everyone is being reintroduced to social isolation and quarantine by the authorities. From March 18 to December 19, 2020, the Bangladeshi government has ordered the shutdown of all schools and educational institutions in the country. Many institutions rely on e-learning as a result of the lockdown. Work at the hospital and in the lab was halted. For teaching and learning, use Google apps and other types of social media. Work on the team came to a halt. Every hospital's authority has refused to allow students to work in the hospital since hospitals, as health services, are in a different condition and it may be unsuitable to conduct research there. Teachers are attempting to provide online classes, but bandwidth in rural locations is limited. We typically work from home, exams and are done over the internet. Many hospital and institution based research affected mach. My topic was “Dosimetric performance evaluation of Semiflex 3D and MicroDiamond ionization chambers: A comparative study”. When educational institutions are closed, it is difficult to collect data from the field and analyze it in the lab. We are the worst victims in the sense that the majority of the research we conduct is either laboratory or field-based and is analytical in nature. We are confused in the sense that the research conducted here are either laboratory or field oriented and are analytical in nature. At last software based topic “Covid-19 detection from x-ray image data by using artificial intelligence” was selected with the help of thesis supervisor.

MS-21

Effect of Research: In Vivo Dose Measurements of Breast Cancer Radiotherapy with Various Treatment Plans.

N Sushma[1,2], ShanmukhappaKaginelli[2], Sathiyaraj Palanivel[1], K.M. Ganesh [1]

1 Department of Radiation Physics, Kidwai Memorial Institute of Oncology, Bengaluru-560029, India.
2 Division of Medical Physics, JSS Academy of Higher Education and Research, Mysuru-570015, India.

Background: The purpose of this study is to evaluate the point dose in PTV and peripheral doses for four treatment techniques of breast cancer radiotherapy with two energies. The importance of low doses in left whole breast cancer caused by radiation treatment, the point dose of critical organs, which were not subjected to radiation treatment in breast cancer radiotherapy, was measured.

Material and Methods: Eleven different plans in four techniques (3DCRT, IMRT, VMAT and HYBRID) and two photon energies (6 FF and 6 FFF) were applied to Rando Alderson Phantom's DICOM images. Thirteen organs were contoured in the treatment planning system and specified on the phantom. To measure the point dose in field and peripheral dose, two dosimeters nanoDot Optically stimulated luminescence dosimeter (OSLD) and GafChromic (EBT3) films were used to find the point dose of 24 locations in Rando Phantom treated with Elekta Versa HD TM linear accelerator. Measured and TPS calculated dose were compared.

Results: The point dose were measurement in Rando phantom for all eleven plans using OSLD and EBT3 films. A maximum dose difference measured with OSLD and EBT3 films were found to be -1.37% and 6.15% difference was observed between the target and TPS. Similarly, for OAR's such as contralateral breast the difference was -1.11% and -4.62%, ipsilateral lung the difference was -1.29% and -13.39%, and for heart the difference was -1.15% and -9.12% was measured with OSLD and EBT3 films respectively.

Conclusions: It was found that the point dose measured with OSLD had less difference when compared to EBT3 films irrespective of locations. Especially in peripheral OSLD shows superior than EBT3. This study found that the OSLD is more suitable for peripheral dose measurements.

Keywords: Flattening filter beam, flattening filter free beam, optically stimulated luminescence dosimeter, GafChromic films, Treatment planning system.

Mini -Symposium V: Medical Physics Contributes during COVID-19

Course Objectives: To present how medical physics can contribute to the fight of Covid-19 pandemic beyond the conventional clinical approaches.

Session Chair

Dr. Jeannie Wong, PhD
Associate Professor
Department of Biomedical Imaging
Faculty of Medicine, University of Malaya, Malaysia

Jeannie Wong studied Biomedical Engineering, followed by Master of Medical Physics at the University Malaya. She received her PhD from the University of Wollongong, Australia. She started her career at the Department of Biomedical Imaging, Faculty of Medicine, the University of Malaya as a senior lecturer in 2011. She coordinated the UM Master of Medical Physics programme from 2013 to 2017, which is accredited by the Institute of Physics and Engineering in Medicine (IPEM), UK. It is the only postgraduate medical physics programme outside the UK and Ireland that has this accreditation.

During her PhD study, she was instrumental in the development of a new field of medical dosimetry in radiation therapy quality assurance with high spatial resolution semiconductor dosimetry and its applications in radiation therapy quality assurance. She has since further extended her research to include dosimetry in diagnostic imaging and patient-specific dosimetry. She has published more than 60 papers to date. She was promoted to associate professor in 2018. Her research interests include radiation dosimetry, radiotherapy, medical imaging and radiomics. She had supervised 1 postdoctoral candidate, 4 PhD students, 2 masters by research students, and more than 37 master by coursework students.

Dr. Wong has vast experience in the teaching of physics and biostatistics at the postgraduate level. She has been involved as lecturer and examiner for the Master of Radiology and Master of Clinical Oncology at the University of Malaya since 2012.

IN 2019, she received the Southeast Asian Federation of Organizations of Medical Physics (SEAFOMP) Young Leader Award.

MS-22

Prof Tomas Kron, PhD, OAM
FIOMP, FCOMP, FCCPM, FACPSEM, FIUPSEM
Director of Physical Sciences
Peter MacCallum Cancer Centre
Department of Physical Sciences

Tomas Kron was born and educated in Germany. After his PhD he migrated to Australia in 1989 where he commenced his career in radiotherapy physics. From 2001 to 2005 he moved to Canada where he worked at the London Regional Cancer Centre on the commissioning of one of the first tomotherapy units. In 2005, Tomas became principal research physicist at Peter MacCallum Cancer Centre in Melbourne, Australia where he now is Director of Physical Sciences. Tomas holds academic appointments at Wollongong, RMIT and Melbourne Universities. He has an interest in education of medical physicists, dosimetry of ionising radiation, image guidance and clinical trials demonstrated by more than 90 invited conference presentations and 300 papers in refereed journals.

COVID-19 pandemic planning: considerations for radiation oncology medical physics

Kron T[1,2]

. 1 Department of Physical Sciences, Peter MacCallum Cancer Centre, Melbourne, Australia
. 2 Centre for Medical Radiation Physics, University of Wollongong, Wollongong, Australia

The COVID pandemic has had a profound impact on most countries in the world and health care systems have been challenged sometimes beyond capacity. This has also affected radiation oncology departments and the medical physicists working there. The presentation explores several aspects of this in the context of a large complex radiotherapy program operating over five campuses:

1. At the commencement of the pandemic at least some countries - such as Australia – had a window of opportunity to prepare for COVID infections reaching the hospital system. The documentation provided by Singaporean colleagues in the context of the SARS 2002-2004 outbreak proved to be most useful for this (Whitaker et al PhysEngSci Med 43 (2020) 473).
2. Being a large department provided us with some opportunities to silo staff particularly the ones in patient facing roles such as brachytherapy and motion management. Co-ordination with other staff groups proved to be essential.
3. Travel restrictions affected collaboration between campuses and restricts how much interaction medical physicists can have with companies, service providers and colleagues. The lack of personal interaction was particularly detrimental to students and trainees.
4. As the pandemic goes on and vaccination reduces the impact on the health system we are investigating what actions taken can be integrated into normal operations after the pandemic. Attention to home infrastructure as an alternate place of work, improved IT infrastructure and better awareness of resilience and mental wellbeing of staff will hopefully benefit the future workplace.

Planning for the COVID-19 pandemic can provide lessons for future challenges as well as lead to planning for an improved post COVID work environment.

MS-23

Dr Zoe Brady
Chief Imaging Physicist
Alfred Health,Melbourne, Australia

Zoe Brady (BSc (Hons), PhD, CMPS, MACPSEM) is the Chief Physicist (Diagnostic Imaging) and Radiation Safety Officer at the Alfred Hospital in Melbourne, Australia. She has worked as a clinical physicist for 15 years and has research interests in the risks from low dose ionising radiation exposure and the implications for current medical policy and practice. Zoe holds an honorary research position at the School of Population and Global Health, University of Melbourne where she is involved in one of the largest paediatric cohort studies worldwide to publish risks relating to exposures from computed tomography scans in childhood and adolescence. Additionally, she holds a teaching appointment in the Department of Radiology at the University of Melbourne and an Adjunct Senior Lecturer position with the Department of Neuroscience, Monash University. Zoe is an Associate Editor for the British Journal of Radiology and the Journal of Medical Imaging and Radiation Oncology.

Chest X-ray Imaging Through Glass During The COVID-19 Pandemic

Brady Z[1,2]

1 Radiology Department, Alfred Health, Melbourne, Victoria, Australia
2 Department of Neuroscience, Monash University, Melbourne, Victoria, Australia

Introduction: The aim was to develop a technique to perform mobile chest X-ray imaging through glass during the COVID-19 pandemic, allowing the X-ray unit to remain outside of the patient's room

Material and Methods: The X-ray attenuation of different glass in the hospital was assessed to determine the technique parameters required to account for glass filtration and additional source to image distance (SID) compared with a standard portable chest technique. Image quality was scored and technical parameter information collated on images acquired during the first month of implementation. Radiation measurements were undertaken in a simulated set-up to determine the appropriate position for staff to ensure occupational radiation doses were kept as low as reasonably achievable.

Results & Discussion: The transmission of the X-ray beam through glass was approximately 50% or equivalent to one half-value-layer at the kilovoltages used. The SID ranged from 180 to 300 cm. A sample of 30 consecutive clinical chest X-ray images for 23 patients was obtained from three hospital locations where the through glass technique was used. The majority (67%) of images were acquired at 110 kV, with an average 5.5 mAs. Image quality was found to be acceptable or borderline in 90% of the images taken through glass. The average patient dose was 0.02 millisieverts (mSv) per image (range: 0.002 to 0.07 mSv). With staff positioned at greater than 1 m from the patient and at more than 1 m laterally from the tube head outside the room to minimise scatter exposure, air kerma values did not exceed 0.5 microgray (μGy) per image.

Conclusions: The chest X-ray through glass method has been implemented safely and continues to be utilised. The technique effectively reduces the cleaning time of equipment, minimises personal protective equipment (PPE) use and decreases the infection risk of radiographers.

MS-24

Prof. Dr. Kwan Hoong Ng
Department of Biomedical Imaging
Faculty of Medicine, Universiti Malaya
Kuala Lumpur, Malaysia

Dr. Ng is a Professor at the Department of Biomedical Imaging, University of Malaya, Kuala Lumpur, Malaysia. He is certified by the American Board of Medical Physics, a Fellow of the Institute of Physics, UK, the International Organization for Medical Physics (IOMP), and the Academy of Sciences Malaysia. He is also a member of the Academy of Medicine Malaysia. Prof. Ng Kwan Hoong is widely regarded as the pioneer of medical physics in the country, having served at the Universiti Malaya's Faculty of Medicine for more than 30 years. He published and presented scientific papers prolifically, being cited by more than 6,000 academics and having h-index of 39. He also founded a number of academic programs, and regional medical physics organisations. He mentored young and upcoming scientists, both locally and abroad. In 2013, Prof. Ng was named as one of top 50 medical physicists in the world. And in 2018, he became the only Malaysian in history to receive the prestigious Marie Sklodowska-Curie Award in 2018, given by the UK-based International Organization for Medical Physics (IOMP), which represents 25,000 medical physicists worldwide. And in 2020, Prof. Ng Kwan Hoong was awarded the highest accolade for a scientist in the country, the Merdeka Award, for his life-long contributions to the country and beyond.

Medical Physics and COVID-19 – Global Experiences and Perspectives

Kwan Hoong Ng[1] and Magdalena Stoeva[2]

1 Department of Biomedical Imaging, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia
2 Department of Medical Imaging, Medical University of Plodiv, Plodiv, Bulgaria

In this talk, we narrate the rationale and our experience in conceiving, inviting authors, editing and publishing the book "Medical Physics During the COVID-19 Pandemic: Global Perspectives in Clinical Practice, Education and Research", Taylor and Francis, 2021. This book chronicles the contributions and responses of medical physicists worldwide as they continue to support the frontline healthcare workers in radiology, nuclear medicine and radiation oncology during critical times. Throughout the pandemic, academic medical physicists were also forced to innovate, resorting to unexplored methods to deliver lessons online and conduct research remotely.

In conceiving this book, we strived to collect diverse experiences and perspectives from low- and middle-income countries to rich industrialized countries. A total of 91 authors (59 men and 32 women) representing 39 countries have contributed their experiences. Seven (41%) out of the 17 lead authors are women. This book begins with clinical practices in radiation oncology, nuclear medicine and radiology, education, training and research. These are followed by chapters from different regions of the world describing their respective experiences. Editors of major medical physics journals provided their insight on the publication landscape, and the Medical Physics for World Benefit organization also presented its activities. The voices and experiences of early-career medical physicists are also recorded. Lastly, the importance of communicating leadership is highlighted.

MS-25

Assoc. Prof. Dr. Chai Hong Yeong, PhD, MIPM
School of Medicine
Faculty of Health and Medical Sciences
Taylor's University, Malaysia

Dr. Chai Hong Yeong is a medical physicist, a certified Radiation Protection Officer and an Associate Professor at the Taylor's University, Malaysia. She completed the IAEA Clinical Training of Medical Physicists Specialising in Diagnostic Radiology (DRMP) in 2014. Dr. Yeong is currently chairing the Professional Relations Committee of the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) 2019-2021. She is also the elected Vice President of the South-East Asia Federation of Organizations for Medical Physics (SEAFOMP) 2019-2021 and Vice President of the Malaysian Association of Medical Physics (MAMP). She is the recent awardee of the prestigious IUPAP Young Scientist Award 2021. She has also been awarded the SEAFOMP Young Leader Awards in 2017. Her research areas focus on theranostics, minimally invasive cancer therapies, 3D printing in medicine and radiomics. She has published more than 70 peer-reviewed journal articles, 2 academic books and 2 book chapters.

Fighting COVID-19 through the invisible light - UVC

CH Yeong
School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, 47500 Subang Jaya, Malaysia

Ultraviolet (UV) is an electromagnetic radiation that falls in the region between visible light and X-rays. UV spectrum can be divided into UVA, UVB, UVC and far or vacuum UV, depending on their wavelength. UVC (in the wavelength of 200 – 280 nm) has strong germicidal (killing germs) effect due to the spectral sensitivity of the microorganism's DNA. When microorganisms are exposed to UVC, the radiation will be absorbed by the DNA, RNA and proteins of the organisms. Absorption by proteins can lead to rupture of cell walls and deaths of the organism, while absorption by DNA or RNA is known to cause inactivation of the DNA or RNA double helix strands through the formation of thymine dimers. If enough of these dimers are created, the DNA replication process will be disrupted, and the cell cannot replicate further. UVC has been used for disinfection for more than 40 years in various industries including healthcare, laboratories, food, water treatment and air disinfection. In the COVID-19 pandemic, UVC has gained more popularity as an effective disinfection technique in killing or inactivate the SARS-COV-2 virus. Current systems include surfaces disinfection, upper room air disinfection, and integrated UVC air ventilation systems. Although the effectiveness of UVC disinfection have been validated by thousands of studies over the past few decades, its efficacy is largely dependent on the design of the system and operating procedures at the user side. Currently the regulations and safety operating standards of its use have not been harmonized across countries. This talk is going to discuss about the basic principles, mechanism, effectiveness and safety standards on the use of UVC for disinfection.

Oral Presentation

Parallel Session - I (A): Radiotherapy

OP-01

Dosimetric Benefits of Daily Treatment Plan Adaptation for ProstateCancer Stereotactic Body Radiotherapy Based on Synthetic Cone-Beam CT

Miriam Eckl[1], Gustavo R. Sarria[2], Volker Steil[1], Michael Ehmann[1], Jens Fleckenstein[1]

1. Department of Radiation Oncology, University Medical Center Mannheim, University of Heidelberg, Germany
2. Department of Radiation Oncology, University Hospital Bonn, University of Bonn, Germany

Introduction: Ultra-hypo fractionation is increasingly applied for prostate cancer, demanding for higher accuracy of daily treatments than in conventional image-guided radiotherapy (IGRT). Based onrecent developments of deep learning-based synthetic CT (sCT), methods of adaptive radiotherapy (ART) such as daily treatment plan modifications can address this issue and thus were analyzed with regard to dosimetric benefits over IGRT.

Material and Methods: According to the PACE-C trial treatment regimen (5x8Gy), treatment plans for 32 patients were retrospectively created. sCT were generated based on five daily CBCT per patient using a previously trained cycle-generative adversarial network. Subsequently, three different treatment plan adaptation approaches were evaluated on sCT and compared to the IGRT approach: Segment aperture morphing with segment weight optimization (ART1), with additional shape optimization (ART2) and a full re-optimization (ART3). Dose distributions were evaluated regarding dose-volume parameters, a penalty score and overlap-volumes between OAR and the PTV.

Results & Discussion: The ART1, ART2 and ART3 approaches substantially reduced the V37Gy(bladder) and V36Gy(rectum) obtained by the IGRT approach from a mean of 7.4cm3 and 2.0cm3 to (5.9cm3, 6.1cm3, 5.2cm3) as well as to (1.4cm3, 1.4cm3, 1.0cm3), respectively. The ART1 approach required an average calculation time of 2.6min. Being accumulated over the entire patient collective, a penalty score revealed that dosimetric benefits over conventional IGRT were either achieved through increasing target coverage (ART1+ART2 approaches) or sparing of OAR (ART3 approach). Potential overdosage to the rectum was correctly predicted by over-average overlap-volumes in 69.1% (IGRT approach) and 96.3% (ART3 approach) of all treatment plans.

Conclusion: Adaptive treatment planning approaches were proven to adequately restore relevant dose criteria of reference plans on a daily basis. Combined with the application of anatomical metrics and a penalty score, the obtained results potentially facilitate the decision of when to apply which adaptation strategy.

OP-02

Effect of Applying SEMAR Filter to CT Scans of Patients and Phantoms with Metal Implants or Inserts on Radiotherapy Treatment Planning Accuracy

Ignatius, D [1,2], Sabet, M [1,3], Alkhatib, Z [3], RowshanFarzad, P [1], Ibrahim, M [4], Goodall, S [2]

1. School of Engineering and Mathematical Sciences, University of Western Australia, Crawley, Western Australia, Australia
2. Radiation Oncology Medical Physics, GenesisCare Cancer Center, Perth, Western Australia, Australia
3. Department of Radiation Oncology, Sir Charles Gairdner Hospital, Nedlands, Western Australia, Australia
4. Radiation Oncology Medical Physics, Icon Cancer Centre, Icon Cancer Centre, Perth, Western Australia, Australia

Introduction: Imaging patients with metal implants results in CT scans with bright and dark streaky artifacts due to photon starvation, beam hardening, and scatter and motion of the metal. Single Energy

Metal Artifact Reduction (SEMAR) algorithm can reduce metal artifacts (MA) and is currently used as a reviewing tool when contouring. The current method of forcing soft tissue density to artifacts is quite rough when the planning target volume is close to the metal implant.

Material and Methods: Phantom study is conducted by scanning CIRS 062M CT-to-ED phantom and two in-house 3D-printed spine and pelvic phantoms with and without metal inserts on Canon Aquilion One CT Scanner and processed with and without SEMAR filter. Retrospective patient study is conducted using three patients' data.

CT number accuracy is calculated by measuring mean Hounsfield Unit (HU) values on multiple slices of the CT images using fixed region of interest. The HU values of phantoms with metal processed with and without SEMAR are compared to phantom without metal (ground truth).

Quantitative dosimetric evaluation is performed using volumetric modulated arc therapy on Eclipse treatment planning system. Dose calculation is verified using two ionization chambers and film measurements. Two-dimensional gamma analysis is performed using SNC Patient.

Results and Discussion: SEMAR filter can significantly reduce MA on CT images used for external beam radiation therapy treatment planning (EBRTTP), which consequently improves the CT number and dosimetric accuracy in SEMAR processed images. Since MA affect CT number accuracy, and accuracy of planned dose in EBRTTP depends on the CT numbers, any improvement in CT numbers of the organs near MA is expected to improve the dose calculation accuracy.

Conclusions: If deemed fit for use in EBRTTP, SEMAR processed CT images will save time and associated cost of contour delineating and increase physician's confidence in the planned dose.

OP-03

Evaluation of Interfraction and Intrafraction Setup Variation of Different Anatomic Sites Using On-Board Imager - Impact on Planning Target Volume Margins

Naser I, Islam A, Islam K, Hasan M

Cancer Center, CMH Dhaka, Bangladesh

Introduction: Clinical radiation therapy procedures aim at high accuracy. Organ motion and inaccurate patient positioning may compromise radiotherapy outcomes which can be minimized with image guidance. The purpose of this study was to evaluate the Intrafractional setup uncertainties and Intrafractional internal organ motion of five different anatomic sites with iso-centric LINAC pre-treatment and post-treatment kilo voltage-kilo voltage (kV-kV) setup pair images and to provide optimal margin guidelines for these anatomic sites.

Material and Methods: A total of ninety-five patients with tumors in the head and neck (HN), brain, lung, abdominal, or prostate regions were included in the study. The kV image of the on-board imager (OBI) was used to verify patient position and tumor target localization before each treatment. Thermoplastic facemasks were used for HN and brain treatments. Vac-Lok cushions or wing board including foot/knee rest were used to immobilize the thorax, abdomen and pelvic patients. The Intrafractional setup variations were recorded and corrected before treatment.

Results & Discussion: The mean Intrafractional setup error was the smallest for the brain among the five sites analyzed. The average 3D displacement for the five sites ranged from 1.6–4.4 mm for brain and lung, respectively. The largest movement in the lung was 2.6 cm in the longitudinal direction, with a mean error of 1.8 mm and standard deviation of 4.2 mm. The maximum 3D Intrafractional organ displacement across all sites was approximately 1.4 mm. The Intrafractional systematic errors and

random errors were analyzed, and the suggested global margins based on Van Herk model for the five sites in the lateral, longitudinal, and vertical directions were ranged from 4.4 mm - 9.7 mm, 5.3 mm - 11.8 mm and 2.8 mm – 6.6 mm respectively.

Conclusions: kV-kV setup pair images as image-guided tools can be used to improve the accuracy of patient positioning and reduce tumor margin.

OP-04

The Iteratively Improved Method with KBP to Standardize VMAT Plan Quality in Prostate Cancer

Kenji Nakamura[1], Katsuya Okuhata[1], Masakazu Otsuka[2], Mikoto Tamura[1], Hajime Monzen[1]

1. Department of Medical Physics, Graduate School of Medical Sciences, Kindai University, 377-2, Onohigashi, Osakasayama, Osaka, Japan
2. Department of Radiology, Kindai University Hospital, 377-2, Onohigashi, Osakasayama, Osaka, Japan

Introduction: This study suggested an updating method of knowledge-based plan (KBP) models to standardize the VMAT plan quality for prostate cancer.

Material and Methods: RapidPlan was employed as a KBP module. The KBP models were updated at two times by setting each goal. First model was created from 47 clinical IMRT/VMAT plans. Second model was created to exceed dosimetric goals, as mean values +1SD of the dose–volume parameters of plans generated by first model (50 consecutive new clinical VMAT plans). Third model was created with more strict dose constraints for organs at risks (OARs) than first and second models (50 consecutive anew clinical VMAT plans). Each KBP model was verified for 30 validation plans (KBP1, KBP2, and KBP3) that were not used for model configuration, and the dose–volume parameters were compared (D95 of target = prescribed dose of 78 Gy/39 fr). The Cook's distances of regression scatterplots of each model were also evaluated.

Results and Discussion: Significant differences (KBP1 vs. KBP2) were found in homogeneity index (3.90 vs. 4.44) and 95% isodose conformity index (1.22 vs. 1.20) for target, V40Gy (47.3% vs. 45.7%), V60Gy (27.9% vs. 27.1%), V70Gy (16.4% vs. 15.2%), and V78Gy (0.4% vs. 0.2%) for rectal wall, and V40Gy (43.8% vs. 41.8%) and V70Gy (21.3% vs. 20.5%) for bladder wall ($p < 0.05$). For KBP2 vs. KBP3, only V70Gy (15.2% vs. 15.8%) of rectal wall differed significantly. The proportions of cases with a Cook's distance of <1.0 (first, second, and third models) were 55%, 78%, and 84% for rectal wall, and 77%, 68%, and 76% for bladder wall, respectively.

Conclusions: The updated KBP models with the clear goals at each step could generate superior dose–volume parameters and converged regression scatterplots in the model. Our approach could be used to standardize the inverse planning strategies.

OP-05

Lifetime Attributable Risk of Radiation Induced Second Cancer from Scattering and Scanning Proton Therapy for Paediatric Cranial Cancer: Age and Sex Impact on Out-of-Field Organs

Mikaela Dell'Oro[1, 2], DrMichala Short[1], DrPuthenparampil Wilson[2,3], Dr Dylan Peukert[4], Dr Chia-Ho Hua[5], Dr Thomas E. Merchant[5], Prof Eva Bezak1[6]

1 Cancer Research Institute, University of South Australia, Adelaide, SA, Australia
2 Department of Radiation Oncology, Royal Adelaide Hospital, Adelaide, SA, Australia
3 UniSASTEM, University of South Australia, Adelaide, SA, Australia

4 ARC Training Centre for Integrated Operations for Complex Resources, University of Adelaide, Adelaide, SA, Australia
5 Department of Radiation Oncology, St. Jude Children's Research Hospital, Memphis, TN, USA
6 Department of Physics, University of Adelaide, Adelaide, SA, Australia

Introduction: Risks of second primary cancer (SPC) following scanning and scattering proton therapy (PT) for paediatric out-of-field organs are not well known. Specifically, measurements of the neutron equivalent dose vary significantly [1-5]. Using Schneider's model [6], we investigated the lifetime attributable risk (LAR) of SPC for paediatric cranial cancer after PT as a function of age and sex for organs such as the salivary gland and small intestine.

Methods: Previously, 108 intensity-modulated PT plans were generated in Eclipse 13.7 for various cranial tumour volumes using sex and age matched paediatric scans of 5, 9 and 13 years-of-age [7].Scattered and scanning neutron equivalent dose spectrums were sourced from literature, recreated, and applied to the modelling. Physical distances of each out-of-field organ were extracted and input into the Schneider model run in MATLAB (R2020B) for each patient. Age and sex were assessed to gauge their influence on LAR of SPC.

Results & Discussion: Overall, scattering PT demonstrated higher LAR (per 10,000 person years) of SPC than scanning. This was prominent for more radiosensitive organs, including the lung (320 vs. 50), breast (1,000 vs. 150) and thyroid (350 vs. 75) but not fororgans furthest from the isocentre (small intestine, rectum, and reproductive organs). For most organs, LAR were highest for 5-year-old females (for example breast LAR was 1,000 higher than for 13-year-olds), however, outliers existed for distal organs such as the stomach and lungs. LAR estimates were highly dependent on neutron equivalent dose distributions, demonstrating uncertainty from published data measurements.

Conclusion: The study compared and applied reported neutron equivalent doses for scanning and scattering PT treatment to LAR estimates. Organ-specific LAR were assessed for age and sex-specific prediction of SPC risk, demonstrating higher risk for younger female cranial paediatric patients compared to males, especially for scattering PT, warranting further investigation.

Parallel Session- I(B): Radiology & Imaging

OP-06

Differentiating primary tumors for brain metastasis with integrated radiomics from multiple imaging modalities

Ji Zhang, Yao Ai, XianceJin

Department of Radiotherapy Center, Wenzhou Medical University First Affiliated Hospital, ShangcaiVillage,Wenzhou 325000, People's Republic of China

Objectives: To differentiate the primary site of brain metastases (BMs) is of high clinical value for the successful management of patients with BM. The purpose of this study is to investigate a combined radiomics model with computer tomography (CT) and magnetic resonance imaging (MRI) images in the differentiating BMs originated from lung and breast cancer.

Methods: Pretreatment cerebral contrast enhanced CT and T1-weighted MRI images of 78 patients with 179 BMs from primary lung and breast cancer were retrospectively analyzed. Radiomics features were extracted from contoured BM lesions and selected using Mann-Whitney U test and the least absolute shrinkage and selection operator (LASSO) logistic regression. Binary logistic regression (BLR) and support vector machine (SVM) models were built and evaluated based on selected radiomics features from CT alone, MRI alone, and combined images to differentiate BMs originated from lung and breast cancer.

Results: A total of 10 and 6 optimal radiomics features were screened out of 1288 CT and 1197 MRI features, respectively. The mean area under the curves (AUCs) of BLR and SVM models using five-folds cross validation were 0.703 vs. 0.751, 0.718 vs. 0.754, 0.781 vs. 0.803 in the training dataset, and 0.708 vs. 0.763, 0.715 vs. 0.717, 0.771 vs. 0.805 in the testing dataset for models with CT alone, MRI alone, and combined CT and MRI radiomics features, respectively.

Conclusions: Radiomics model based on combined CT and MRI features is feasible and accurate in the differentiation of the primary site of BMs from lung and breast cancer.

OP-07

Precision improvement of the Agatston score using the latest multi-slice CT (Thin slice CT scan and Agatstonscore correction)

Katsumi Tsujioka[1], Kyohei Yamada[2], Masayoshi Niwa[2]

1 School of Medical Sciences, Fujita Health University, Toyoake-city, Japan
2 Yokkaichi Municipal, Yokkaichi-city, Japan

Purpose: The Agatston method is one of Ca-Scoring used widely in a clinical field. However, as for it, slice thickness is appointed with 3mm. This is a scan condition in the very old CT. We tried Ca-scoring in the thinner slice. And we utilized this experiment result for the precision improvement of the Agatston method.

Materials and Methods: We used handmade calcified phantom for an experiment. The phantom set it up on the moving table which exercised in the Z-axis direction. We changed slice thickness of the CT scanning with 1mm, 2mm and 3mm. The volume of the calcification was measured.
Results: The true volume of the calcification was 60mm3. The error of calcification volume was 0% to +67% in 3mm slice, -25% to +33% in 2mm slice, -5% to +5% in 1mm slice. By using 1mm slice data, the error of Agatston score was changed to 87% to 10% against the 3mm slice data.

Conclusion: The Agatston method is a convenient method for Ca-scoring. However, the technique of the Agatston method uses an old CT device. We developed a method for Agatston score that have high precision in a new CT device.

OP-08

Cluster Size Analyses of ALPIDE-CMOS Pixel Sensor for pCT

Afroz [S1], Tambave [G1], Meric [I4], Odland OH[1,2], Alme [J1], Ullaland [K1], Peitzmann [T3], Brink [AVD3], Shafiee H1,4, Sølie JR[1,4], Chaar [M1], Yang [S1], Roehrich [D1]

1. Department of Physics and Technology, University of Bergen, Bergen, Norway.
2. Department of Oncology and Medical Physics, Haukeland University Hospital, 5021 Bergen, Norway
3. Institute for Subatomic Physics, Utrecht University/Nikhef, Utrecht, Netherlands
4. Faculty of Engineering and Science, Western Norway University of Applied Science, 5063 Bergen, Norway

Introduction: The idea of Proton Computed Tomography (pCT) was developed to mitigate the conversion related problem from conventional X-ray CT used in Proton therapy for cancer treatment. The uniquely featured Digital Tracking Calorimeter (DTC) used in pCT is made of multiple layers of Monolithic Active Pixel Sensor (MAPS) chips. ALPIDE is conceptually an ideal MAPS because of its low power consumption and chip area with more than half a million pixels with in-pixel readout scheme. But it was not known that how the cluster size varies depending on the energy and type of radiation sources.

Purpose: This study was aimed to evaluate the performance of ALPIDE in particle detection by analyzing the cluster size.

Material & Methods: Sealed radioactive sources were used in the laboratory to check the detection performance of proposed ALPIDE pixel detector. Radioactive sources mainly Alpha source (241Am), Beta Source (90Sr), Mono-Energetic Radiation Source (55Fe) and Variable Energy X-ray Sources (8.91 KeV to 50.65 KeV) were used. Cluster size was measured from the detector for each radiation type and verified based on their different interaction probability. Cluster size analysis was done with C++ and root programming.

Results & Discussion: The mean value of cluster size increases with the increasing energy of radiation sources. The variation of cluster size formed by different radiation sources contents the basic principle of particle interaction with material.

Conclusion: As ALPIDE is considered as the best MAPS for pCT, it was important to know how the ALPIDE sensor responds to and forms cluster for different low energy particles available at the laboratory. It has been observed from this study that the cluster size is distinguishable for each of the particle. Furthermore, cluster size and deposited energy change with the particle energy.

Keywords: pCT, DTC, MAPS, ALPIDE

OP-09

Translation from Non-Contrast to Contrast Images by Cycle-GAN in Head Neck Vascular CT Imaging

Kuratani Yosuke[1], Teramoto Atsushi [2], Niwa Masayoshi[1]

1 Department of Radiology, Yokkaichi Municipal Hospital, Yokkaichi, Mie, Japan
2 Graduate School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan

Background: Computed tomography angiography (CTA) is very important for the diagnosis and treatment planning to understand the head and neck vessels in three dimensions. The most common technique for CTA of the head and neck is the bolus tracking method, in which a region of interest (ROI) is defined in the neck vessels and the CT values of that is monitored. However, Placing ROIs on vessels before contrast (plain CT) is difficult for newcomers because it requires knowledge and experience. Therefore, we have developed a new technology that virtually converts a plain CT image to a contrast-enhanced CT image using Cycle-GAN, one of the deep learning technologies, to predict the position of the vessel to be contrasted and to support head -neck CTA imaging.

Methods: GAN is a technique for generating sophisticated pseudo-images by alternately training a generator that generates fake images and a discriminator that detects between real and generated images. In this study, a bi-directional image transformation was performed using two GANs, one to transform a plain CT image into a contrast CT image and the other to do the opposite. After the training, the images not used for the training were input to the Cycle-GAN, and the image quality of the converted images was subjectively evaluated.

Results: As a result of image transformation and evaluation using CT images of patients who underwent cervical plain and contrast CT at our facility, it was confirmed that mutual transformation between non-contrast and contrast images was performed, and the results of subjective evaluation were also good.

Conclusion: From the results, it was shown that Cycle-GAN can mutually convert cervical plain CT images and contrast images, and our technology can be a technology to support head-neck vascular CT imaging.

OP-10

Preliminary Study on The Automated Lung Cancer Detection in CT Images Using Mask R-CNN

Oshita Yuki[1], Takeuchi Nonoko[1], Teramoto Atsushi[1], Saito Kuniaki[1], Fujita Hiroshi[2],Suzuki Yuki[3], Tomiyama Noriyuki[4], Kido Shoji[3]

1 Graduate School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan
2 Faculty of Engineering, Gifu University, Gifu, Gifu, Japan
3 Department of Artificial Intelligence Diagnostic Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, Japan
4 Department of Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, Japan

Background or Introduction: Lung cancer is one of the most common cancers with a large number of patients and a high mortality rate around the world. For that reason, it is important to detect and treat it early. With the development of imaging equipment and technology, the number of images that can be obtained in a one-time examination has greatly increased and can also be obtained in a rapid time. As a result, the burden on the physician to read the images has increased and there is concern that this will lead to a decrease in diagnostic accuracy. Therefor the purpose of this study is to develop computer-aided diagnosis (CAD) technology for lung cancer detection using artificial intelligence (AI). In advance, to pick up the location of objects that may be lung cancer by using AI, it is expected to reduce the burden of reading the images and improve the accuracy of diagnosis.

Material and Methods: For this study, we collected CT images of 301 cases. First, we selected the slices containing lung areas from each case, and then preprocessed them such as window processing. Next, we attempted to detect lung cancer using Mask R-CNN, a kind of convolutional neural network (CNN). We used Mask R-CNN as object detection model. The detection accuracy was evaluated by the true positive rate and false positive rate.

Results and Discussion: We evaluated the detection performance via 5-fold cross-validation method to confirm the effectiveness of the proposed method. As a result, the detection accuracy of lung cancer was about 90%.

Conclusions: These results indicate that Mask R-CNN is effective in detecting lung cancer from CT images.

OP-11

Preoperative prediction of lymph node metastasis in cervical cancer with radiomics nomogram based on multiparameter MRI

Zhenhua Zhang[1], Xiance Jin[2,3]

1. The First Affiliated Hospital of Wenzhou Medical University, Department of Radiology
2. The First Affiliated Hospital of Wenzhou Medical University, Radiotherapy Center
3. School of Basic Medical Sciences, Wenzhou Medical University

Objective: To establish and validate a radiomics nomogram that can predict the risk of lymph node metastasis (LNM) according to each patient's clinical risk factors and radiomics signature based on multiparametric MRI in patients with cervical cancer.

Material and methods: A total of 250 patients (age range,28-79) with cervical cancer were enrolled in our retrospective study. Patients were randomly divided into training set and testing set by a ratio of

7 to 3.163 patients were allocated to a training set(mean age ±SD, 52.4±11.2), and 87 patients were allocated to a testing set(mean age ±SD, 52.6±10.2). The region of interest (ROI) of tumor was manual segmented by a radiologist with 7 years of experience.1022,1022 and 103 imaging features were extracted respectively from T2WI, diffusion weighted imaging (DWI), and apparent diffusion coefficient (ADC) of each patient. A two-step feature selection methodology was applied to reduce dimension and select the significant features for each sequence in training set. Firstly, Mann–Whitney U tests were used to select features with $p < 0.05$ as potentially informative features. Secondly, the least absolute shrinkage and selection operator (LASSO) method was employed to obtain the key features. Radiomics signature was established by the key features. Combining the clinical risk factors, a radiomics nomogram was constructed. The area under the receiver operating characteristic curve (AUC) was used to assess the predictive performance of the radiomics signature and the combined model of three sequences; the AUC and the correction curve were used to assess the predictive performance of the radiomics nomogram.

Results: There was no significant difference between training set and testing set($P > 0.05$).A total of 4 key features which were related with LNM were obtained. The AUC for single sequence in training set was 0.806,0.726 and 0.736 and the AUC corresponding to the combined above sequences was 0.83. The predictive performance of the combined model was better than any single sequence and was validated in testing set. Encouragingly, radiomics nomogram that incorporated radiomics signature and clinical risk factor also showed good calibration and discrimination in both training and testing sets, the AUCs of 0.839 and 0.828, respectively.

Conclusion: Radiomics nomogram established by multiparametric MRI can be used as an adjunctive method for predicting LNM in cervical cancer.

OP-12

Image quality evaluation on-center and off-center FOV of CT (Spatial resolution and motion artifacts)

Katsumi Tsujioka[1], Kyohei Yamada[2], Masayoshi Niwa[2]

1. School of Medical Sciences, Fujita Health University, Toyoake-city, Japan
2. Yokkaichi Municipal, Yokkaichi-city, Japan

Purpose: There are many reports on image quality evaluation in CT. However, they have been examined at the center ofFOV, and there are no reports on off-center of FOV. We measured spatial resolution and motion artifacts at thecenter and off-center FOV of CT.
Materials and Methods: A wire phantom is suitable for evaluating the spatial resolution off-center of the FOV. We used it to measure thespatial resolution off-center of the FOV. The position of moving object and X-ray tube become the importantproblem by the evaluation of the motion artifact in the CT. We developed a new moving phantom to solve thisproblem. And we compared the motion artifact in the center and the off center of FOV by using this phantom.

Results: Comparing the center and off-center of FOV, the center had better spatial resolution than the off-center. Thiswas thought to be due to the geometric extent of data collection in CT. The shapes of the motion artifact we rehanged by a position of the X-ray tube. However, according to the moving phantom which we developed, themotion artifacts of the center and off center of FOV were possible to evaluate in same X-ray tube position. Theartifact of the off center became bigger than the center of FOV.

Conclusion: We evaluated the spatial resolution and motion artifacts off-center of the FOV. As a result of the experiment, itwas found that the spatial resolution is reduced and motion artifacts occur in the off-center of the FOV. Fromthe results of this experiment, it was found that it is important to place the

subject in the center of the FOV whenperforming a CT examination.

Parallel Session- II(A): Nuclear Medicine & Radiopharmaceuticals

OP-13

Preclinical Testing of 177Lu-DOTA-C595 for the Treatment of Pancreatic Cancer

Hull [A1,2], Li [Y1], Tieu [W1], Hsieh [W1,2], Bartholomeusz [D2,3], Bezak [E1,4]

1. Cancer Research Institute, Allied Health & Human Performance Academic Unit, University of South Australia, Adelaide, SA, Australia.
2. Department of Nuclear Medicine, PET and Bone Densitometry, SA Medical Imaging, Royal Adelaide Hospital, Adelaide, SA, Australia.
3. Adelaide Medical School, The University of Adelaide, Adelaide, SA, Australia.
4. School of Physical Sciences, The University of Adelaide, Adelaide, SA, Australia.

Introduction: Pancreatic cancer is an aggressive malignancy with limited therapeutic options. Targeted radionuclide therapy (TRT) has improved survival of several cancers such as prostate and neuroendocrine tumours, however there only limited investigations into TRT agents for pancreatic cancer. The aim of this study was to develop and test the in vitro behaviour of a novel TRT agent, 177Lu-DOTA-C595. This radio immune conjugate is designed to target cancer-specific mucin 1 epitopes (MUC1-CE) known to be overexpressed in pancreatic cancer.

Material and Methods: The mouse monoclonal C595 antibody (QED Bioscience, USA) was conjugated to the bifunctionalchelator p-SCN-Bn-DOTA. DOTA-C595 was radiolabelled to [177Lu]LuCl2 using standard methods. Radiolabelling efficiency was determined using radio-ITLC. In vitro behaviour of [177Lu]Lu-DOTA-C595 was evaluated in a series of cell binding and internalisation assays using four pancreatic cancer cell lines: PANC-1, CAPAN-1, BxPC-3 and AsPC-1 (American Type Culture Collection, USA) which ranged from strong to low MUC1-CE expression, respectively. The potential cytotoxicity of [177Lu]Lu-DOTA-C595 was evaluated in terms of clonogenic assay and γ-H2AX foci formation in PANC-1 and AsPC-1 cell lines.

Results and Discussion: [177Lu]LuCl2 labelled to DOTA-C595 with high efficiency. Cell binding assays showed significantly greater binding to PANC-1 and CAPAN-1 compared to BxPC-3 and AsPC-1 cell lines, correlating with the MUC1-CE expression pattern of these cells. Further, [177Lu]Lu-DOTA-C595 was rapidly internalised by all cell lines with 15.9 – 28.4% internalised at 1 h. All cell lines achieve maximal internalisation at 48 h (39.2 – 75.3%). The clonogenic survival of cell lines was impaired by [177Lu]Lu-DOTA-C595. Irradiation of [177Lu]Lu-DOTA-C595 also lead to the formation of γ-H2AX foci in cell lines, suggesting it can induce double-strand DNA breaks.

Conclusions: The strong binding, internalisation and cytotoxicity of [177Lu]Lu-DOTA-C595 to MUC1-CE positive cell lines indicates [177Lu]Lu-DOTA-C595 may be a feasible therapeutic radioimmunoconjugate for pancreatic cancer and warrants ongoing investigation to understand its full effects.

OP-14

Novel Biodegradable Microsphere Loaded with Sm-153 and Doxorubicin for Chemo-Radioembolization Therapy of Liver Cancer

Alregib [AH1], Wong [YH1],Kasbollah [A2], Wong [EH1], Yeong [CH1]

1 School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, 47500 Subang Jaya, Selangor, Malaysia

2 Medical Technology Division, Malaysian Nuclear Agency, 43000 Bangi, Selangor, Malaysia

Liver cancer is the 6th most common cancer and 4th leading cause of cancer death worldwide. It has a high mortality rate due to the delayed diagnosis of liver cancer at intermediate and advanced stages. Chemoembolization and radioembolization are both useful treatments for advanced liver cancer. However, both treatments are administered on separate occasions. The combination of chemotherapy and radiation therapy have shown a better anti-tumoral effect due to their synergistic action. This study aims to develop a novel biodegradable microspheres formulation loaded both radioactive samarium-153 (Sm-153) and Doxorubicin (Dox).

In this study, the Sm-152 and chemotherapy drug, Dox, were encapsulated in the polyhydroxybutyrate-co-3-hydroxyvalerate (PHBV) microspheresthrough solvent evaporation procedure. The developed microspheres underwent neutron activation using a 1 MW open-pool nuclear reactor to produce radioactive Sm-153 and Dox loaded PHBV microspheres via 152Sm (n,☒) 153Sm reaction. Physicochemical characterization, Dox and Sm-153 content, and in-vitro release of Dox from the microspheres were performed.

The developed Sm-153 and Dox-loaded PHBV (Sm-Dox-PHBV) microspheres shown a smooth and spherical morphology with a mean diameter of 33±1.05 μm. Histogram showed that the sizes of the microspheres were within 20-60 μm. The thermal stability of the microspheres was up to 150°C. There were 12.8 ± 0.01% of Sm-153 and 66.0 ± 0.12% of Dox encapsulated on the PHBV microspheres. The Sm-153 and Dox-loaded PHBV microspheres has a nominal radioactivity of 4.20 ± 0.16 GBq.g-1 and Dox concentration of 1.89±0.36 mg.g-1. The in-vitro release of Dox from the microspheres achieved a cumulative release of 41.5 ± 0.15% at 430 hours.

A novel biodegradable microsphere loaded with Sm-153 and Dox were successfully developed. The microspheres achieved desirable physicochemical properties as a chemo-radioembolic agent for liver cancer treatment. Further experiments are planned to study the anti-cancer properties of the developed formulation using cell lines and then animal models.

OP-15

Assessment of the Small Object Detection using K-Means Clustering in PET/CT Imaging.

Mu'minah IAS, Nabila AP, Hardiansyah D, Soejoko DS

Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok, West Java, Indonesia

Background or Introduction: Segmentation in medical images has become an important tool to aid the initial diagnosis of a disease, for example, the emergence of tumors in organs that are small and difficult to observe manually. Automatic segmentation on a PET image is still rare due to poor spatial resolution limitations. This research was aimed to apply an automatic segmentation method based on K-Means clustering to identify and quantify the object detectability in PET/CT imaging.

Material and Methods: A series of PET images were generated by scanning an in-house phantom consisting of six pairs of small cylindrical objects with varying object diameters and positions on the phantom. This phantom was scanned by a PET/CT unit (SiemensBiograph). Image segmentation was automatically carried out by applying the K-Means algorithm using Matlab r2020. The accuracy of K-Means clustering was evaluated bycomparing a relative deviation between the physical object diameter (D_t) and the measured diameter by the automatic segmentation based on the K-Means algorithm (D_p) for each object detection.

Results & Discussion: Validation of the algorithm accuracyshowsthatthe object diameter quantified by K-Means clustering (D_p) is± 1 to 3 mm larger than the physical diameter of the object (D_t). The object detection by K-Means clustering has good accuracy with the relative deviation of less than 10% compared to the physical diameter of the objects.

Conclusions: K-Means algorithm fully succeeded in detecting the positions and number of objects on the phantom image. In addition, this algorithm worked to measure the quantification of object (lesion) diameter in PET imaging.

Keywords: Automatic Segmentation, K-Means Clustering, Small Object Detection, PET/CT imaging

Parallel Session – II(B): Radiotherapy

OP-16

Application of a Robustness Analysis Method to Multiple-Field Optimized IMPT Plan in Head and Neck Cancer Patients

Chen Jiayun[1,2], Wang Xiaochun[1], Sahoo Narayan[1], Zhu Xiaorong Ronald[1], Gunn G. Brandon[3], Frank Steven J.[3], Li Yuting[4] and Zhang Xiaodong[1*]

1. Department of radiation physics, The University of Texas MD Anderson Cancer Center, Houston, TX, United States,
2. Department of Radiation Oncology, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China,
3. Department of Radiation Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, United States,
4. Department of Radiation Oncology, St. Jude Children's Research Hospital, Memphis, TN, United States

Background: IMPT is highly sensitive to uncertainties in beam range and patient setup compared to photon IMRT. Our study retrospectively evaluated the robustness of IMPT plans, and compared the clinical benefit of IMPT and IMRT.

Material and Methods: A fast, approximate dose-calculation method was developed, and the worst-case scenario robustness analysis was implemented using this dose-calculation method. 54 head and neck cancer patients given IMPT and 54 given IMRT at MDACC from 2011 to 2015 were studied. The average D95/D5 to targets were compared for the nominal IMPT plan (N-plan) and worst-case scenario plan (W-plan). Dmax/Dmean/D2CC of OARs also were compared for the two plans.

Results & Discussion: The differences in the mean D95 to the GTV and CTV 1-4 for the W-plan and N-plan were -0.26, -1.52, -1.34, -1.62, and -1.65 Gy, respectively. Also, the differences in average Dmean to the brain stem, spinal cord, left and right parotid glands, left and right cochleae, larynx, and whole brain were 0.21, 0.25, 0.06, 0.20, 0.63, 0.63, 0.37, and 0.04 Gy, respectively. The differences in the average Dmax to the brain stem and spinal cord were 0.48 and 0.38 Gy, respectively. The 5-year local recurrence-free survival rates for the IMPT and IMRT recipients differed but not significantly ($p = 0.43$). All of these findings demonstrated that within these dose uncertainties, IMPT plan provided comparable good local control to IMRT.

Conclusions: This is the first study to establish the extent for robustness of an IMPT plan for the target D95, D5 and D2CC, Dmax, and Dmean for selected OARs in IMPT for head and neck cancer. Furthermore, this is the first report of standard tolerance about the robustness of an IMPT plan when administering IMPT to patients for the first time.

OP-17

Photon Beam Commissioning of Elekta Versa HD Linear Accelerator: A Multi-Institutional Study

Jalalludin [N.A1], Md Radzi [Y1], Noor Rizan [N.N2], Abdul Malek [I.S3], Phang [A4], Yong [S5]

1 School of Physics, UniversitiSains Malaysia, Gelugor, Penang, Malaysia
2 Radiotherapy Department, Gleneagles Medical Centre, George Town, Penang, Malaysia.
3 Radiotherapy Department, Pantai Hospital, Bangsar, Kuala Lumpur, Malaysia.
4 Radiotherapy Department, Pantai Hospital, Bayan Lepas, Penang, Malaysia.
5 Radiotherapy Department, Thompson Hospital, Kota Damansara, Kuala Lumpur, Malaysia.

Background or Introduction: ELEKTA has recently released linear accelerator referred as Versa HD. Beam modelling and commissioning is an important step in the acceptance and validation of beams during installation before being put into clinical use to ensure a successful treatment.

Material and methods: In this work, we report on the dosimetric analysis of means, standard deviations, and relative differences of 6 MV and 10 MV photon beam commissioning from 4 institutions with Elekta Versa HD unit. These included percent depth dose (PDD), beam profiles, and relative photon and electron output factors.

Results and discussion: Dosimetric data showed good agreement between machines. PDDs deviation of dmax and D80 were within the tolerance for field size 10×10 cm2 and 30×30 cm2 with maximum relative difference were <±1% for both energies. However, for small field (5×5 cm2)as at 10 cm depth recorded the highest relative difference but still within the tolerance value of ±2%. Beam flatness and symmetry of the profiles were within tolerance range with maximum relative difference values at central region for 10×10 cm2 and 30×30 cm2 at 10 cm depth were <1.5%. However, at field size of 5×5 cm2 for both 6 MV and 10 MV, the maximum relative difference showed a greater value (>±2.5%). However, output factors for 10 MV were in good agreement with coefficient of variation <2.15%.

Conclusion: Although both 6 and 10 MV photon beam passed the standard beam tolerance set by vendor, only 10 MV can be represented by one set of data. For 6 MV, output factors from two of four accelerators showed large discrepancy.

OP-18

Profile calculation with a given incident free air profile: A montecarlo method

S Poudel[1], G Hartmann[2], G A Zakaria[3], A Kulshreshtha[1]

1. Amity School of Applied Science, Amity University, Lucknow, India
2. German Cancer Research Center, Heidelberg, Germany
3. Klinikum Oberberg, Teaching Hospital of University of Colonge, Germany

Introduction: Precise profile measurement and proper detector selection for its measurement in small photon fields is critical in modern radiotherapy.Either during commissioning of megavoltage photon beam or regular QA measurements, it is a time consuming process demanding huge skills and dedication. In this study, we performed montecarlo simulation for different detectors in order to calculate profiles at various depths with a given incident free air profile for 6 MV photon beam generated by a medical linear accelerator.

Method: Monte Carlo programs were coded in fortran visual studio for the detectors selected. A free air profile is designed as estimator to estimate the profiles at various depths.As a part of Montecarlo

calculation, the density function of the given input distribution was created which lies between 0 and 1. Then a random number between 0 and 1 was selected and analyzed to which abscissa of the density function the random number taken as ordinate value of the density function refers. This is done stepwise. Random numbers are taken very often (N_MC= 108) creating a huge number or distribution of x-values.The values were analyzed in a grid in order to determine the frequency within each grid bin. This frequency distribution is converted into a histogram output file and later plotted as profiles.

Results: Profiles at different depths were both measured, calculated with montecarlo method and then compared. They achieved a good agreement.

Conclusion: Full Montecarlo simulation with standard codes are time consuming and have some limitations. However, with this process we have been able to calculate profiles at various depths with greater ease.

OP-19

Deep Inspiration Breath-Hold Technique for Left-Sided Breast Cancer: A Single Institutional Review

Kausar A, Nawrin R N, Alam M, Huque S, Jobber A, Kabir E, Kader K M
Dept. of Medical Physics, Delta Hospital Limited, Dhaka, Bangladesh

Deep Inspiration Breath Hold (DIBH) is a common method for left-sided breast cancer patients that reduce the potential impact of radiation on the heart. This study investigates the DIBH technique to optimize cardiac sparing in left-breast radiotherapy (RT) and the impact of dose variables upon organs at risk (OAR) dose in DIBH RT at our institute.

Ten left-breast mastectomy patients were immobilized with breast board and underwent using DIBH radiotherapy controlled by the Varian Real-time Position Management (RPM) system. Selected patients had two sets of CT images of both free breathe (FB) and DIBH in the same setup. Treatment plans for FB and DIBH were retrospectively generated by using Varian Eclipse treatment planning system with three dimensional conformal radiation therapy techniques (3DCRT). The standard fractionation regimen of 40.05 Gy in 15 fractions. The dosimetric parameters in heart (mean dose) and lung (mean &V20) were obtained from the dose–volume histogram. Comparison of free-breathing (FB) and DIBH treatment plans for all patients enrolled confirmed DIBH reduced heart radiation dose by 60%. Low OAR doses were achieved overall: the mean heart dose was 2.76 Gy, and the mean & V20 of ipsilateral lung dose was 10.44 Gy and 20.11%.

Treatment of left-sided breast cancer in DIBH reduced dose to the heart and in most casesthe lung dose. Most patients have significant dosimetric benefit with DIBH, and this technique should be planned and evaluated for all patients receiving left-sided breast/chest wall radiation.

OP-20

Dosimetric Comparison between Intensity modulated radiotherapy versus volumetric modulated arc therapy treatment plans for Breast Cancer

Rahman M[1], Dr. Md. Akhtaruzzaman[3], H.A.Azhari[1], G.A. Zakaria[1,2], Mokhlesur [R1]

1 Dept. of Medical Physics and Biomedical Engineering, Gono University, Dhaka, Bangladesh.
2 Dept. of Medical Radiation Physics, Gummers Bach Hospital, Academic Teaching Hospital of the University of Cologne, Gummers Bach, Germany.
3 Dept of Labaid Cancer Hospital and Super Speciality Center, Dhanmondi, Dhaka.

Purpose: This study compared the dosimetric characteristics of volumetric modulated arc therapy and Intensity modulated radiotherapy techniques regarding target volume coverage and dose to heart, spinal cord, and lung for patients with breast cancer. We analyzed the dosimetric differences of plans in the treatment planning system between VMAT and IMRT in treating breast cancer.

Method and Materials: Treatment plans were analyzed for 10 patients. Patients were treated with a technique that concurrently combines IMRT beams and the VMAT technique. IMRT treatments are generated using 4 tangential fields IMRT and VMAT plans were made with one arcs fields for the same patients. IMRT and VMAT treatments plans were planned for 50 Gy in 25 fractions. All treatment plans were planned due to protocols & the patient's condition. Comparative endpoints were dose homogeneity within PTV, target dose coverage, doses to the critical structures and number of monitor units, treatment delivery time. Both plans were optimized to Dose-volume histograms values.

Result: The IMRT & VMAT average mean heart dose was (cGy), V30 (%) and V33 (%) for the heart were 453.7±75.5,0.85%±0.06% and 0.19%±0.017% by VMAT, and 421.7±48.6 ,0.25%±0.11% and 0.016%±0.011% by IMRT, respectively. The left lung mean dose (cGy), V10 (%), V20 (%) were significantly reduced from 1459.5±36.99, 36.5%±0.96% and 19.1%±0.51% with VMAT to 1356.2±48.77, 35.7%0.49% and 18.27%±0.64 with IMRT, respectively. The mean dose (Gy), 0.03 cc for the spinal cord were by 1 872.6 ± 25.64 cGy VMAT, and 872.6 ± 25.64 cGy by IMRT, respectively.

Conclusion: IMRT plans showed significantly higher mean dose coverage to the PTV and conformity, homogeneity Index better than the VMAT plans. The IMRT plans typically had more favorable dose characteristics to the lung, heart, spinal cord and body dose when compared with VMAT. The main important advantage of VMAT is MU & treatment delivery time better than IMRT.

OP-21

Electron Beam Commissioning of Elekta Versa HD Linear Accelerator: A Multi-Institutional Study

Huang E.P.S[1], Md Radzi Y[1], Noor Rizan N.N[2], Abdul Malek I.S[3], Phang A[4], Yong S[5]

1. School of Physics, UniversitiSains Malaysia, Penang, Malaysia
2. Radiotherapy Department, Gleneagles Medical Centre, Penang, Malaysia
3. Radiotherapy Department, Pantai Hospital Bangsar, Malaysia
4. Radiotherapy Department, Pantai Hospital Penang, Malaysia
5. Radiotherapy Department, Thomson Hospital Kota Damasara, Malaysia

Background or Introduction: Electron beam commissioning of a linear accelerator is an important step in the acceptance and validation of beams during installation before being put into clinical use. The beam commissioned must meet the standard beam profile offered by the vendors.

Material and Methods: In this work, we report on the means, standard deviations, and relative differences of 6, 12, and 15 MeV electron beam profiles from 4 institutions. The beam profiles studied include PDD, crossline profile, inline profile, and electron output factor.

Results & Discussions: The result shows significant differences between PDDs of different field sizes and linacs with p-value < 0.05. There were small standard deviations around buildup region and dmax of PDD with maximum variations in the exponential region. Maximum standard deviations were all less than 8% for all energies. Relative differences reached maximum at 122% for 4 MeV PDD. P-values < 0.05 obtained for beam profiles between linacs for all energies except 6x6 cm2 in 12 MeV and 15 MeV (crossline) and 6x6 cm2 in 12 MeV (inline). Less than 1% standard deviations and 2% relative differences were observed approximately 64.56%, 76.92%, 81.08% and 90.48% of FWHM for crossline and inline profile of 6x6 cm2, 10x10 cm2, 14x14 cm2, and 20x20 cm2 field sizes respectively.

Conclusions: The data offers an insight into the current beam variation of Elekta Versa HD, technical guideline data for future Elekta Versa HD commissioning, and the improvement needed to produce linear accelerators with standardized beam profiles.

OP-22

The Role of Dose Rate and Gantry Speed Variations in Progressive Resolution Optimizer (PRO) and Photon Optimizer (PO) Algorithms for Rapidarctm Volumetric Modulated Arc Therapy Delivery

Sundaram Venugopal[1], Govind Rao[1], Moujhuri Nandi[1], Manjulika Bhattacharjee[1], Josmi Joseph[2], Boopalan balaji[3], DeepaliBhaskar Patil[4]

1. Meherbai Tata Memorial Hospital, Jamshedpur, Jharkhand, India.
2. All India Institute of Medical Sciences, Jodhpur, Rajasthan, India.
3. KLES Belgaum Cancer Hospital, Belgaum, Karnataka.
4. State Cancer Institute, IGIMS, Patna.

Introduction: The study was performed to assess and compare the performance of two different RapidArcTM optimization algorithms such as PRO and PO by changing the Gantry speed and Dose Rate technical parameters. Additionally, the study aimed to assess the plan quality, agreement between plan delivery and TPS calculation, technical delivery performance using with trajectory log files.

Material and methods: Total five patients selected for this study from each site: Brain, Head and Neck, Hodgkin's Lymphoma, Advanced Right Lung, Ca cervix. The RapidArcTM plans were generated using Varian Eclipse TPS v15.6 PRO and PO algorithms with maximum range of Dose Rates (DR) from 100 to 600 MU/min, minimum 0.5 and maximum Gantry Speed (GS) fixed at 6.0 deg/sec. The reference plans were created for all patients by PO algorithm with GS 6.0 deg/sec and DR 600 MU/min, other plans were re-optimized using same dose constraints and objectives, for each patient 24 plans were generated and total 120 plans were created. Pretreatment gamma verification were performed using Portal dosimetry and ArcCheck to assess deliverability and accuracy. Plan quality scores were analyzed using target and OAR's values. Trajectory log files from Truebeam LINAC controllers were collected and analyzed to verify delivery performance.

Results: The result of the study shows: (i) Plan quality values both algorithms achieved similar results and no significant differences were observed; (ii) Closely similar results of dynamic range MU/deg is achieved across all dose rates with both gantry speed modulation and the values range from 2.244±0.38 and 2.027±0.35 (iii) Total mean Monitor Units (MU) for PO maximum is 14 % higher than the PRO; (iv) Reduced total beam on time is a major benefit of high DR and GS compare to constant DR and GS; (v) DR has higher priority over GS modulation and compensation mechanism adjustment between both algorithms are different for higher DRs. (vi) Pretreatment quality assurance in gamma evaluation (1 % & 1 mm) using Portal dose and ArcCheck analysis shows a maximum difference of 15 % in slow GS compare to max. GS. For both PO and PRO (vii) Trajectory log files maximum deviations observed for gantry positions, MU and DR results for PO and PRO were -0.1 deg, -0.03, 88.17 MU/min and -0.12 deg, -0.03, 83.84 MU/min respectively.

Conclusion: These results show that new PO algorithm is either clinically beneficial or neutral in terms of plan quality and efficiency in comparison to PRO. The parameters GS and DR in optimization engine might be undeviating for those variables and capable of generating plans unaided from the limits chosen. The pattern of DR variation between adjacent Control Points in PO was significantly different than PRO.

Parallel Session- III(A): Brachytherapy

OP-23

Impact of Dwell Time Deviation Constraint on Dosimetric Parameters in Interstitial Brachytherapy of Cervical Carcinoma Using Ipsa Technique

Srivastava S[1], Abdussameeh M[2], Moirangthem N3, Varghese M[1]

1. Department of Radiotherapy, King George's Medical University, Lucknow, Uttar Pradesh, India
2. Department of Radiation Oncology, Artemis Hospitals, Gurugram, Haryana, India
3. Department of Radiation Oncology, Dr. B. Borooah Cancer Institute, Guwahati, Assam, India

Introduction: Inverse planning simulated annealing (IPSA) optimization technique has been used in cervical cancer to arrive at an optimal solution by finding a suitable combination of dwell positions and dwell time. However, significant variation in intracatheter dwell times can result in localized hot spots. The study aims to evaluate the effect of dwell time deviation constraint (DTDC) on dosimetric parameters in IPSA-based HDR interstitial brachytherapy of cervical cancer patients.

Material and Methods: 8 patients with 16 CT data sets of Martinez Universal Perineal Interstitial Template (MUPIT) implants in cervical cancer were retrospectively studied. HR-CTV and organs at risk (OAR) were contoured in the Oncentra treatment planning system using GYN GEC-ESTRO guidelines. Patients were planned for 24 Gy in 4 fractions using the IPSA technique at DTDC values of 0, 0.2, 0.4, 0.6, 0.8 and 1.0 respectively. The impact of change in DTDC values on dosimetric parameters was studied in terms of HR-CTV coverage, OAR doses, homogeneity index (HI), conformity index (CI) and modulation index (MI).

Results & Discussion: HR-CTV V100 values decreased by 1.54% and 8.11% respectively with increase in DTDC values from unconstrained (DTDC=0) to extremely constrained (DTDC=1) plan. There was a significant decline in the host spot volumes V150 and V200 at DTDC value 0.2. Similarly, the dose to 2cc, 1cc and 0.1 cc volumes of bladder and rectum were minimum at DTDC 0.2. A decrease in MI by 35.30% and 84.69% was found at DTDC values 0.2 and 1 respectively compared to DTDC 0. Plans generated with DTDC 0.2 showed better HI and CI of the target volume.

Conclusion: DTDC variation can help in reducing large dwell times on a single dwell position and in respective catheters. DTDC value 0.2 was optimal in achieving the homogenous dose distribution and reducing the high dose volumes.

OP-24

A Retrospective Study On the Dosimetric Effect of Not Applying a Shift in Varian Ring Applicators for HDR Cervix Brachytherapy Treatments

Khalid, Abdul Sattar

National Center for Cancer Care and Research, Hamad Medical Corporation,Doha, Qatar

Background: It is critical to ensure Varian Ring applicators are commissioned correctly and this study aims to highlight this importance by retrospectively showing the potential dosimetric impact on Cervix Brachytherapy treatments.

Materials & Method: 88 HDR plans for 22 Cervix Brachytherapy patients previously treated with the GammMed plus iX HDR unit were recalculated in Eclipse v16 BrachyVision after re-planning by removing the shift applied in the Ring. DVH metrics for the Gross Tumour Volume (GTV), High-Risk Clinical Target Volume (CTV-HR), Intermediate Risk Clinical Target Volume (CTV-IR), Bladder,

Rectum, Sigmoid and Bowel were compared between the original plans and the plans with no Ring Shift applied.

Results & Discussion: The V100% and D98% doses for HR-CTV were lower in the plans with no shift by up to 4% and 18% respectively (statistical significance of $p < 0.05$). The GTV D98% was shown to be on an average 0.5% lower and up to 16.5% lower in the plans where no shifts were applied; however, there was no statistical significance in the difference. No statistical difference was seen in the D98% for the IR-CTV between the plans. Bladder, Rectum and Sigmoid D2cc doses were on average higher in the plans with no shifts and by up to 29.6%, 30.2% and 18.4% respectively (strong statistical significance seen in these differences). There was no statistical difference seen in the D2cc for the Bowel between the plans.

Conclusion: Based on this planning study; not applying a shift in the Varian Ring applicator can have a large impact and increase on the doses delivered to Bladder, Rectum and Sigmoid where the increases were seen to be significant and would result in plans outside the recommended tolerance for these Organs art Risk (OARs). The effect on the target organs is not as pronounced and the differences are insignificant.

OP-25

Dose Comparison between TG-43 and TG-186 behind small air cavity

Khondakar M. J[1], Walter R[2], Zakaria G. A[1,3,4], Azhari H. A[5]

1. Department of Medical Physics and Biomedical Engineering (MPBME), Gono Bishwabidyalay, Savar, Dhaka, Bangladesh.
2. Department of Medical Physics and Radiation Protection, University Hospital, Augsburg, Germany.
3. South Asia Centre for Medical Physics and Cancer Research (SCMPCR), Dhaka, Bangladesh.
4. Department of Biomedical Engineering, Anhalt University of Applied Science, Koethen, Germany.
5. Secretory-General of Asia-Oceania Federation of Organization (AFOMP) for Medical Physics.

Introduction: The human body has several air cavities including lung, oral cavity, nasopharyngeal, paranasal sinuses, etc. In the case of nasopharyngeal treatment, a small air cavity impacts the calculation dose due to small air space in the nasopharynx. The effect has been verified for the presence of different size air cavities close to an Ir-192 source and determines the dose calculation errors introduced by ignoring their presence in treatment planning system through TG-43 & TG-186 based algorithms.

Materials & Methods: Oncentra Brachy with ACE was used to create an empty image series and a virtual cuboidal phantom with a uniform density of water was set up by contouring in the series. A semi-immersed cylindrical structure was added, and the cuboid structure was adjusted. The cylinder was given by air density and water density in the outer margin covered by the contour of 3 mm thickness. The sizes of cylinders had been varied and the virtual catheter was defined along the cylindrical axis. A dwell position was activated in the center of the cylinder and in later calculations, 2 and 4 dwell positions were added symmetrically. Seven points were created to compare the dose from 4 mm source distance in the air cavity and other points in tissue or behind the air cavities, 6 mm to 6 cm variable distances.

Results: Comparing between TG-186 and TG-43 did show significant difference for air cavity dose but did not show considerable difference in water or behind the air cavity for smaller sizes and with different active dwell positions. For small air cavities, the dose deviation or error can be ignored but for larger, the difference might be clinically significant.

Conclusion: TG-186 algorithm offered a better method for brachytherapy dose calculation except for

OP-26

High Dose Rate Brachytherapy Machine Installation and Quality Management

Miah Md. Shahidul

Department of Radiotherapy, Rajshahi Medical College Hospital, Rajshahi

Introduction: In this work perform to evaluate the accuracy of radiation dose delivered to the cancer patients byusing HDR Brachytherapy and to know proposed methods for the initial source installation tests, acceptancetesting, and quality assurance and audit program is done on BEBEG Multisource Co-60 HDR Brachytherapyafterloader at Rajshahi Medical College Hospital.

Methods and Materials: The observation of reference Air Kerma strength (maximum dose distribution) wasdetermined by using a well-type ionization chamber [PTW SN000595] and PTW UNIDOSE electrometer[SN082145]. A careful radiation survey has been completed around the brachytherapy machine and outer wallof the machine room by using a well-calibrated NUCLEONIX radiation survey meter [CMP710P]. The qualityassurance programmed and Acceptance testing, commissioning of the HDR brachytherapy unit have beencompleted carefully and successfully.

Result and Discussion: The reference Air Kerma strength in the newlyinstalled source was calculated and the measured values were 23.66mGy/h and 24.12mGy/h respectively, andthe deviation was 1.94% which does not exceed the tolerance limit ±3%. The calculated and measure sourceactivity were 67.99GBq and 68.64GBq, and the deviation was 0.9% respectively, which does not exceed itstolerance limit ±3%. The quality assurance program has been done completely such as door interlock,emergency equipment, treatment interruption, dummy check, communication system, treatment planningsoftware check; data transfer from planning computer, etc and results was satisfactory. The source positionalaccuracy, Dwell time accuracy, and Timer accuracy have been determined and results within the tolerance limit.

Conclusion: BEBEG Multisource Co-60 HDR brachytherapy system has been implemented in our unit. Theacceptance test shows that status of brachytherapy and its components are functioning well. The radiationdose which will be delivered to the cancer patients is within the planned dose.

Parallel Session- III (B): Machine Learning and Artificial Intelligence in RT

OP-27

Designing of a Decision Support System for Cancer Treatment Using Artificial Intelligence

Md. Anwarul Islam[1], Md. Shafiul Alam[2], Md. Ashrafuzzaman[3*]

1 3Department of Biomedical Engineering, Military Institute of Science and Technology (MIST), Dhaka-1216, Bangladesh

2 Department of Electrical and Electronic Engineering, University of Dhaka, Dhaka-1000, Bangladesh

Introduction: The terrifying rise of deadly disease cancer requires urgent attention of clinicians, researchers and people. In recent years, Decision Support System (DSS) and Artificial Intelligence

(AI) have emerged as an active research area in cancer informatics: prediction, diagnosis, prognosis and treatment design for chemotherapy and radiotherapy.

Problem Statement: Several reasons influence the chemotherapy schedule including the form of cancer, the nature of cancer, the medications used, the expected toxicities of the drugs, and the time required to recover from these toxicities. The oncologists need multifactor analysis of such variables to set the dose of chemotherapy or radiotherapy so that with the reduction of the cancer cells the toxicity in patients' body remains acceptable range. To achieve such an assist multifactor analysis based on the patient body model with DSS and AI is a challenging task but reportedly promising.

Methods: A DSS is designed for single drug chemotherapy and radiotherapy using fuzzy expert control and artificial neural network to capture knowledge of expert oncologists. The whole body with tumor growth is modelled by physiological pharmacokinetic in MATLAB platform. The dosages and schedules designed out of DSS are tested on these models using computer simulation and the results are observed. Finally, these results are compared with the clinically practiced data and tuned the proposed model.

Results: The proposed method response almost same as the patient body for different doses of chemotherapy and radiotherapy as well as it can take decision based on several factors of patient. Else, it is found that dose calculation in our country for chemotherapy and radiotherapy are done just on experience not on the multiple factors influencing the cancer cell growth and patient condition.
Conclusions: This promising proposed method can assist the oncologist to take decision on dose calculation for the cancer patient based on several factors that would help both patient and oncologist. Since the parameters of this model can be regulated from the outcomes of clinical practices, the collective effort of oncologists and engineers could be able to make this model exquisite enough to use it as the second brain of the doctor.

OP-28

Detection and of Lung Cancer Based on Deep Learning: A Comprehensive Review

Lestari F. P., Haryanto F., Arif I.

Department of Physics, Institut Teknologi Bandung, Bandung, Jawa Barat, indonesia

Lung cancer is one of the deadliest diseases in the world. Treatment of this disease is often delayed due to misdiagnosis in the early stages of the most common examination. This misdiagnosis occurs due to differences in the experience of doctors and also the quality of image itself. A method is needed to improve image quality, classification and segmentation automation to assist in cancer diagnosis. To improve image quality, there is a Super Resolution method, while for the classification and image segmentation stages, deep learning methods can be used. In this paper, we present the findings of a systematic literature review covering the articles in which the authors described the application of a deep learning technique and method to an lung cancer purpose such as image improvement, segmentation and classification. We analyzed 50 journal articles published in the last two decades by searching in Scopus and PubMed databases. We report the findings by outlining the articles' content in terms of the main deep learning techniques mentioned the source data and the quality of their predictive performance.

OP-29

Efficient Dose Volume Histogram Based Pretreatment Patient Specific Quality Assurance Methodology with Combined Deep Learning and Machine Learning Models for Volumetric Modulated Arc Radiotherapy

Kecheng Zhu

Department of Radiotherapy Center, Wenzhou Medical University First Affiliated Hospital, Shangcai Village, Wenzhou 325000, People's Republic of China.

Purpose: To develop a dose-volume histogram (DVH)-based pre-treatment patient specific quality assurance (PSQA) for volumetric modulated arc therapy (VMAT) with combined deep learning (DL) and machine learning (ML) models to overcome the limitation of conventional gamma index (GI) and improve the efficiency of DVH-based PSQA.

Methods and Materials: A DL model with a 3DSEBlock incorporated into a modified Unet was developed to predict the measured PSQA DVHs of head and neck (H&N) patients underwent VMAT. After evaluating the differences between treatment planning system (TPS) and PSQA DVHs predicted by DL model with multiple metrics, a pass or fail (PoF) classification model was developed using XGBoost algorithm. Domain experts were consulted during dose errors comparison between TPS and reconstructed PSQA DVHs, as well the final PoF classification evaluation.

Results: A total of 208 H&N patients underwent VMAT between 2018 and 2021 from two hospitals were enrolled. The prediction model was able to achieve a good agreement between predicted, measured and TPS doses. Quantitative evaluation demonstrated no significant difference between predicted PSQA dose and measured dose for target and OARs, except for Dmean of PTV6900 ($p = 0.001$), D50 of PTV6000 ($p = 0.014$), D2 of PTV5400 ($p = 0.009$), D50 of left parotid ($p=0.015$) and Dmax of left inner ear ($p=0.007$). The XGBoost model achieved an area under curves (AUC), accuracy, sensitivity and specificity of 0.89 vs. 0.88, 0.89 vs. 0.86, 0. 71 vs. 0.71, and 0.95 vs. 0.91 with measured and predicted PSQA doses, respectively. The agreement between domain experts and the classification model was 86% for 28 test cases.

Conclusions: The successful prediction of PSQA doses and classification of PoF for H&N VMAT PSQA indicating that this DVH-based PSQA method is promising to overcome the limitations of GI and to improve the efficiency and accuracy of VMAT.

OP-30

Automated approach for estimation of the normal or abnormal stages of the kidney using an artificial neural network for the prediction model of the Glomerular Filtration Rate

Hossain A[1],Sarker S[1], Chowdhury S I[2], Ahsan M S[2], Laz N B[2]

1. Department of Physics, University of Rajshahi, Rajshahi-6205, Bangladesh
2. Institute of Nuclear Medicine and Allied Sciences, Rajshahi-6000, Bangladesh Atomic Energy Commission, Bangladesh

Introduction: Chronic kidney disease (CKD) is diagnosed using a gamma camera in a nuclear medicine center or hospital as part of a routine procedure, but the gamma camera does not provide accurate disease stages. The goal of the study was to use an artificial neural network to determine whether CKD was in normal or abnormal stages based on the value of GFR (ANN).

Material and Methods: The two hundred fifty (Training 188, Testing 62) kidney patients scanned using gamma camera who underwent the ultrasonography test to diagnose the renal test in our nuclear

medical centre. Before the scanning procedure, the patients were given a 99mTc-DTPA injection. The gamma camera calculates the pre-syringe and post-syringe radioactive counts after pushing the injection into the patient's vein. The artificial neural network was used to detect CKD normal or abnormal labels based on the value of GFR in the output layer.

Results & Discussions: For K-fold cross-validation, the proposed ANN model had a 99.20 percent accuracy. The sensitivity and specificity were 99.10 % and 99.20 %, respectively. The AUC (area beneath the curve) was 0.9994.

Conclusions: The proposed model, which employs an artificial neural network, can distinguish between normal and abnormal CKD stages. After clinical implementation of the proposed model, the gamma camera may be upgraded to diagnose normal or abnormal stages of CKD with an appropriate GFR value.

OP-31

Radiomic prediction of distant metastasis after dynamic tumor tracking stereotactic body radiation therapy for non-small cell lung cancer: a multi-institutional analysis

Adachi T[1,2], Nakamura M[1,2], Karasawa K[3],†, Kokubo M4, Sakamoto T[5], Matsuo Y[2], Hiraoka M[6], Mizowaki T[2]

1. Division of Medical Physics, Department of Information Technology and Medical Engineering, Human Health Sciences, Graduate School of Medicine, Kyoto University, Kyoto, Japan
2. Department of Radiation Oncology and Image-applied Therapy, Graduate School of Medicine, Kyoto University, Kyoto, Japan
3. Division of Radiation Oncology, Department of Radiology, Tokyo Metropolitan Cancer and Infectious Diseases Center Komagome Hospital, Tokyo, Japan.
4. Department of Radiation Oncology, Kobe City Medical Center General Hospital, Hyogo, Japan
5. Department of Radiation Oncology, Kyoto Katsura Hospital, Kyoto, Japan
6. Department of Radiation Oncology, Japanese Red Cross Society Wakayama Medical Center, Wakayama, Japan

Deceased April 27th, 2021

Introduction: To develop the predictive model of distant metastasis (DM) in non-small cell lung cancer (NSCLC) patients afterdynamic tumor tracking stereotactic body radiation therapy (DTT-SBRT) using computed tomography (CT)-based radiomic features.

Material and Methods: The study analyzed 609 patients with NSCLC who underwent lung SBRT from 12 institutions. Patients were divided into training/validation (567 patients in 11 institutions) and external test (42 patients in four institutions) dataset. First, a total of 944 CT-based radiomic features were extracted from inside gross tumor volumes with a resampled voxel size of 1 × 1 × 1 mm. Next, the predictive model for DM was developed using random survival forest algorithm, and the patients were dichotomized into high-risk and low-risk group based on the median value of patient-specific risk scores. After feature selection and optimal hyper-parameter searching in the training/validation dataset, the model was applied to the test dataset. Finally, the model classification performance of time to the DM incidence was evaluated by concordance index (C-index) at three years. Gray's test was conducted to evaluate the statistical significance between the high-risk and low risk-groups.

Results: A total of 122/567 (21.5%) and 6/42 (14.3%) patients developed DM in the training/validation and test dataset, respectively. The C-indices of training, validation, and test datasets were 0.69, 0.62, and 0.55, respectively. CT-based radiomic model successfully dichotomized the incidence of DM after DTT-SBRT in the training ($p = 1.33e-8$) and validation ($p = 0.029$) dataset; however, the incidence of DM in the test dataset was 6/27 patients (22.2%) and 0/15 patients (0.0%) in the high-risk and low-risk groups, respectively ($p = 0.054$).

Conclusion: CT-based radiomic approach may be useful to predict the incidence of DM after DTT-SBRT in multi-institutions. Standardization of CT imaging parameters of each institution would be required to predict DM after DTT-SBRT accurately.

OP-32

The Effects of Automatic Segmentations on Preoperative Lymph Node Status Prediction Models with Ultrasound Radiomics for Patients with Early-Stage Cervical Cancer

Juebin Jin, Yao Ai, Xiance Jin

Department of Radiotherapy Center, Wenzhou Medical University First Affiliated Hospital, Shangcai Village, Wenzhou 325000, People's Republic of China

The purpose of this study is to investigate the effects of automatic segmentation algorithms on the performance of ultrasound radiomics models in prediction the status of lymph node metastasis (LNM) for patients with early-stage cervical cancer preoperatively. Ultrasound images of 148 cervical cancer patients were collected and manually contoured by two senior radiologists. Four deep learning based automatic segmentation models: U-net, CE-Net, Resnet, and Attention Net were constructed to segment the tumor volumes automatically. Radiomics features were extracted and selected from manual and automatically segmentedregions of interest (ROIs) to predict the LNM of these cervical cancer patients preoperatively. The reliability and reproducibility of radiomics features, the performances of prediction models were evaluated. A total of 449 radiomics features were extracted from manual and automatic segmented ROIs with LIFEx. Features with an ICC > 0.9 were all 257 (57.2%) from manual and automatic segmented contours. The AUCs of validation models with radiomics features extracted from manual, attention U-net, CE-net, Resnet, and U-net were 0.692, 0.755, 0.696, 0.689, and 0.710, respectively. Attention U-net showed best performance in the LNM prediction model with a lowest discrepancy between training and validation. The AUC numbers of models with automatic segmentation features were 9.11%, 0.58%, -0.44%, and 2.61% higher compared with models with manual contoured features for attention U-net, CE-net, Resnet, and U-net, respectively. In a conclusion, the reliability and reproducibility of radiomics features, as well as the performance of radiomics models were affected by manual segmentation, automatic segmentations, as well as by different feature extracting methods.

OP-33

Lesion Image Synthesis Using AI-Based Sketch-to-Image Translation: A Preliminary Study on Lung Cancer CT Images

Ryo Toda[1], Atsushi Teramoto[1], Masashi Kondo[2], Kazuyoshi Imaizumi[2], Kuniaki Saito[1], Hiroshi Fujita[3]

1. Graduate School of Health Sciences, Fujita Health University, Toyoake, Japan
2. School of Medicine, Fujita Health University, Toyoake, Japan
3. Faculty of Engineering, Gifu University, Gifu, Japan

Introduction: With the remarkable advances in artificial intelligence (AI) technology, its applications are rapidly expanding in medicine. For the AI applications in this field, especially medical image, data shortage is a common challenge. Recent years, a realistic image synthesis technology with AI named Generative Adversarial Networks (GAN) has been adopted to solve this problem. However, it has a difficulty about controlling the feature or the shape of the object in its generated image. This is one of the reasons for the limited application of generated images. In this study, we introduce Pix2pix, a derivative of GAN, to synthesize images with arbitrary lesion shape from sketches. For the preliminary

study, we chose CT images of lung cancer as the target.
Material and Methods: In this study, we used chest CT images of 133 lung cancer cases. Axial images around the lesion were extracted from each CT image for the analysis. Pix2pix is a technology that can translate simple input images to photorealistic images. In this study, for alternatives to sketches, edges detected from CT images are used for the training of Pix2pix. Generated images were compared with the real CT images. In addition, images were generated from handwritten sketches made by doctors based on real CT images.

Results & Discussion: Lesion images with complex shapes could be generated from both edges and handwritten sketches. Several variations of handwritten sketches were used, from coarsely to finely drawn. Although images could be generated from coarse sketches, fine sketches yielded more realistic images. This was confirmed by image quality metrics such as Peak signal-to-noise ratio. On the other hand, since the input was just a sketch, it was difficult to represent the surrounding structures.

Conclusions: We conducted the realistic lesion image synthesis from the sketches. Although there is room for improvement, the feasibility of our method was indicated.

OP-34

Deep Learning-Based Auto-Segmentation of Breast Cancer: A Systematic Review of Multi-Modality Imaging Methods

Yazid, F. N. A[1], Rahmat K.[1], Wong J. H. D.[1], Kuo T. L.[1], Ab Mumin N.[1,2]

1 Department of Biomedical Imaging, Faculty of Medicine, Universiti Malaya, Kuala Lumpur 50603, Malaysia
2 Department of Radiology, Faculty of Medicine, UniversitiTeknologi MARA, Selangor, 47000, Malaysia

Background or Introduction: Primary imaging modalities of breast cancer are mammography and ultrasound. Recently, newer technologies such as digital breast tomosynthesis (DBT) and automated breast ultrasound (ABUS) provided 3D imaging, thereby improving breast cancer diagnosis. Radiomics and the application of artificial intelligence in breast cancer management is a relatively new field that attempts to explore imaging features in medical images. Studies had shown the potential of this technique in complementing the current method. However, one of the bottlenecks and limitations in radiomics is the number of curated medical images, which often required radiologists' manual segmentation of the breast lesions. Manual tumour segmentation is time-consuming, and the segmentation needs to be accurate as it will affect the classification performance. Hence, there is a need to explore methods to develop automatic tumour segmentation algorithms which can assist radiologists.
Material and Methods: A literature search was done by searching the databases (PubMed, Web of Science and IEEE) for articles published between 2012 to 2021. Furthermore, this review analyses the datasets, methods and results of the previous works. Then, future works were discussed to find a significant gap between published papers.

Results & Discussion: Publications that utilized deep learning to segment breast tumour were identified. Papers on mammography and DBT have the highest(n=60) and lowest(n=4) number of articles published, respectively. These papers reviewed the deep learning technique on public and/or private datasets. U-Net architecture is in trend and more effective from the convolutional network layers. The segmentation results were compared in terms of accuracy and dice coefficient.

Conclusions: There are considerable concerns in breast cancer and swift development in deep learning architecture for breast tumour segmentation. Combination from different architectures make U-Net a successful model for breast tumor segmentation. Later, one can develop a good segmentation method that can be useful for mammography, DBT, ultrasound and ABUS modalities based on our review paper.

OP-35

Preliminary study on virtual cleansing by CycleGAN in CT colonography

Isobe Yoshitaka [1,2], Yoshida Nobutaka[1] Teramoto Atsushi[2]

1. Japan Community Healthcare Organization Yokkaichi Hazu Medical Center,Yokkaichi, Mie, Japan
2. Graduate School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan

Purpose: CT colonography is an examination of the colon using CT imaging without the use of an endoscope. After CT imaging, virtual cleansing (VC) which eliminates the region of the mixed residue and oral contrast medium is performed for diagnosis. Although various methods regarding to VC have been proposed, further improvement in accuracy is required. Various VC methods have been proposed, but further improvement in accuracy is desired. In this study, we focused on CycleGAN, which is an artificial intelligence technology used for image transformation. In this study, we aimed to develop a VC method to remove residues in the colon using CycleGAN.

Methods: CycleGAN is a method that realizes image transformation by training the relationship between the two kinds of images. For this study, we collected 50 colorectal CT images and 50 VC images that regions of contrast agents were manually removed on a workstation; they were fed them to CycleGAN to learn the relationship between them. After the training, CycleGAN was used to remove the contrast agent component from the colon CT images, and the obtained images were subjectively and quantitatively evaluated.

Results: As a result of processing by CycleGAN, only the region of contrast medium was removed while maintaining the structure of the body. The results of quantitative evaluation also showed that the effect of contrast media in the colon was reduced.

Conclusions: In this study, we investigated whether VC of CT colonography can be performed by CycleGAN, which is one of the artificial intelligence techniques. The output images and quantitative evaluation results showed that the contrast medium in the colon was removed well, and it was confirmed that VC was possible by CycleGAN.

Parallel Session- IV (A): Dosimetry & QA-1

OP-36

Influence of Post-synthesis and Post-irradiation Times on Dosimetric Properties of a VIPET-type Gel Dosimeter

Mosleh-Shirazi MA [1,2], Farahani S [1], Riyahi Alam N [3,4], Raeisi F [1], Mahdavi SR [5]

1. Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
2. Physics Unit, Department of Radio-oncology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
3. Department of Medical Physics and Biomedical Engineering, Tehran University of Medical Sciences, Tehran, Iran
4. PERFORM Center, Concordia University, Montreal, Quebec, Canada
5 Department of Medical Physics, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

Introduction: Knowing how long after synthesis and/or irradiation a gel dosimeter can still produce reliable results is practically helpful. We aimed to assess the effects of elapsed time on the dosimetric response of a VIPET-type polymer gel dosimeter. The elapsed times between gel synthesis, phantom irradiation and readout using MRI were of interest, especially but not exclusively, for radiotherapy

applications.

Materials & Methods: The global dose response, reproducibility and high-dose-gradient spatial integrity of the gel dosimeter (mean dose over a uniform area and positions of specific isodose levels in a high dose-gradient penumbra region) were studied for up to 6 Gy. Also, their stability during nine-day post-synthesis and post-irradiation periods were investigated at three-day time intervals. After synthesis, several batches of gel vials were irradiated with 6 MV photon beams using a radiotherapy linear accelerator, imaged on a 3T MRI scanner and analysed subsequently. This procedure was carried out for different time and dose schedules.

Results & Discussion: Statistical analyses of the results showed reasonably good reproducibility of dose sensitivity (standard error of measurement, SEM: 0.009) and offset (R0) value (SEM: 0.023) throughout the studied period. Good linear dose-response up to 6 Gy was observed (correlation coefficient, R-squared, being >0.99 and >0.91 over six-day and nine-day 'synthesis-irradiation' periods, respectively). The measurements indicated satisfactory spatial stability of dose distribution in high-dose-gradient regions during the same time period (variations in beam penumbra widths and off-axis positions being typically less than 1 mm).

Conclusions: Our findings show acceptable dosimetric behaviour in terms of dose sensitivity, offset values, dose-response linearity and spatial integrity of isodoses over the course of the nine-day post-synthesis and post-irradiation times. The offered practical flexibility and robustness highlight the promising suitability of the VIPET-type gel for 3D dosimetry in challenging clinical settings such as those encountered with complex radiotherapy techniques.

OP-37

Isodose-Shaped Scintillation Detectors for Measurement of Small Field Output Factors

Hyun-Tai Chung[1], Tae Hoon Kim[2], HyeJeong Yang[3], Jae Young Jeong[2], and Yong Kyun Kim[2]

1 Department of Neurosurgery, Seoul National University College of Medicine, Seoul, Republic of Korea
2 Department of Nuclear Engineering, Hanyang University College of Engineering, Seoul, Republic of Korea
3 Department of Biomedicine & Health Sciences and Biomedical Engineering, Catholic University College of Medicine, Seoul, Republic of Korea

Introduction: Field output factors(OF) of the small fields of Gamma Knife (GK) model Perfexion/Icon were measured using self-developed scintillation detectors, which were designed so the volume averaging correction factors(VACF) could be calculated arithmetically.

Material and Methods: Detectors to measure absorbed dose rates of small field beams were manufactured by 3D printing using self-developed scintillating plastic resin. An isodose-shaped scintillation(ISS) detector was built to the same shape and size as the specific isodose surface of the 4 mm collimator. The ratio of the absorbed dose to a central voxel to an ISS was defined as the VACF. Five scintillators were produced in the ISS-1 type(97.2%), and five were in ISS-2(95.6%). The VACF was calculated using the treatment planning software(LGP: Leksell Gamma Plan) and Monte Carlo simulations. An ISS was connected to an optical fiber, transmitting lights to a photomultiplier tube. The Cherenkov lights from the fiber were excluded by subtracting the output from a dummy detector. The absorbed doses to ten ISS detectors were measured at the center of a solid water phantom in the GK Icon's 4, 8, and 16 mm collimators. Effect of the material density of an ISS and the phantom were obtained by Monte Carlo simulations. Output factors were also measured at seven GK sites with an ISS-1, an ISS-2, and a PTW TM60019 micro-diamond detector to assess the system's stability.

Results and Discussion: The detector output ratios before any correction, after volume averaging

correction, and including the density correction are given in Table 1. The 4 mm OF was 0.8265 +/- 0.0049 with ISS-1 and 0.8246 +/- 0.0050 with ISS-2. The 8 mm OF was 0.8984 +/- 0.0034 and 0.8996 +/- 0.0032, respectively. The 8 mm OF coincided with the LGP value within the standard uncertainly, but 4mm OF was 1.4% higher than the LGP value. The ratio of the ISS output factors to PTW TM60019 was very stable, with variations less than 0.12%.
Conclusion: It was possible to precisely measure the output factors of GK small fields using self-developed isodose-shaped scintillation detectors. The system provided consistent results comparable to a commercial detector.

OP-38

Effect of Gamma Radiation-Induced Crosslinking on Long-Term Dose Response of Novel Graphene Oxide Dosimeter Using Raman Spectroscopy

Nesa E[1], Mohammad Amin H[2], Shahryar M[3]

. 1 Department of Nuclear Engineering, Islamic Azad University, Arsanjan Branch, Arsanjan, Iran
. 2 Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), Paramedical School, Shiraz University of Medical Sciences, Shiraz, Iran
. 3 Radiation Application Research School, Nuclear Science and Technology Research Institute, Karaj, Iran

Background: A dosimeter should have different characteristics including precision, linear dose response in a wide range of radiation dose, energy independent, angular independent, repeatability of the dose response, reproducibility and finally long-term stability of the dosimeter response. In the previous works, the authors introduced a novel gamma radiation dosimeter based on carbon nanostructured materials. In order to use these materials in a suitable dosimeter system, long-term stability of the dose response under the ionizing radiation should be investigated. In the present study, the effect of gamma radiation-induced crosslinking on long-term dose response of graphene oxide dosimeter has been explored using Raman spectroscopy.

Materials and Methods: Graphene oxide was irradiated by gamma-rays of 1.25 MeV using a gammacell-220 in the range of 0-80 kGy at room temperature. Then, the amount of ID/IG parameter was measured subsequently using Raman spectroscopy for various absorbed doses, in which ID and IG are two main peaks of D-band and G-band at 1344 cm-1, 1574 cm-1 respectively. In factthe ratio of ID/IG is a characterizing agent for determination of structural defects created in the material. Then ID/IG plotted versus dose, also after 40 days this method was repeated to investigate fading or stability of the dose response.

Results: Results showed that the samples have been oxidized after 40 days due to storage in room conditions. However, irradiated samples at high doses are less prone to oxidation, due to the fact that gamma irradiation may have created a series of functional groups on graphene oxide surfaces that cause crosslinking between the plates and some defects.

Conclusion: Crosslinking of graphene oxide nano-powder using gamma-rays at high doses near 80 kGy can be an effective method in order to stabilize the dose response of this novel dosimeter.

OP-39

Comparison of the different dosimetric indices for volumetric arc modulated treatment planning using two different treatment planning systems: A Feasibility study for Total Body Irradiation

ReenaKumari [1], Budhi Singh Yadava [1], Pankaj Kumara [2]

1 Chitkara University Institute of Engineering & Technology, Chitkara University, Rajpura, Patiala -140401, Punjab, India
2 Post Graduate Institute of Medical Education & Research (PGIMER), Radiotherapy Department, Chandigarh – 160012, Punjab, India

Aim: The aim of present study is to compare two different planning systems (TPSs) for plan quality and competency of volumetric modulated arc therapy for total body irradiation (VMAT TBI) on elekta linear accelerator 'Versa HD'.

Material and Methods: In this retrospective study ten patients were taken for dosimetric analysis. The montecarlo based TPS Monaco from Elekta and progressive resolution optimizer 3 and anisotropic analytical algorithm (AAA) based Eclipse from Varian were used for generating treatment plans. A total of 12Gy in 6 fractions, daily two fractions six hourly apart was prescribed to cover 95% volume of planning target volume. Upper body CT scans upto mid of thigh with 5mm slice thickness (already treated on Varian trilogy) were exported through dicom to Monaco system. The OARs were brain, b/l lungs, b/l kidneys and liver. The clinically deliverable twenty plans of VMAT TBI, ten for each TPS were generated and analysed. All planning parameters like location of iso-center, beam angles, total arcs and field size were identical for both beams except collimator angle.Dosimetric optimization and calculation was performed in Monaco using Monte Carlo Algorithm with statistical uncertainty of 1%, 1mm dose grid and for eclipse planning system 3mm grid size. The chosencriterion for plan evaluation and comparison was on the basis of plan quality, dosimetric indices like conformity and homogeneity index and OAR doses. The comparison of time for optimization, monitor units and beam on time was also analyzed.

Results: The calculated maximum and mean doses of planning target volume were in the range 14.3321Gy and 12.235Gy for eclipse; and 14.428Gy and 12.198Gy for Monaco system, respectively. The single optimization and dose calculation time for Monaco was approx 2.0-2.5 hrs as compared to 6-8 hrs for eclipse. The variation of HI and CI is shown in (Fig.1a&b). Calculated p values of HI, CI and brain using wilcoxon signed rank test for VMAT TBI plans showed statistically insignificant difference ($P > 0.05$). But monitor units, mean doses to lungs, kidneys and planning time were statistically significant different ($P<0.05$) between the two planning systems.

Conclusion: The plan analysis and dosimetric comparison showed the feasibility of VMAT-TBI treatment using Monaco planning software. Both systems were capable of high quality VMAT-TBI plan generation. But the planning of VMAT-TBI using monaco is easier as it offers better optimization on single target in comparison to eclipse in which target is split into three/four segments to get better quality plan. The montecarlo based dose calculation accuracy with robust optimization tools in Monaco allowed much faster generation of VMAT-TBI plans.

Keywords: Total body irradiation (TBI), volumetric modulated arc therapy (VMAT), organ at risk (OAR), AAA (Anisotropic Analytical Algorithm)

OP-40

Dosimetric Properties of Graphene Oxide Nano-Powder After Electron Irradiation in the Range of Radiation Processing Doses (20-200 kGy)

Hamidreza Z[1], Mohammad Amin H[2], Shahryar M[3]

1 Department of Nuclear Engineering, Islamic Azad University, Arsanjan Branch, Arsanjan, Iran
2 Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), Paramedical School, Shiraz University of Medical Sciences, Shiraz, Iran
3 Radiation Application Research School, Nuclear Science and Technology Research Institute, Karaj, Iran

Background: Radiation processing is one of the well-known techniques in radiation sciences in which ionizing radiations such as electrons are used in the range of high doses. Currently, the radiation processing has extensive applications in various industries, including maintaining the quality of food products, sterilization of healthcare products and medical materials, modification of polymers, etc. However, there is a growing need for accurate and sensitive dosimeters in the high dose range. Following previous promising reports on the unique properties of carbon nanostructures, the present study explored the effects of radiation on structural characteristics of nano graphene oxide.

Materials and Methods: Building upon previous experiences, nano graphene oxide was transferred to special tubes after weighing. Using a 10 MeV Rhodotron accelerator system, the samples were exposed to electron irradiation in the range of 20-200 kGy at room temperature, and a non-irradiated group (0 KGy) was considered as a control. Immediately after irradiation, characterization tests were performed on the samples by Raman spectroscopy, X-ray diffraction (XRD), Field Emission Scanning Electron Microscope (FESEM), and Fourier-transform infrared spectroscopy (FTIR), and the results were qualitatively and quantitatively analyzed.

Results: According to FESEM results, the irradiation induced break and defects in graphene surfaces. However, the cross-linking phenomenon was well found at several dose points. These phenomes were observed through shifts in Raman characteristic peaks (D, G, 2D). In general, changes in the space between the plates were also seen in XRD. A high-dose linear response (R2> 0.99) was found in several wavelengths of FTIR spectrums.

Conclusion: Following these promising results, graphene oxide can be considered as an effective option for the dosimetry of electron radiation in the high dose range. However, further studies in this field are recommended to investigate other dosimetric properties.

Parallel Session- IV(B): Biomedical Engineering

OP-41

The Safe Sticker: Verification of Solar Disinfection of Water by Solar Ultraviolet (UV) Radiation

BUTSON Martin Jonathan

Butsonian Industries Pty Ltd: The SAFE Sticker project Mangerton, NSW, Australia

Introduction: Presently, many millions of people world-wide don't have safe drinking water. One method of sanitation for biological contamination is SODIS or Solar Disinfection of Water. In this process, an appropriate amount of UV is required to disinfect water.

WHO currently recommends 6 hours of sunlight but this number varies substantially in actual use depending on factors such as time of day, cloud cover, shade conditions etc. Thus end users are still often uncertain whether their water is indeed safe to drink.

This work details the invention and properties of the SAFE Sticker. A simple, easy to use , cheap yet accurate detector for verification of SODIS for the people most in need in our world.

Materials and Methods: The SAFE Sticker is constructed from priority materials and designed to slowly change colour under solar UV radiation. The SAFE Sticker has two sections and when both sections are the same colour, the required amount of UV for Solar Disinfection of water has been received.

Results and Discussion: Results show that wild strain E-coli under goes a more than 3 log (99.9%)

reduction from SODIS when solar exposure is verified by the SAFE Sticker. These values are acceptable by the World Health Organisation. Viral and protozoan effects are currently under investigation. End users have stated that the SAFE Sticker is easy to use and does not require any scientific knowledge and very little education to accurately evaluate and determine if SODIS has been achieved.

Conclusion: The SAFE Sticker is simple to use, and a cost effective detector to verify that biological disinfection has been achieved via SODIS and has the potential to improve the life quality and life safety of many lives worldwide.

OP-42

An Automated Classification Scheme of Cytological Images Using Attention-based Deep Multiple Instance Learning

Atsushi Teramoto[1], Yuka Kiriyama[2], Tetsuya Tsukamoto[2], Ayano Michiba[3], Eiko Sakurai[2], Kazuyoshi Imaizumi[2], Kuniaki Saito[1], Hiroshi Fujita[4]

1 Graduate School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan
2 School of Medicine, Fujita Health University, Toyoake, Aichi, Japan
3 Graduate School of Medicine, Fujita Health University, Toyoake, Aichi, Japan
4 Faculty of Engineering, Gifu University, Gifu, Gifu, Japan

Purpose: Cytology, the first step in detecting malignant cells, plays an important role in influencing the final diagnostic results. However, the screener must find suspicious cells within a large number of cells. To assist this, we previously proposed an automated method based on supervised learning that classifies cells in lung cytological images as benign or malignant. However, it is often difficult to label all cells. In this study, we developed a weakly supervised method for the classification of benign and malignant lung cells in cytological images using attention-based deep multiple instance learning (AD MIL).

Methods: Original images of lung cytological specimens were divided into small patch images and stored in bags. Each bag was then labeled as benign or malignant, and classification was conducted using AD MIL. It consists of feature extraction and classification based on attention mechanism. Final classification results are obtained for each bag.
Results: As a result of evaluation, overall classification accuracy reached 90%. As for the comparison of convolutional neural network models for feature extraction, Alex-Net model showed best performance.

Conclusions: These results indicate that our weakly supervised method based on AD MIL may be useful to classify the cytological images without strict annotation.

OP-43

A Study on EEG Signal Classification using Deep Learning Method

Gani AM[1], Haekal M[2], Septiawan RR[3], Arif I[4], Haryanto F[4], Khotimah SN[4]

1 Master Program of Computational Science, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung, Indonesia
2 Department of Physics, Faculty of Science and Data Analytics, Institut TeknologiSepuluhNopember, Surabaya, Indonesia
3 Computer Engineering Study Program, School of Electrical Engineering, Telkom University, Bandung, Indonesia
4 Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung, Indonesia

Electroencephalography (EEG) is a monitoring method based on electrophysiological process to tracks and record brain wave patterns. One of its applications is to identify the brain wave in epileptic seizure cases, which could improve the early detection of such cases. Thus, the focus in this research is to design a robust signal processing algorithm that extracts epilepsy information and classify the diagnosed patients using deep learning algorithm. The subject EEG recordings were obtained from CHB-MIT datasets, collected from 22 subjects, which consist of 5 males and 17 females in the 3-22 age range. All signals was sampled at 256 Hz with 16-bit resolution and most of the file were using 23 channel EEG apparatus. Multiple domains feature extraction was considered for this research since it offers a wide range of important information that is fed into the classification system. The Discrete Wavelet Transform (DWT) and Statistical Moments were used for extracting the spectral and temporal information of epileptic seizures. The spectral analysis aimed to extract the brain rhythmic information while the temporal analysis aims to extract the distribution insights between seizure and non-seizures signal. The wavelet breaks down a signal in the sum of scaled and shifted versions of the wavelet function and the wavelet coefficients were then computed. The performance of the designed classification algorithm was tested with the epilepsy dataset. The results show that the system has achieved high accuracy in determining each class, providing reasonable seizure prediction with 85% average sensitivity and 75% average specificity.

OP-44

Skin Disease Detection Module through Image Processing

Sk. Saima[1], Sadi Mahmood[1], Mala Khan[2], Md. Ashrafuzzaman[1], Md. Asadur Rahman[1]

1 Department of Biomedical Engineering, Military Institute of Science and Technology (MIST), Dhaka-1216, Bangladesh

2 Bangladesh Reference Institute of Chemical Measurements (BRiCM), Dhaka-1205, Bangladesh

Introduction: Skin is the biggest and one of the vital organs, protecting the body and organs of the body from the outside harsh environment while acts as a protective shield to ensure a healthy lifestyle. This integral body part can be affected by various diseases due to the presence of numerous known and unknown micro-organisms. Although, skin diseases are regarded mostly as short-time players but also considered the fourth common cause of human illness, and almost one-third of the world's population is statistically suffered from skin disease.

Problem Statement: Different classes of skin diseases can be identified computer aided image processing technique. In this processing technique significant feature extraction and machine learning based classification are two important challenges need to be overcome for acceptable performance.
Proposed Method: In our proposed work, Skin diseases of four different classes are considered for analysis. With some general preprocessing technique our method proposes to utilize histogram of oriented gradients or HOG features extraction technique as well as multiclass support vector machine or SVM for feature extraction and classification.

Results: We have 87.4126% accuracy by carrying out our methodology on the dataset of 572 images of various diseases. This work will become a prime accomplishment for us if additional improvement can be done for a larger dataset while distinguishing both diseased, non-diseased conditions with upgraded precision.

Conclusions: The present result is promising for 4-class skin disease detection. In future 7-class skin disease with normal condition classification with systematic medication prediction process will be added to this work to enhance the performance of the computer aided method in terms of skin disease detection and medications.

OP-45

Studies on the Propagation of Elastic Waves in Bovine Compact Bones as a Function of Temperature

DeshmukhSaira Khanam[1], Syed Mohammed Shoaib[2], R Jeevan Kumar[1] and Adeel Ahmad [3]

1 Molecular Biophysics Laboratory, Department of Physics, Sri Krishnadevaraya University, Anantapur-500 003, Andhra Pradesh., India.

2 Engineering Physics Lab, MANUU Polytechnic Kadapa Satellite Campus, Dept. of Physics, School of Technology, Maulana Azad National Urdu University, Gachibowli, Hyderabad-500 032, T.S., India

3 Biophysics Laboratory, Department of Physics, Nizam College (Autonomous), Osmania University, Hyderabad-500 001, Telangana State., India.

The study of the propagation of elastic waves in bony hard tissues is an effective means of examining the physical properties of biomaterials. Processes such as recrystallization, annealing, quenching and tempering, plastic deformation and strain ageing can be successfully studied from the internal friction measurements. In the present investigation we calculate and reported the internal friction loss (Q-1) for all the six types of bovine compact bones for the first time in a single experiment by using the ultrasonic piezoelectric composite oscillator technique with the help of X-cut crystal in different physiological conditions. Significant variation is observed from bone to bone. This may be attributed to composition and mineral content of the bones. Peak temperature data also is also determined. Temperature variation of logarithmic decrement in X-cut quartz transducer is also verified with mounting of bovine compact bar shaped bone samples. Variation of internal friction (Q-1) with temperature is also calculated to understanding the mechanism of acoustic losses and phase transitions in these bony hard tissues. Internal friction measurements are also useful to obtain the information about imperfections in bony hard tissues. The present investigation constitutes a step towards the application of natural bovine bone ceramic materials for the transducer applications.

Key Words: Internal friction loss (Q-1) bovine compact bone, fresh and oven dried decalcified condition.

OP-46

Design and Construction of a Portable ECG Machine Operated by Mobile Application for Patients

Hossain A, Alim M N, Zakaria G A

Department of Medical Physics and Biomedical Engineering, Gono University, Savar, Dhaka;

Introduction: Now a day's heart disease (cardiovascular diseases) has become a very big problem for human health. This cardiovascular disease causes the death of human. This paper presents the development of a microcontroller based system for the data visualization of a wireless portal electrocardiogram machine using smart phone by Wi-Fi module which will help those cardiovascular disease patient to diagnose accurately and minimize the risk of sudden death.

Materials and Methods: The materials used in this project were ECG Electrodes, ECG Module (AD8232module), microcontroller (ATmega328p), Wi-Fi Module (ESP8266module), TP4056 lithium battery charger, ultra-fire 18650 batteries (3.7v), power supply (5v), capacitor 22pF, crystal (16MHz),

push button, ECG electrode connector (3.5mm), resistors, power supply and connecting wires. At first the basic microcontroller circuit was designed by Proteus 8.12 and demonstrated. Then the ECG, Wi-Fi and power circuit modules were connected to the microcontroller. The whole device was programmed in C++ and loaded to the microcontroller. A mobile application was developed by using MIT app inventor to operate the device from distant places. ECG data were measured from three patients and recorded in mobile application. The recorded ECG data were analyzed and compared with standard ECG data.

Results: The recorded ECG data represented the time intervals of following segments: P wave, T wave, P-R interval, QRS complex, Q-S interval and S-T interval of the signal. The range of wifi module was upto 50 meters. The values of the segments in seconds were compared to the standard values and found within the normal range.

Discussion and Conclusion: The components used in this device were collected from the local market and costs around 50 USD. There was some noise present in the ECG graph, which needs to be filtered, and it will increase the cost. But, the results are quite satisfactory and reliable at this rate. The device can transfer the ECG data anywhere within range using WLAN, display a long time span and store the signal graphically and numerically.

Parallel Session- V (A): Radiotherapy

OP-47

Short-Term Pain Management of Severe Osteoarthritis Patient for the Hip or Knee Joint Using Low-Dose Radiotherapy: A Literature Review

Ropak R[1],Mokhlesur R[2], Shaheen M[3],Bonosree S[4], Nasima Y[1]

1. Dept. of Physiotherapy,Gono ShasthayaSamajVittik Medical College Hospital,Dhaka, Bangladesh
2. Dept. of Medical Physics and Biomedical Engineering, Gono University, Dhaka, Bangladesh
3. Ahsania mission cancer hospital. Dhaka, Bangladesh
4. Gono ShasthayaSamajVittik Medical College Hospita, Dhaka, Bangladesh

Background: There are many treatment modalities for pain management such as medicine, surgery, physiotherapy and Low-dose radiotherapy (LDRT) etc. Low-dose radiotherapy (LDRT) is used for the reduction of osteoarthritis (OA) pain in Germany and Eastern European countries.
The aim of study is to find out the effect of LDRT on pain in patients with severe OA of the hip or knee joint.

Method: The work is carried out by using different publications which are taken from PubMed, MEDLINE, BMC-Part of springer Nature and Google Scholar with the following LDRT. The number of publications of LDRT is finally used to be completed for the study. The inclusion criteria were: patients older than 50 years, severe OA (Kellgren–Lawrence grade III–IV) of the hip or knee joint, patients not responding to conservative treatment and patients who are inoperable or not willing to undergo surgery. The joint was irradiated with a total dose of 6.0 Gray. The treatment consisted of low-dose irradiation using two parallel-opposed 6MV photon beams. A total dose of 6.0 Gray (Gy) was given in 6 fractions of 1.0 Gy during a period of 2 weeks.

Results: The median age of the included patients was 74 years (range 58–89).The most important finding of this study was that patients showed a clinical relevant pain relief in almost 50% of the joints at 6 weeks after LDRT. No improvement in functioning was observed, and no side effects of LDRT were reported.

Conclusion: The study exhibits that a clinical relevant pain relief at 6 weeks after radiotherapy of LDRT. However, the long-term effect of LDRT was limited. A randomize trial is need to assess the effect of LDRT on pain in patients with OA of the hip or knee joint.

Keywords: Hip, Knee, Low-dose radiotherapy, Osteoarthritis, Pain.

OP-48

Robust Planning Evaluation of Stereotactic Body Radiation Therapy on Hepatocellular Carcinoma

MurtiV.Z[1], Azzi A[1], Wibowo W.E[2], Pawiro S.A[1]

- 1 Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok, West Java, Indonesia
- 2 Department of Radiotherapy, Dr. Cipto Mangunkusumo National Central Public Hospital, Central Jakarta, Jakarta, Indonesia

Introduction: Internal movement during the radiotherapy process is one thing that needs to be considered to achieve a better dose delivery. For example, respiration would stretch the chest and abdominal organs as well as the liver, which is resulting in a dose deficiency. This study aims to observe the efficiency of the robust treatment planning method that calculated the uncertainty of the internal target volume position.

Material and Method: We used ten secondary patient data of hepatocellular carcinoma cases at Dr. Cipto Mangunkusumo National Central Public Hospital. The displacement of 3 and 6 mm to all directions was stated to the target volume as the uncertainty of internal movement, and the scenario was reduced to voxel-wise mean dose distribution. The planning was done by using Eclipse for both standard and robust SBRT techniques. Parameter evaluations such as CI, HI, and GI were observed in this study. Furthermore, we also compared the volume dose loss on GTV between standard and robust plans.

Results and Discussion: We found that the average CI and HI of standard planning were around 17% superior to the robust plan, while the GI of the robust plan was 50% higher than the standard plan. Consequently, the OAR dose in this method is lower than the standard treatment plan. The estimated dose received on GTV of robust plan tends to be lower than standard planning. However, these methods' linear aggregation between volume dose loss showed a good relationship with R2 of 0.962.

Conclusion: The SBRT technique has a purpose to be an ablative method with having a good spare to the surrounding normal tissue. The GI and OAR of the robust plan have achieved that purpose despite the conformity was inferior to the standard technique. In other words, robust planning could be an alternative for hepatocellular carcinoma cases.

OP-49

Comparison of Progressive Resolution Optimizer (PRO) and Photon Optimizer (PO) Algorithms in Rapid Arc (VMAT) Delivery for Head and Neck Sib Treatments

Sundaram Venugopal[1], Govind Rao[1],Moujhuri Nandi[1], Manjulika Bhattacharjee[1]

1Meherbai Tata Memorial Hospital, Jamshedpur, Jharkhand, India.

Introduction: The aim of this study is to analyze and verify characterization of two different algorithms using Simultaneous integrated boost (SIB) in Head and Neck plans.
Materials and methods: In our study 15 patients) were selected, who received radiation therapy by

using Eclipse VMAT PRO algorithm 15.1. The same cases were re-optimized using a PO algorithm 15.6. A total of 30 treatment plans (15 PRO-VMAT plans and 15 PO-VMAT plans) were produced in the present study. All plans were created using double full arcs, keeping the identical constraints, cost functions and optimization time. Plan evaluation was done using PTV parameters (D98%, D95%, D50%, D2% mean dose and V105%), Homogeneity index (HI), Conformity index (CI), MU per degree with control points (CP), OAR doses and gamma verification (Portal dose and ArcCHECK) values were evaluated. Treatment was delivered in Varian Truebeam V2.7, energy 6 MV with Millennium 120 MLC.

Results: The PTV coverage (D95%) for PRO and PO were 98.69 Gy ± 0.83, 98.80 Gy ± 0.94, HI were 0.093 ± 0.022 and 0.086 ± 0.020, CI were 0.987 ± 0.008 and 0.988 ± 0.009. Monitor units (MU) for PRO and PO were 647.47 ± 137.88, 655.17 ± 138.36. The Portal dose results were (3%,3mm (%) & 1%,1mm (%)) for PO and PRO 100 ± 0.06, 95.1 ± 1.37 and 100 ± 0.05, 95.2 ± 1.32. For ArcCHECK 99.95 ± 0.12, 94.67 ± 3.01 and 99.95 ± 0.07, 93.55 ± 3.86 respectively. OAR's dose results are given. Conclusion: Results showed that PTV coverage and OAR's doses were comparable. For individual patients CI and HI of PO showed slightly higher values than PRO. MUs for PO were slightly increased as compared to PRO. MU per degree with each individual control points generated by PO showed high degree of modulation compared to PRO. Hence, new PO optimizer can produce comparable degree of plan while using same PRO objectives.

Keywords: Progressive Resolution Optimizer, Photon Optimizer, Rapid arc, MU per degree

OP-50

Evaluation of Intrafractional Prostate Displacement during Prostate Radiotherapy using Clarity Ultrasound System

MZ Nur Syazana[1], Saad M[2], Alip A[2], Rejab M[2,3], Wong JHD[1], Ung NM[2]

1 Department of Biomedical Imaging, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia
2 Clinical Oncology Unit, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia
3 Medical Physics Unit, Universiti Malaya Medical Centre, Kuala Lumpur, Malaysia

Background: The Clarity Ultrasound (US) (Elekta AB Stockholm, Sweden) is an image-guided radiotherapy system which can be used for tracking intrafraction prostate displacements continuously. The objectives of this study are to evaluate intrafraction prostate displacements using the Clarity transperineal US system and to derive planning target volume (PTV) margins for prostate radiotherapy at our institution.

Material and methods: This study analysed US tracking data of nine prostate radiotherapy patients recorded during treatment delivery. Prior to beam on, patients were set up in the treatment position with the US probe positioned transperineally with the use of reference images (fused ultrasound and computed tomography CT images). During every fraction, prostate displacements in 3 directions (superior/inferior (SI), left/right (LR) and anterior/posterior (AP)) were recorded and subsequently analysed. PTV margins were determined using the van Herk's formula. To assess the prostate displacement-time trend, continuous displacement data for each individual were plotted and analysed along 3 directions in 30 seconds time intervals for an eight-minute period, starting from the zero point which was the position immediately after prostate tracking was initiated.

Results and discussion: The intrafraction prostate monitoring resulted in population mean setup error (μ), systematic error (Σ) and the random error (σ) of μ= (0.8, 0.1, -1.7) mm, Σ= (0.7, 0.4, 0.9) mm and σ= (0.4, 0.2, 0.5) mm in the SI, LR and AP directions, respectively. The PTV margin was found to be the largest in the AP direction with a margin of 2.5 mm, in comparison to 1.9 mm and 1.1 mm in the SI and LR directions respectively. The PTV margin required for prostate radiotherapy at our institution

to account for intrafraction motion is 2.5 mm in all directions for an accurate and safe treatment. The prostate displacements time trend showed that there was an increase in intrafraction prostate displacements over time, with the largest dispersal in the AP direction, and the least displacements in LR direction.

Conclusion: The Clarity US system is feasible for monitoring intrafraction displacement of the prostate and facilitate PTV margin generation to account for such displacement during radiotherapy.

OP-51

Evaluation of digital linac log data for patient-specific VMAT quality assurance

Fatima Adel U'wais

An accurate and efficient patient-specific quality assurance (QA) method is highly desired for the advanced radiotherapy delivery techniques such as volumetric arc radiotherapy (VMAT). The techniques involve delivery of complex treatment parameters including the dynamic movement of the multi-leaf collimators (MLC). This study aims to evaluate the use of digital linac log data for the VMAT QA. The treatment log data for an Elekta Synergy linac was recorded using the service graphing tool on the linac control computer. VMAT treatment plans were delivered from the linac and all the dynamic treatment parameters including monitor unit (MU), MLC position and speed, collimator angle were recorded in real-time using the service graphing tool. The recorded raw data were extracted and analysed for discrepancy between the log dan planned data using algorithms written in MATLAB (Math Works, Natick, MA). The gamma pass rate of the fluence delivered, calculated using the treatment parameters logged was compared to the Octavius1500 (PTW, Freiburg, Germany) 2D ion chamber array that was measured during the pretreatment dose verification measurements. Our results demonstrated that the digital log data can track MLC leaves and that position errors of the dynamic MLC motion can be detected with an accuracy of 1.0 mm at speeds ranging from 3.04 to 3.4 cm/s. Evaluation of the measured dose distribution for VMAT delivery using digital log data was shown to agree well with planned dose distribution measured in 2D detector array, with an average gamma pass rate of 92% at 3%/3mm. Gamma pass rate from the log data was higher than the 2D array detector, with an increase ratio up to 7.99%. and the range of variation within 1.3 to 7.3. Log data obtained gamma pass rate superior than 97.5% while 2D array within 91.5%.The digital linac log data provides the basis to an essential high resolution real-time verification tool, useful in accessing accurate delivery of complex high energy radiation to the tumor and ultimately to achieve better cure rates for cancer patients. We concluded that the method under investigation may be used interchangeably for routine patient specific QA.

OP-52

Investigation of Uncertainty in Internal Target Volume Definition for Lung Stereotactic Body Radiotherapy

Daiki N [1,2], Masataka O [2], Jun-Ichi F [1], Taka-Aki H [1], Tadamasa Y [3]

1 Division of Radiology, Department of Medical Technology, Kyushu University Hospital, Fukuoka, Japan
2 Graduate School of Interdisciplinary Science and Engineering in Health Systems, Okayama University, Okayama, Japan
3 Department of Clinical Radiology, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan

Background or Introduction: For conventional treatment planning of lung SBRT under free-breathing based on 3DCT, the peak-exhale and the peak-inhale breath-hold images are used to

yield an ITV. However, it has the disadvantage that the respiratory level may differ from free-breathing and the trajectory between the two phases is unknown. The purpose of this study was to evaluate the validity of the respective ITVs defined by 3DCT and 4DCT, and to compare them with actual movements during treatment.

Material and Methods: Five patients with upper lobe lung tumors were treated with SBRT of 48 Gy in four fractions. Planning 3DCT images were acquired with the peak-exhale and the peak-inhale breath-hold, and 4DCT were acquired in cine mode under free-breathing. For each fraction, EPID cine images were consecutively acquired during irradiation. The tumor position on the isocenter was calculated from its projection position on an EPID image. Tumor coverage was evaluated by the extent to which the peak-to-peak breathing amplitude on the planning CT cover the range of tumor motion (3 SD) during irradiation.

Results & Discussion: Random tumor localization inaccuracies (1 SD) by EPID were 0.8, 1.4, and 0.6 mm, respectively. The mean tumor coverage of 3DCT- and 4DCT- based ITV were 43.8 ± 49.1% and 78.2 ± 52.1%, 18.9 ± 12.6% and 32.8 ± 21.0%, 32.8 ± 26.0% and 102.4 ± 50.4%, respectively. For only CC direction, the difference of coverage was statistically significant ($p < 0.05$). We should consider the internal margin for setting an irradiation field by utilizing 4DCT.
Conclusions: 4DCT-based ITV could be used as an efficient approach in free-breathing SBRT for upper lobe tumors of the lung since its coverage is superior to that of 3DCT.

Parallel Session – V (B): Dosimetry & QA-II

OP-53

Is a Reference Field Enough for Calibration of VMAT Quality Assurance?

P. Sathiyaraj[1],Henry Finlay Godson[2],Y. Retna Ponmalar[3]

1 Kidwai Memorial Institute of Oncology, Bangalore, India
2 Department of Radiation Oncology, Christian Medical College, Vellore, India

Introduction: VMAT fields are encompassed by a group of sub-fields called segments and each segment has its own size which may not be equal to the field size that are used for calibration. The aim of this study is to investigate the influence of using multiple calibration fields on gamma pass rate (GPR) of complex VMAT plans.

Methods: Patient specific QA was performed for 12 VMAT patients with Octavious-4D phantom in conjunction with vented ion chamber array in Varian Unique-Performance linear accelerator. Calibration factors were obtained for 4x4, 6x6, 8x8, 10x10, 12x12 and 15x15 cm2 fields. Each plan was delivered with the corresponding calibration factors obtained for above-mentioned fields. Plans were evaluated using gamma analysis method and the GPR was evaluated with the criteria of 3%/3 mm, 2%/3 mm and 2%/2 mm in global normalization with 10% threshold dose.

Results: The average 2D-GPR (averaged over axial, sagittal and coronal planes) obtained with the calibration factors of 4x4, 6x6, 8x8, 10x10, 12x12 and 15x15 cm2 fields were found to be 87.31%, 86.8%, 85.86%, 84.94%, 84.7% and 81.24% respectively with 2%,2mm criteria whereas with 2%/3mm criteria, it was 94.25%, 94.3%,93.75%, 93.1%, 93.1% and 90.6% respectively. For 3%/3mm criteria, it was 96.93%, 96.96%, 96.84%,96.55%, 96.48%, 95.54% respectively.High GPR was observed in most of the plans when the calibration factors of small fields (<10x10 cm2) were used. Better GPR can be yielded if appropriate calibration factor is used in 2D-array measurements. The

calibration factor can be chosen depending upon the maximum number of repeated segment's dimension in a given plan. This was also verified by creating a multi-field plan consisting of three 4x4 cm2 field and one 6x6 cm2 field. This plan was executed with the above calibration factors obtained with different fields. It was observed that the measured dose was in close agreement with the TPS calculated value when the 2D-array was calibrated by an appropriate field which is equal to the size of the sub-fields of the plan. It provides the strong evidence to the hypothesis on the relationship between GPR and calibrated field size.

Conclusion: Single reference calibration field may mask in obtaining better patient specific QA results. This study suggests that, using smaller calibration fields or a most appropriate calibration field that is equal to the dimensions of the subfields of VMAT plan would yield a better result during patient specific QA.

Acknowledgement: Authors would like to acknowledge the management of CIHSR, Dimapur, India for their support to carry out this study.

OP-54

A Simplified Method to Estimate Energy Spectra at the Central and Off-Axis by Reconstructing the Monoenergetic Depth Doses

Puspen Chakraborty[1], Hidetoshi Saitoh[2], Weishan Chang[2], N. Syed Ibrahim[1]

1. RadiationOncology, KhwajaYunus Ali Medical College & Hospital, Sirajganj, Bangladesh
2. Radiological Sciences,Graduate school of Human Health Sciences, Tokyo Metropolitan University, Tokyo, Japan

Introduction: In the model-based algorithms, information of precise energy spectra at the central and off-axis is very important to enhance the accuracy of the dose calculation. Monte Carlo method by modeling the treatment head is considered as the most reliable method to estimate the energy spectrum. However, it consumes a lot of computing time and the treatment head geometry is hardly available. This study is intended to develop a simplified method to estimate energy spectra at the central and off-axis by reconstructing the monoenergetic depth doses.

Material and Methods: To estimate energy spectra of 6MV photon beams for Clinac-21EX and Versa-HD linear accelerators, monoenergetic depth doses were calculated for a 10cm × 10cm equivalent circular field in water at 100cm SSD by the DOSRZnrc. After formulating analytical models in Microsoft-excel, GRG (Generalized-reduced-gradient) was performed repeatedly until getting a good agreement between the reconstructed and reference PDD. Thus, by minimizing the varianceσ^2 of the relative deviation δ_j(%) between the reconstructed and reference PDD, parameters for the energy spectrawere determined.

Results and discussion: The root mean square σ was <0.2 at the central-axis, <0.15 at the off-axis and estimated energy spectra also represented good agreement with reference energy spectra simulated withthe BEAMnrc. The charged particle contamination was determined by the difference between the reconstructed and reference PDD at the build-up region. Moreover, the time required for the reconstruction process was very short and the same datasets can be used to calculate energy spectra for different linear accelerators as well as energies.

Conclusions: A simple method is introduced to estimate energy spectra both at the central and off-axis by reconstructing monoenergetic depth doses in agreement with the measurement. Considering the clinical importance of reproducing the dose distribution precisely, estimated energy spectra using this method are significantly trustworthy for accurate dose calculation.

OP-55

The Perturbation Factor of Plane-Parallel Chamber to Scanning Proton Beams: A Monte Carlo Study

Hironari Kumazaki[1], Keisuke Yasui[2], Masaya Ichihara[1], Naoki Hayashi[2]

1. Graduate school of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan
2. School of Medical Sciences, Fujita Health University, Toyoake, Aichi, Japan

Introduction: Beam quality correction factors (k_Q) provided in the IAEA TRS-398 CoP for proton beams are approximated using the water-to-air mass stopping power ratio and by assuming the proton beam quality related perturbation correction factors (P_Q) to be unity. At present, there is not sufficient data on the perturbation factor of scanning proton beam. In particular, the proton beam quality varies with depth, however, the relationship between depth and P_Q has not been investigated. The purpose of this study is to calculate the P_Q of a plane-parallel chamber of scanning proton beam using Monte Carlo simulations.

Method: The Monte Carlo toolkit PTSIM/Geant4 was used to determine the ratio of the dose to water and the dose to the sensitive air volume of ionization chambers (f_Q) for five monoenergetic proton beam: 70, 100, 150, 200, 250 MeV. The P_Q can be found by the ratio of f_Q calculated by Monte Carlo to $S_{w,air}$. The IBA NACP-02 was inserted on the simulation geometry as plane-parallel ionization chamber. The stopping power and W_{air} were referred from the latest ICRU90 recommendations.

Result: For the five energies investigated, the P_Q was a maximum of 0.995 and a minimum of 0.988. The maximum deviation from unity was 2.2% for 250 MeV proton beam. The f_Q and P_Q calculated in this work agreed within 0.5% with values described in previous paper. At higher energies, the f_Q and P_Q have a difference larger than the those at low energies.

Conclusion: In this study, the P_Q indicated ranging from 0.988 to 0.995 on scanning proton beams. However, simulation was undergone monoenergetic proton beams, therefore the dependence of P_Q on the beam quality and the P_Q in clinical irradiation fields should be investigated in the future work.

OP-56

Study and Analysis of Small Field Photon Beam Dosimetry Using Diamond Detector and Comparison with PTW Pinpoint Ionization Chamber and PTW Silicon Diode Detector: A Review

Khan A , Alim M N · Zakaria G A

Department of Medical Physics and Biomedical Engineering, Gono University, Savar, Dhaka.

Introduction: Recent developments of new therapy techniques using small photon beams, such as stereotactic radiotherapy, gamma knife and cyber knife require suitable detectors to determine

the delivered dose with a high accuracy. The aim of this work was to test the suitability of a PTW diamond detector for non-reference condition dosimetry in 6 MV photon beam and field size from 0.6 × 0.6 cm^2 to 5 × 5 cm^2.

Materials & Methods: In this study, various literatures have been used where dosimetrical studies (PDD, output factor and beam profile) were done using Diamond detector, unshielded and shielded silicon diode; and PinPoint ionization chamber. IAEA TRS-483 protocol was used to evaluate the study. Depth dose curves were normalized at the depth of maximum dose (d_{max}). The value of d_{max} and the percentage depth dose (PDD) at 10 cm in water were analyzed for all detectors. Output factor (OF) measurements were performed with an SSD of 100 cm and at a depth of 10 g cm^{-2} for all fields. The dose profiles measured at 10 cm-depth in water. Dose profiles were normalized at 100% on beam axis and the 20%–80% penumbras were evaluated for all detectors. In this study, standard deviations (SD) and percentage deviations were calculated and a comparison has been done among different detectors.

Results: Among the literatures, for the smallest field sizes of 0.6×0.6 cm^2 the PDD value was found smallest for Slilicon diode detector. The maximum deviation was ± 0.8% for small field PDD values among three detectors. The maximum standard deviation was 0.023 for the smallest field size of 0.6×0.6 cm^2 among different detectors during output factor study. Silicon diode detector shows the maximum percentage deviation in comparison with Diamond detector while PinPoint chamber shows larger percentage deviations than Silicon diode when compared to the diamond detector. In beam profile study, maximum standard deviation was found 0.79 for the field size of 2.6×2.6 cm^2 and PinPoint ionization chamber shows small percentage deviation 3.31% in comparison with Diamond detector.

Discussion: In small field sizes (less than 3×3 cm^2) Diamond and Silicon diode are more suitable for precise dose delivery than Pin Point ionization chamber detector.

OP-57

Design and Dosimetry of 6 MV Elekta Synergy Linear Accelerator using EGSnrc based Monte Carlo Simulation code.

[1]**Md. Anwarul Islam**, [2]Abdul Mannan Chowdhury, [3]Golam Abu Zakara

1. Oncology & Radıotherapy Centre, Square Hospıtals Ltd, Dhaka, Bangladesh
2. Depatment of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh
3. Professor of Clinical Engineering, Anhalt University of Applied Sciences, Koethen, Germany

Purpose: The purpose of this study was to simulate dose calculation of external photon beam using EGSnrc Monte Carlo (MC) code and compare them with the measured doses in homogenous medium.

Method and Materials: The complete geometry of the Elekta Synergy linear accelerator (Linac) treatment head was designed using BEAMnrc MC Code and calculated dose using DOSXYZnrc MC Code both are user codes from the EGSnrc. All the physical and technical parameters were provided by the manufacturers for designing the module. The Elekta Synergy was simulated to compare the MC Simulated data with experimental measurement data in homogeneous medium.

Several numbers of relative data and a single absolute data have been investigated. The relative data were PDD, Off Axis Beam Profile and Output Factor for the field size of 5 x 5 cm, 10 x 10 cm, 30 x 30 and 5 x 30 cm. The flatness, symmetry and penumbra also investigated. The absolute measurement and simulation have been done in 10 x 10 cm field size according to TRS 398 and Popesu et all provided formula respectively. During relative measurement chamber was moved in continuous mode. Farmer chamber (FC56-P-4952, 0.65 cc volume) was palced at 10 cm depth to measure the Output Factor at 100 SSD with 100 MU. For MC simulation, the phantom dimension was 40 x 40 x 40 cm. The voxel dimention for PDD was defined as group and width of X, Y and Z were 1 cm, 1 cm and 0.5 cm respectively. In the case of Off Axis Profile, the voxel dimension were 0.2 x 0.2 x 0.5 cm. The phantom materials were H2O521ICRU from the pegs4 data library. The gamma criteria of 3%/3mm has been used to evaluate the difference between the measured and MC data. Other two criteria of 2%/2 and 1%/1mm also have been used to see the difference medium and extreme conditions. The reference value of flatness, symmetry was 3% and for penumbra was 1 cm.

Results: In homogeneous media, the average gamma pass rate of PDD for 3%/3mm, 2%/2mm and 1%/1mm for all field sizes were 100%, 100 % and 98.75% respectively. The results of Off Axis Beam Profile were 100%, 98.79% and 85.23% respectively for the same gamma criteria and field sizes. The average Output factor difference of different field sizes was < 1.5%. The flatness, symmetry and penumbra were 1.31 %, 0.052 % and 0.81 cm respectively. The absolute dosimetric difference was 0.65 %.

Conclusion: The results showed a very good agreement between measured and MC simulated data in homogeneous media. Based on evaluation it can be concluded that our designed MC dose simulation machines clearly outperform. Therefore, our designed MC simulation could be a significant second check alternative of dose calculation along with commercial TPS in homogeneous media. These machines also could be used as future tool to investigate small field dosimetry.

OP-58

Profile Measurements for SOBP Carbon Ion Beams Using Radiochromic Films

Masato Kobayashi, Motohiro Kawashima, MutsumiTashiro

Gunma University Heavy Ion Medical Center, 3-39-22, Showa-machi, Maebshi, Gunma, Japan.

Background: Since the film response of carbon ion beam depends on LET and dose, it is challenging to determine LET and dose by film measurements. In this study, we used a method reported in a previous study to determine the LET and dose by analyzing films irradiated with two or more different doses. This method was applied to the profiles of SOBP carbon ion beams to obtain the dose and LET of the profile.

Material and Methods: To create calibration curves, the films were irradiated with various known LETs and doses using SOBP carbon ion beams. The irradiated films were scanned to obtain the pixel values of the films and the pixel values were converted to netOD. The

correlation between netOD and dose was calculated for each LET. Then, in order to obtain beam profiles, the three films were irradiated using SOBP carbon-ion beams with a bolus. The number of irradiated particles was 20,000, 40,000, and 60,000, respectively. These films were analyzed to determine LET and dose along the profiles. The results were compared with the dose measured with the ion chamber and simulated LETs.

Results & Discussion: The most dose profiles obtained from the film measurements agreed with the ionization chamber measurements within 5%. However, in the low dose range, there was a large difference. Since the LET result correlates with the dose, the difference in LET is also large when the difference in dose errors is large. We believe that the differences are caused by the errors in the approximate equations of the calibration curves and the optimum solution.

Conclusions: We obtained dose profiles from film measurements for SOBP carbon ion beam. In the future, we would like to apply this method to patient specific quality assurance to shorten the time for quality assurance.

Parallel Session- VI(A): Radiobiology & Radio Protection

OP-59

Computed Tomography Dose Reference Levels for head, chest and abdomen regions: A nationwide survey

T Amalraj[1], DM Satharasinghe[1], AS Pallewatte[2] andJ Jeyasugiththan[1]

1. Department of Nuclear Science, Faculty of Science, University of Colombo, Sri Lanka.
2. Department of Radiology, National Hospital of Sri Lanka, Colombo, Sri Lanka.

Introduction: The computed tomography (CT) is identified as the highest contributor of the population radiation dose among medical radiation examinations. Therefore, routine monitoring of the delivered radiation dose is critical. The Diagnostic Reference Levels (DRL) are identified as a form of investigation level that can be used as a tool in identifying the abnormally high radiation doses which cannot be justified based on the image quality requirements. Therefore, many countries now attempt to define their own DRL which reflect their own practice. However,to date no formal effort has been taken in establishing a National DRL (NDRL). Therefore, the present study is aimed to establish NDRLs for commonly performed CT examinations which include brain, chest and abdomen.

Methodology: A nationwide survey was conducted covering more than 40% (25 CT units) of the CT units in the country. The patient morphometric (age and gender) together with dosimetric data (Volume CT dose index: $CTDI_{vol}$ and dose length product: DLP) were recorded for non-contrast studies of head, chest and abdomen regions belonging to 2982 patients. The median doses for each CT units were calculated initially and the third quartile of the distribution of the medians were considered as the NDRL. The obtained NDRLs were compared with the internationally published NDRLs of Japan, Canada and France to determine the degree of optimization requirements.

Results and Discussion: The NDRLs based on $CTDI_{vol}$ and DLP for head, chest and abdomen regions were 82.2 mGy/1556 mGy.cm, 7.4 mGy/350 mGy.cm and 10.5 mGy/721 mGy.cm respectively.

Conclusion: The majority of the NDRLs were well below the internationally published values. However, further dose reductions can be achieved through implementing dose optimization strategies.

Results comparison with Japan, France and Canada

The head NDRL was comparable with the NDRL of Japan (85.5 mGy) and Canada (79.1 mGy) but double the value of France (46 mGy). The chest NDRL was lower than the NDRL of France (10 mGy) and half the values reported in Japan and Canada (14.3 mGy and 14.1 mGy). The abdomen NDRL was considerably lower than the values reported for Japan, Canada and France (18.2 mGy, 18.1 mGy and 13 mGy). The NDRL based on DLP for head region was higher than all compared countries while for chest and abdomen region the obtained values were lower than that of Japan (543 mGy.cm and 870 mGy.cm) and Canada (483 mGy.cm and 806 mGy.cm). Nevertheless, the NDRL for chest and abdomen regions were comparable with that of France (350mGy.cm and 690 mGy.cm).

OP-60

Gadolinium Oxide in Polyamide Substrate: A New Composite for Protection Against Neutron Radiation

Azadeh N[1], Javad M[2], MohammdHossein C-D[2], Mohammad Amin H[3]

1. Department of Nuclear Engineering, Islamic Azad University, Arsanjan Branch, Arsanjan, Iran
2. Reactor and Nuclear Safety Research School, Nuclear Science and Technology Research Institute, AEOI, Isfahan, Iran
3. Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), Paramedical School, Shiraz University of Medical Sciences, Shiraz-Iran

Background: Gadolinium is one of the known elements in nature with unique properties in terms of neutron absorption. It has also been used as a contrast agent in MRI imaging for many years due to its paramagnetic properties. This study focused on the use of new gadolinium oxide/polyamide compounds as neutron shields.

Materials and Methods: Seven different compounds of gadolinium-oxide micro powder (as filler) with different weight percentages (0-50%) in polyamide-6 (as matrix) were synthesized and molded by melting method. Then, characterization tests such as scanning electron microscope (SEM), as X-ray powder diffraction (XRD), and Thermogravimetric Analysis (TGA) were performed on the samples. Subsequently, the samples were irradiated using output of the dry channel in the Miniature Neutron Source Reactor (MNSR), and quantities such as total absorption cross-section and mean free path were measured.

Results: After characterization, it was found that there is a symmetrical distribution of the filler in the matrix and this uniformity was well seen up to 30% of the weight percentage of the filler. Analysis of the XRD pattern of the samples, especially in the characteristic peaks, showed the

combination of filler and matrix, which increased the crystallization process and decreased the amorphous region by increasing the filler concentration. This trend, however, in the TGA tests was associated with the improving trend in the lost weight or an increase in thermal stability. Besides, satisfactory results of thermal neutron absorption in the dry channel were reported.

Conclusion: This experimental study showed that polyamide 6/gadolinium oxide composites are well able to absorb thermal neutrons and show structurally acceptable properties. This finding can be further attested in future studies.

OP-61

The Effect of High Dose Rate Irradiation on Cell Survival: Simple Investigation with Non-Cancer and Cancer Cells.

Maki Kurimoto[1], Keisuke Yasui[2], Takashi Watanabe[3], Hisano Yanagi[4], Yasunori Saito[5], Shuta Ogawa[5], and Naoki Hayashi[2]

1 Graduate school of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan

2 School of Medical Sciences, Fujita Health University, Toyoake, Aichi, Japan

3 Department of Biochemistry, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

4 Department of Medical Oncology, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

5 Division of Radiology, Fujita Health University Hospital, Toyoake, Aichi, Japan

Background/Introduction: The high dose rate irradiation (HDR) contributes to advantages in radiotherapy by shortening the treatment time and reducing the positional uncertainty of the target due to body motion. Also, it is widely known that dose-rate related cell survival. However, our knowledge of such dose-rate effects is limited mainly because of the lack of an experimental system using cultured cells. The purpose of this study is to establish the HDR method for culture cells with a linear accelerator and verify its effects on cells in a high-dose-rate field.

Material and Methods: We employed a phantom of silicon to consider scattered rays for HDR toward culture cells. To verify the dose-rate effect, non-cancer cells (HEK293FT) and cancer cells (Caki-1) derived from kidney, kidney cells were cultured in a 35 mm culture dish and irradiated with a flattening filter-free (FFF) 10 MV beams. The prescription dose to the cells was set to 2 Gy with four dose-rate: 3.83 Gy/min, 23.01 Gy/min, 31.85 Gy/min, and 45.56 Gy/min. After growing those cells for additional 10 days, the cell survival rate was evaluated using colony formation assays. The colony number was manually counted, and the survival rate was determined.

Results and Discussion: The differences in survival rates were observed depending on the dose-rate in both non-cancer and cancer cells. Non-cancer cells likely have higher cell survival rates at higher dose-rate. 31.85 Gy/min and 45.56 Gy/min significantly improved the survival rate compared to 23.01 Gy/min (student's t-test $P < 0.05$).

Conclusion: We have established the method where isolated culture cells are irradiated by a linear accelerator. Using this developed experimental platform, changes in survival rates were

observed at clinically available dose-rate. In the future, we will apply this method to other cells and investigate the mechanism underlying the effects of high-dose-rate on cell survival.

OP-62

Influence of the Average Adult Definition on International DRL Comparison and Optimization.

[1].Satharasinghe Duminda, [2]WanninayakeMihira, [3]Pallewatte Aruna, [4]Jeyasugiththan Jeyasinga

Introduction: The diagnostic reference levels (DRL) can be used to identify the appropriate level of exposure for a given X-ray procedure. The DRL also defined per standard patient or phantom to limit the effect of patient size on the radiation dose. The definition of the standard patient varies from country to country. The Sri Lankan average adult weighs 58 kg, while the average European weigh around 70 kg. Therefore, the defined DRLs will be different since the exposures usually depend on the patients' physique. The optimization of radiation dose requires a DRL comparison between different countries with varying average adult populations. Therefore, such comparisons would mislead the optimization process. The present study aimed to evaluate the impact of the average adult definition on the calculated DRL.

Material and Methods: The dose area product (DAP) data of seven X-ray projections (cervical spine - AP/Lateral, abdomen AP, chest-PA, KUB and lumbar spine AP/Lateral) belong to 235 adult patients (18-89 years) were filtered into two average adult groups of weight 58 kg and 70 kg.

Results & Discussion: The percentage difference of the mean DAP (µGym2) value obtained for the groups mentioned above was found to vary between 2.7% to 67.0%. The mean DAP value for the 58 kg group was consistently lower than that of the 70 kg group. In addition, the resultant comparison of calculated IDRLs of two groups with the UK DRL showed the varied degree of optimization requirements (between (-1.2%) to (+53.1%) and (+2.3%) to (+64.2%) for group A and group B respectively).

Conclusion: Improper comparison of DRLs between different average adult populations could adversely affect both patient radiation dose and image equality. Therefore, it is recommending to compare DRLs between the countries with the same average adult populations during optimization.

Parallel Session- V I(B): Dosimetry & Radiotherapy

OP-63

Dosimetric Comparison of FF and FFF Beams for SRS and SBRT

Sharma Reena, Lehal Priyanka and Singh Yadav Budhi

Department of Radiotherapy and Oncology, Post Graduate Institute of Medical Education and Research Chandigarh, India

BACKGROUND: Stereotactic Radiosurgery (SRS) and Stereotactic Body Radiation Therapy (SBRT) has become the choice of treatment for typically small tumors. Planning SRS and SBRT in linear accelerator with flattening filter (FF) involves achieving high dose gradients that further require high fluence modulation which in turn increases scatter and leakage from gantry head contributing to escalate the normal tissue dose. Removing Flattening Filter is a logical choice to reduce scatter and shrink the probability of secondary tumor. This retrospective study aims to compare and analyses the dosimetric differences between flattening filtered and flattening filter free (FFF) beams for 6 MV in SRS and SBRT mode of delivery.

MATERIALS AND METHODS: Twenty previously treated patients out of which 11 received SRS and 9 received SBRT were selected for study. Same planning target volume (PTV) and Organs at Risk (OAR) contoured for FF and FFF were taken. Clinical dose constraints were as per AAPM TG 101 protocol. And dose prescription prescribed by the physicians. Two clinically acceptable plans each with FF and FFF were generated with all identical parameters. Comparison was of Homogeneity Index, Gradient Index, and Conformity Index. TPS dose distribution was compared with measured dose distribution using Octavius 4D phantom.

RESULTS: For 3%DD – 3mm DTA criteria and 2%- 2mm DTA criteria at least 95 percent of the assessed points should achieve gamma index. Statistical Analysis is done using Wilcoxon Signed rank test. Calculated indices indicated higher GI and CI values ($p<0.05$) for 6MV FFF.

CONCLUSION: Better treatment plan quality is reflected with FFF beams on the basis of dosimetric indices. The better plan quality and the improved treatment delivery accuracy achieved by using FFF beams for SRS & SBRT carries potential to achieve ultimate goal of SRS and SBRT i.e., high therapeutic ratio.

OP-64

The Current Status of Radiotherapy Facilities in Developing Countries

Vijitha Ramanathan

Department of Radiography & Radiotherapy, Faculty of Allied Health Sciences, General Sir John Kotelawala Defence University, Werahera, Sri Lanka

Cancer is one of the leading causes of death worldwide. It has been reported that there is a significant increase in cancer incident rate and mortality rate in developing countries in last few years. Radiotherapy (RT) is one of the major treatment modalities in cancer treatment. About 50% of cancer patients receive radiotherapy during their course of treatment. The concern has been expressed that there is a very limited radiotherapy access to the cancer patients in developing countries. This study sought to find out the current status of radiotherapy facilities in developing countries. The International Atomic Energy Agency (IAEA) – DIRAC (Directory of Radiotherapy Centres) database was used to collect the date. The developing countries were identified. The available radiotherapy facilities from all low- and middle-income countries were accumulated. In addition, the population of each low- and middle-income countries were collected. 91 countries from developing countries were identified with RT facilities. Totally, 11-

Light ion therapy, 2377- Linear accelerators, 1078- Cobalt-60 teletherapy machines, 907 – High Dose Rate Brachytherapy, and 268 – Cs-137 based Low Dose Brachytherapy units were identified in 3072 radiotherapy treatment centres. The range of megavoltage machine per million people in developing countries is 0.02 – 4.77. Most of the countries of low- and middle-income countries have very low value of megavoltage machine per million people than IAEA recommended value of 1 megavoltage machine per 250,000 people. There is no radiotherapy access in about 50 countries. Due to the very limited access to radiotherapy, it will lead to more waiting list for cancer patients and it will worsen the cancer patient condition. Therefore, it is essential to develop, new radiotherapy facilities to the countries where there is no RT access, and to expand RT facilities where the countries have limited RT access.

Keywords: Cancer, Radiotherapy facilities, Developing Countries, IAEA-DIRAC database, Megavoltage machines per million people

OP-65

BMI-adjusted Dose Conversion Factor of Effective Dose Estimation for Coronary Computed Tomography Angiography: Patient Study

Lin CS[1], Change SL[2], Tsai HY[3]

[1] Department of Medical Imaging and Intervention, New Taipei City Municipal Tu Cheng Hospital, New Taipei City 236, Taiwan

[2] Radiation Protection Association R.O.C., Hsinchu 300, Taiwan
[3] Institute of Nuclear Engineering and Science, National Tsing Hua University, Hsinchu 300, Taiwan

Coronary computed tomography angiography (CCTA) is an effectively clinical tool to exam and diagnose coronary artery stenosis. However, the CCTA has a high radiation dose and not being recommended for asymptomatic individuals to undergo this examination. CT radiation dose to patients could be estimated by using a Monte Carlo-based CT dose calculation software or simplified by using CT dose conversion factor. After conducting a systematic review, we found no dedicated dose conversion factor for CCTA. The purpose of this study is to provide a dose conversion factor (k_E) of CCTA from the dose length product (DLP). The study with institutional review board approval included 155 patients (male, 121; female, 34) who underwent CCTA examinations from August 2019 to November 2019. The patients were classified as normal size and overweight and obese by BMI. CCTA scanning parameters were collected for individuals to calculate organ and effective doses using a modified version of the Monte Carlo-based CT dose calculation software VirtualDose^{TM}CT (Virtual phantoms Inc., Albany, USA). The effective dose of CCTA ranges from 5.5 to 18.5 mSv for male patients and 8.6 to 18.9 mSv for female patients. The k_E factors varywith body size and are 0.0236, 0.0229 and 0.0203 mSv mGy^{-1} cm^{-1} for the normal, overweight, and obese groups undergone CCTA. The dose uncertainty keeps within 3% as considering body size, otherwise with maximal uncertainty of 25% for female patients. The k_E factor is independent of CT tube voltages. However, the scanning ranges related to the coverage of anatomic structures is the main influential parameter. Therefore, the k_E factor of the chest CT examination of 0.014 mSv mGy^{-1} cm^{-1} provided from the AAPM TG 96 report is not appropriate for the CCTA examinations.

OP-66

Comparing Step-and-Shoot IMRT with Dose Painting using a Histopathologically Verified Model Based on Hierarchical Clustering and mpMRI to Treat Prostate Cancer

Hashemi B[1*], Rezaeijo SM[1], Mofid B[2], Mahdavi A[3], Hashemi MS[4]

1. Department of Medical Physics, Faculty of Medical Sciences, TarbiatModares University, Tehran, Iran.
2. Department of Radiation Oncology, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
3. Department of Radiology, Modares Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
4. Department of Aerospace Engineering, Iowa State University, Ames, IA 50011, USA.

Background: Commonly prescribed dose to low-risk prostate tumors is insufficient to control and treat dominant intraprostatic lesions (DILs). In this study, a Dose Painting (DP) procedure was performed to safely deliver appropriate higher doses to DILs and assess its' potential outcome compared with a uniform 80-Gy IMRT plan.

Material and Methods: 34 DILs were predicted in 20 patients using a Histopathologically verified model based on hierarchical clustering with a combination of diffusion-weighted and dynamic contrast-enhanced imaging modalities. A DP procedure or simultaneous integrated boost-IMRT (SIB-IMRT) was planned with focal boosts of 80, 85, and 91 Gy being delivered to various planning treatment volumes of PTV1, PTV2, and PTV3, respectively. The mean dose and normal tissue complication probabilities (NTCPs) for bladder and rectum and tumor control probability (TCP) for prostate were compared with those of a uniform 80-Gy IMRT plan.

Results & Discussion: DP plans were feasible for all the patients with identifiable DILs. The mean dose of DP was slightly higher than IMRT for bladder (37.5±5.66 vs. 35.15±10.14 Gy; 95% CI: -2.762 to 10.07) and lower for rectum (39.7±3.12 vs. 41.45±2.12 Gy; 95 % CI: -4.659 to 0.5579). The mean TCP in three investigated PTVs was increased, and significant differences were observed between the DP vs. IMRT (PTV1, PTV2, and PTV3: 72.39±1.57, 89.9±1.2, and 91.86±1.02 Gy vs. 70.52±1.47 Gy of IMRT; 95 % CI: 0.5828 to 3.162, 18.24 to 20.52, and 19.80 to 22.87 for the three PTVs, respectively). In boosted DP vs. IMRT plans, the bladder NTCPs were slightly increased (5.4±2.1 Gy vs. 4.8±2 Gy; 95 % CI: -1.867 to 3.027) while the rectum NTCPs lowered (16.54±2.9 Gy vs. 19.2±3.7 Gy; 95 % CI: -5.575 to 0.1254).

Conclusions: Delivery of a boost dose to DILs using DP procedure is feasible and significantly increases TCP and therapeutic ratio.

Keywords: IMRT, SIB-IMRT, Dose Painting, Prostate Cancer, TCP, NTCP, Hierarchical Clustering, mpMRI

OP-67

Comparison of Different Radiotherapy Planning Techniques for Carcinoma of Breast Conserving Surgery

Naznin Aktar Pina

Department of Medical Physics and Biomedical Engineering, Gono University, Savar, Dhaka.

Purpose: The main purpose of this study is to perform the dosimetric comparison of 3DCRT, Intensity Modulated Radiation Therapy (IMRT) and Volumetric Modulated Arc Therapy (VMAT) for some different patients in the Treatment of Breast cancer. This study compared different plans for breast cancer and evaluated the irradiated dose of planning target volume and OARs, especially focusing on heart and Ipsilateral Lung.

Methods and Materials: Of the 15 patients received radiotherapy, 5 were 3DCRT plans, 5 were IMRT plans, and 5 were VMAT plans using Varian Eclipse planning system (version 13.7, Varian medical system, Palo Alto CA). For all the selected patients 3DCRT, IMRT and VMAT treatment plans were generated. Plans were created using a 10MV photon beam with 0.5 cm bolus for 3DCRT and 6MV photon beam for IMRT and VMAT applicable to a Varian linac D2300CD linear accelerator with a 120 leaf Millennium dynamic multi-leaf collimator (MLC). Plan comparison was done in terms of OAR dose, PTV coverage, dose homogeneity index (HI) and dose conformity index (CI). Dose Volume Histogram (DVH) comparative analysis was performed for PTV and OARs. Target conformity, dose to the critical structures and low dose volumes were recorded and analysed for 3DCRT, IMRT and VMAT plans for all patients.

Results: The results from three of the techniques are satisfactory and are clinically acceptable. The PTV dose evaluation showed that VMAT plan produced values closer to the prescription dose than the IMRT plan. Hence, Dose Homogeneity was better in IMRT plan than in VMAT and 3DCRT plan. For all patients Homogeneity Index different such as average value is 0.082 in 3DCRT, 0.066 in IMRT and average value is 0.063 in VMAT. The Conformity Index was also slightly better in VMAT plan. Conformity Index different such as average value is 1.181 in 3DCRT, 1.118 in IMRT and 1.051 in VMAT plan. VMAT plans yielded good quality of the plan compared with IMRT, resulting in reduced treatment time and improved efficiency for that case which used in this study.

Conclusions: Using a range of dosimetry parameters, we found no significant differences between IMRT and VMAT techniques but more difference in 3DCRT. Both the VMAT and IMRT produced clinically acceptable treatment plan for some different cases. VMAT were associated with faster delivery times and less number of mean monitor units than IMRT and 3DCRT.This study observed that VMAT techniques is better than IMRT techniques in terms of dose coverage, OAR spearing and for plan evaluation

OP-68

Moliere weighted multicomponent analysis of flat top Gaussian radiotherapy beam for small fields

Silpa Ajaykumar[1,2], M.M. Musthafa[1,] Midhun C.V[1], RijinN. T[3]

Department of Physics, University of Calicut, Calicut University P.O Kerala-673635, India

Department of Radiation Oncology, Malabar Cancer Centre, Thalassery, Kerala-670103, India

Jain University,Bangalore,karnataka, India

Introduction: Modern treatment techniques deal with very small fields. The dosimetry of small fields is challenging due to non-equilibrium conditions. Further, small field being intense, out-of field contribution will be significant. Realistic estimation of the same is to be derived empirically, in terms of basic physical phenomena.

Materials and Methods: In order to measure the out of field contribution precisely, EDR2 Films were irradiated, with small beam slits (0.4x40, 1x40, 2x40 and 4x40 cm^2), using 6 MV X-rays from Varian ClinaciX linear accelerator. The films were positioned perpendicular to the beam. The profiles were digitized and processed using, image analyzing software, ***Image J***. Dose distribution was plotted as a function of distance, using GNU plot, and is fitted with the Gaussian distribution. A mathematical Expression for out of field secondary dose distribution is developed in terms of Moliere scattering.

Result and Discussions: Practically, a small radiotherapy field includes primary and secondary doses. The effect of scattering, in out of field dose distribution, for small radiotherapy fields is evaluated using theoretical modeling, in terms of Moliere scattering. The model reproduced the measured dose distribution around the primary beam satisfactorily. The study found that, in the case of small fields, it is the scattering of electron which contributes significantly to the observed out of field doses.

Conclusion: The out of field dose distribution around the primary beam can be precisely expressed in terms of Moliere scattering.

Keywords: Radiotherapy, Small field, out of field, Moliere scattering, EDR2films, Dosimetry

Parallel Session – VII (A): Radiotherapy

OP-69

Introducing New Indices for Assessment of Dose-Painting Prostate IMRT Plans Using Diffusion Weighted-MRI Based on Weighted Dose Distribution Homogeneity and Conformity Indices

Hashemi B

Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran.

Introduction: The aim of this study was to introduce a new plan quality index, named “index of effectiveness (IOE)” that assesses the effectiveness of dose-painting plans for the patients undergoing prostate radiotherapy**.**

Materials and Methods: CT-images of twenty patients were used for dose-painting planning; boost volumes were identified using DW-MRI images. ADC maps of patients were used to estimate the initial number of cells within each voxel, using sigmoid relationship between ADC values and cell density. Two boost volumes were defined inside the prostate with the prescribed dose of 66 and 70Gy based on the ADC values. The prostate dose outside the boost volumes was 60Gy. The IOE was introduced based on both the dose distribution homogeneity index (HI) and conformity index (CI) obtained from different target volumes with and without considering cellular densities. Tumor control probability (TCP) values were calculated and the relationship between the obtained TCP and IOE was evaluated.

Results: The correlation between TCP and IOE based on HI considering cell density was moderate and negative (R^2= -0.415). While the IOE without considering cell density has not any correlation with the TCP (R^2=0.152). Furthermore, the correlation between TCP and IOE based on CI considering cell density was moderate and negative (R^2= -0.403). In contrast, IOE based on CI without considering cell density had a strong and positive correlation with TCP (R^2=0.624). The correlation between TCP and mean values of HI and CI was not significant (R^2<±0.2). The correlation coefficients between all the introduced IOE indices were low (R^2<±0.2), showing the independence of the indices from each other.

Discussion: The IOE based on the HI considering cell density and the IOE based on the CI without considering cell density had higher correlations with the TCP. Therefore, we propose to use these indices as appropriate evaluating tools for dose-painting plans.

Keywords: Dose-painting, prostate cancer, apparent diffusion coefficient, cellular density, plan quality index, tumor control probability

OP-70

Design Fabrication and Validation of 3D Printed Specific End Term Applicator for Electron Radiation Therapy

Islam M J[1], Steil V[2], Azhari H A[3], Zakaria G A[4]

1. Department of Radiation Oncology, Labaid Cancer Hospital and Super Specialty Center, Bangladesh
2. Department of Medical Physics and Central Radiation Protection, University Medical Center Mannheim, Heidelberg University, Germany.
3. Centre for Biomedical Science and Engineering, United International University (UIU)
4. Department of Medical Radiation Physics, Gummersbach Hospital, University Cologne, Germany

Introduction: Electron radiotherapy is a labor-intensive treatment option that is complicated by the need for field shaping devices such as electron applicators (cones). The purpose of this paper is to demonstrate that an inexpensive 3D printer can be used to manufacture end term electron applicator for electron beam therapy and verify the validity of the 3D printed electron applicator.

Methods: To create the electron applicator with a 3D printer, converted data in the DICOM format to the stereolithography (STL) format. The different thicknesses and filament densities ABS and metal filled with PLA end term electron applicator for LINAC with diameter 2cm, 3cm, 4cm, and 1cm, 2 cm respectively with the help of German RepRap 3D printer. The measurements with the ionization chamber have taken at the surface, there is no build-up above the Ionization chamber. Firstly, the data took the "100%" measurement without any additional slabs. After that was carried out with additional slabs (2) from both materials with the described thickness in the protocol. The absorber radiation is measured for 6MeV,8MeV,10MeV,12MeV and15 MeV as surface dose in the applicator distance of 95 cm SSD.

Results: The measurements with 6 MeV energies for 4 cm and 2 cm thickness of 3D cones showed the leakage radiation about 0.01 Gy for plastic filament and 0.09 Gy for metal filament respectively. From this measurement, it has been seen that the 3D printed applicator worked well for the lower electron energies and surface-based skin cancer. A small modification can reduce the radiation leakage for higher energies.

Conclusion: This study developed a new 3D Printed end term electron applicator and demonstrated its validity and superiority to provide more accurate treatment for small lesion cancer cases using irregular and regular shaped end term applicator for the lower energies and surface-based skin cancer.

OP-71

Radixact with Synchrony On SBRT Planning for Liver Malignancies: A Focus On Respiratory Gated (4D) PET BasedTarget Volume Delineation, A Pilot Study

Anson H.Y. Cheung, Jing Cai, Andy L.Y. Cheung
Department of Health Technology & Informatics, The Hong Kong Polytechnic University

Background: To evaluate the feasibility and potential advantage of using 4D PET/CT for liver SBRT planning.

Material and Methods: 6 patients with 8 liver lesions were recruited by Oncologist in this study. The non-gated CT images were used as primary data set for image registration and considered these as the planning CT for SBRT liver radiotherapy planning. Radiation Oncologist first contoured the GTV liver lesions with the consideration of 4D PET images, a biological Internal target volume (BITV) was generated for each lesion. The gated PTV was created by adding 3mm to account for set-up margins. Later the same radiation oncologist manually contoured the GTV, Biological Target Volume (BTV) obtained from non-gated PET and finally created the PTV with a 5mm radial and a 10mm craniocaudal margins applied. Non-parametric Wilcoxon matched pair tests were used for comparison between BTV vs BITV and PTV vs gated PTV.

Results and discussion: The mean volume (ml) of BTV is 19.66 ± 22.10 and BITV is 20.99 ± 25.58. The difference between BTV and BITV is considered to be not statistically significant ($p = 0.5511$). The utilization of 4D gated PET/CT images in liver SBRT treatment allowed a statistically significant reduction in the PTV ($p = 0.0035$). The mean volume (ml) of PTV is

56.58 ± 49.75 and gated PTV is 33.26 ± 36.69. All gated PTV were smaller than PTV in all SBRT liver contouring. The mean volume of PTV reduction is 47.50% and range from -26.08% to 68.87%.

Conclusion: Compared to 3D PET/CT, 4D PET/CT provided respiratory movement of liver tumours to Radiation Oncologist. 4D PET image may better define target volume. Furthermore, the reduction of irradiating normal liver may allow safer or potentially dose escalation of SBRT treatment in Radixact system with synchrony.

OP-72

A Comparative Treatment Planning Study on the Feasibility of Hybrid IMRT Treatment Planning for Left-Sided Chest Wall Irradiation

Mr.Subhas Haldar[1],Mr.Dinesh Saroj[2], Dr.Archana Dixit[1], Dr.Suresh Yadav[3], Prof.Dr. Abu Golam Zakaria[4]

1. Department of Physics, Institute of Applied sciences and Humanities, GLA University, Mathura -281406, U.P. India.
2. Department of Radiotherapy, Alexis Multispecialty Hospital, Nagpur-(M.H) 440030 India.
3. Department of Radiotherapy, Gandhi Medical College, Bhopal (M.P), India
4. South Asia Centre for Medical Physics and Cancer Research (SCMPCR).

Introduction: Irradiation of the chest wall (CW) and lymphatic nodes is more difficult due to the small target volume and irregular body surface. There is always unsatisfactory target coverage, low conformity, and homogeneity under coverage at CW and supraclavicular in 3D-CRT. Treatment delivery technique advancements such as intensity-modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) aid in achieving better dose coverage and homogeneity, as well as a lower dose to the heart and ipsilateral lung. The biggest worry with IMRT and is an increase in the radiation to healthy soft tissue and a greater Monitor Unit (MU), which could result in an increased risk of late secondary cancer.

Methods & Materials: For 10 patients undergoing left-sided breast chest wall irradiation, the three different planning strategies (FiF [Field-in-field], IMRT, and Hybrid IMRT) were evaluated. A prescription dose of 40 Gy in 15 fractions was used for the planning target volume (PTV). Plans were compared using dose-volume histograms to assess PTV dose conformity, homogeneity, and the volumes of normal tissues treated (DVHs).

Result: $D_{95\%}$ of PTV was 37.10 ± 0.48 Gy in FiF, but considerably improved to 39.32 ± 0.34 Gy and38.39 ± 0.29 Gy in IMRT (p=0.01) and Hybrid IMRT (p=0.01). When compared to IMRT (0.981 ± 0.014) and Hybrid IMRT (0.970 ± 0.013) FiF plans have the lowest CI value of 0.931 ± 0.026. IMRT plans (0.087 ± 0.021) were found to be more homogeneous than other 2 planning techniques (0.111 ± 0.013 [FiF, p=0.016], 0.107 ± 0.021[hybrid IMRT, p=0.056]).

Conclusion: We suggest adapting Hybrid IMRT treatment plans for the ca-breast since these modalities have superior and comparable PTV dose coverage and greater OAR sparing than IMRT and FiF plans. Lower MU and BOT, as well as a smaller lower dosage area, characterize hybrid IMRT plans.

OP-73

Advantages of Thermoplastic Sheet Bolus in Postmastectomy Radiation Therapy

Sakai Y[1,2], Tanooka M[1], Monzen H[2], Tamura M[2], Tanaka M[1]

Radiation Therapy Center, Takarazuka City Hospital,Takarazuka, Hyogo, Japan

Department of Medical Physics, Kindai University, Osakasayama, Osaka, Japan

Introduction: This study clarified the advantages of an immobilizing thermoplastic shell as a bolus, named "shell bolus," for postmastectomy radiation therapy (PMRT).

Material and Methods: First, we compared the dosimetric characteristics of a conventional gel bolus to that of thermoplastic sheets. The doses at surface and depth of 5 cm were obtained with gafchromic film and farmer type ionization chamber in a solid water phantom, respectively. The thicknesses of the thermoplastic sheets were 3.2 to 16.0 mm with 3.2 mm increments, while those of the gel bolus were 5.0 to 20.0 mm with 5.0 mm increments. A 6-MV X-ray flattening-filter-free (FFF) beam was employed (gantry angle = 0°) and the monitor unit was set to prescribe 2 Gy at depth of 5 cm without bolus. Second, the air gap between the body and each bolus was measured using planning computed tomography (CT) images for 7 and 13 patients who underwent PMRT using the gel and shell boluses with optimal thicknesses, respectively. The mean and maximum air gap thicknesses were obtained from each patient.

Results & Discussion: The doses of the 9.6-mm-thick thermoplastic sheet at the surface and depth of 5 cm were a 4.2% higher surface dose and 0.5% lower compared with the 10-mm gel bolus. The mean and maximum air gaps with the gel bolus were 4.3±1.7 mm and 9.9±2.8 mm, respectively, while those were 2.8±0.8 mm and 3.9±1.0 mm with the shell bolus, respectively. The air gap with shell bolus was significantly lower than that with the gel bolus ($p< 0.05$).

Conclusions: The shell bolus provided the equivalent bolus effect and higher adhesion compared to the conventional gel bolus.It is expected to be an effective bolus for PMRT.

OP-74

Unification of QA criteria considering the systematic errors of measurement-, calculation-, and prediction-based QA methods for VMAT

Tomohiro Ono, Mitsuhiro Nakamura, Yukinori Matsuo, Takashi Mizowaki

Introduction: The purpose of this study was to derive the systematic errors of measurement-, calculation-, and prediction-based quality assurance (QA) methods for volumetric modulated arc therapy (VMAT) and to evaluate the unified gamma passing rate (GPR) corrected using the systematic errors.

Material & Methods: This study involved 50 patients with lung cancer who underwent VMAT–stereotactic body radiotherapy (SBRT) between April 2018 and May 2019. VMAT–SBRT plans

were created using collapsed-cone convolution in RayStation. For measurement-based QA, ArcCHECK was used to evaluate measurement doses. For calculation-based QA, Acuros XB was used to recalculate VMAT–SBRT plans in Eclipse. For prediction-based QA, plan complexity parameters of a previously developed prediction model were used to predict QA results. The GPR was 3%/2 mm for each QA method. Systematic errors were calculated by conducting the Bland–Altman analysis, and the GPR was corrected using the systematic errors. The Bland–Altman analysis revealed the difference between the averaged GPR of the three QA methods and GPR of each QA method. The averaged GPR of the three methods was assumed to be the unified GPR. The level of agreement between uncorrected and corrected GPRs with the averaged GPR were evaluated using the difference mean value and the width of 95% limits of agreement (LoA).

Results & Discussion: For the uncorrected GPR (3%/2 mm), the difference mean values were −1.4% (LoA: −6.7–4.0%), 3.1% (LoA: −2.0–8.2%), and −1.7% (LoA: −6.1–2.7%) for the measurement-, calculation-, and prediction-based QA methods, respectively, reducing to 0.0% (LoA: −3.1–3.1%), 0.0% (LoA: −3.1–3.1%), and 0.0% (LoA: −2.8–2.8%), respectively, for the corrected GPR (3%/2 mm). The systematic errors and the difference from the averaged GPR were reduced.

Conclusions: The systematic errors of three QA methods were evaluated. The result can be used to determine unified QA criteria.

OP-75

Dosimetric Verification between 6mv FF & 6 mv FFF Beam for SBRT Lung & SBRT Spine Treatment Plan

S. A. Sarah[1], M. J. Islam[2], S. Das[3], H.A. Azhari[4], Golam A. Zakaria[5]

1. Department of Radiation Oncology, Delta Hospital Ltd, Bangladesh.
2. Department of Radiation Oncology, Labaid Cancer and Superspeciality Center, Bangladesh.
3. Department of Radiotherapy, Narayana Superspeciality Hospital, India.
4. Centre for Biomedical Science and Engineering, United International University, Bangladesh
5. Department of Medical Radiation Physics, Gummersbach Hospital, University Cologne, Germany.

Introduction: When using radiation to treat tumors, it is important not only to cover the target area, but also to minimize the dose to surrounding normal tissues. The aim of the study is the dosimetric comparison of 6MV FFF beams and 6MV FF beams in VMAT for the medically inoperable Primary lung cancer and Spinal Oligometastases in SBRT plan.

Materials and Methods: Treatment plans of lung & Spine SBRT patients were prepared using the same fields and physical parameters for 6FFF and 6FF energies. Total prescribed dose was 36-60Gy in 3-5 fractions for Lung cases & 21-24Gy in 2-3 fractions for Spine cases. Highly conformal coplanar VMAT plans are used. Total lung and spine doses, planning target volume doses, quality of plans GI, HI_{ICRU}, HI, CI, MU values had been compared between the two plans. All parameters were followed to RTOG 0813/0915 & RTOG 0631 protocols.

Result: Both plans were agreed to RTOG-0915,0813 and RTOG-0631 protocols compliance respectively for lung and spine cases. Significant changes were shown in the MU comparison, lower MU values were obtained with 6FF energy compared to 6FFF. 6FFF plan was almost similar to 6FF plan in terms of GI, CI, HIICRU and max dose, min dose, V107, V95, D2%, D98% but significant change was found in HI value, the HI value of 6FF energy was higher than the 6FFF energy.

Discussion: The 6FFF and 6FF both are suitable for lung and Spine SBRT. There are no dosimetric differences between the 6FF and 6FFF energy. Only the differences can be found in MU comparison due to the dose rate of 6FFF energy.

Conclusions: The 6FFF energy is more suitable for SBRT treatment because the treatment time & intrafraction error can be reduced and also patent comfortable treatments by using the FFF beam.

random errors were analyzed, and the suggested global margins based on Van Herk model for the five sites in the lateral, longitudinal, and vertical directions were ranged from 4.4 mm - 9.7 mm, 5.3 mm - 11.8 mm and 2.8 mm – 6.6 mm respectively.

Conclusions: kV-kV setup pair images as image-guided tools can be used to improve the accuracy of patient positioning and reduce tumor margin.

Abstracts of Poster Presentation

Brachytherapy

PP-01
A Single Institution Study of Dosimetric Comparison Between Tandem Ovoid and Tandem Ring Applicators in Cervical Cancer Brachytherapy

Neelima Pokala[1], Aaditya Prakash[1,2], Kaustav Mandal[1], Govinda Rao Amanapu[1], Venugopal Sundaram[1]
1. Department of Radiotherapy, Meherbai Tata Memorial Hospital, Jamshedpur, Jharkhand, India.2.
2. Department of Radiation Oncology,Tata Main Hospital, Jamshedpur, Jharkhand, India.

Introduction: A Tandem ovoid applicator is the most commonly used applicator for intracavitary brachytherapy. Nowadays, different applicators are available, such as Tandem-ring, tandem-cylinder, and hybrid intracavitary, interstitial applicators. The study aims to evaluate the differences in dosimetry between tandem-ovoid (TO) and tandem-ring (TR) applicators using different optimizing techniques in image-based brachytherapy.

Material and methods: In our study, 20 patients were included during the period October 2020 to July 2021, aged 40 to 70 years, with cancer of the cervix FIGO Stages II-IV. We used TR and TO applicators for the same patients in 2 fractions of brachytherapy. Four plans were generated for each patient utilizing 2 optimization techniques. A dose of 9Gy was prescribed and plans were normalized to left point A and in other technique, the optimization is done to achieve the recommended OAR dose-volume constraints. Dose-volume and dose point parameters were compared.

Results: The results indicate that the OAR doses assessed by DVH criteria were lower than ICRU point doses for bladder and rectum with both TO and TR applicators for Point A normalized plans and both Bladder and Sigmoid are higher in TO than TR but not statistically significant and the rectum doses are higher in TR than TO and statistically significant. The isodose volumes are higher in Point A normalized plans than in OAR-based optimized plans in both applicators. The ICRU point doses are lower in OAR optimized plans than in PointA normalized plans in both applicators.

Conclusions: The study shows that point doses and DVH parameters for TO and TR were dosimetrically comparable. The selection of the applicator depends on the patient's anatomy and the decision of the oncologist. The selection of planning techniques depends on a physicist and oncologist.

PP-02
The Effect of Total Reference Air Kerma on the Outcomes of Single-Channel and Tri-Channel Applicators in High-Dose-Rate Brachytherapy for Cervical Cancer

Hossain A[1], Miah S[2], Ray P K[2]

1. Department of Physics, University of Rajshahi, Rajshahi-6205, Bangladesh
2. Department of Radiotherapy, Rajshahi Medical College Hospital, Rajshahi, Bangladesh

Introduction: The traditional method for treating cervical cancer is to use single channel and tri-channel applicators. The goal of this retrospective study was to observe if there was a link between total reference air kerma (TRAK) and treatment outcomes in high-dose-rate brachytherapy for cervical cancer using single-channel and tri-channel applicators.

Material and Methods: Patients who received external radiotherapy (EBRT), chemotherapy, and brachytherapy using single and tri-channel applicators were followed in the retrospective cohort study from 2016 to 2020 in the department of radiotherapy. The international protocol was used to calculate all brachytherapy parameters, including TRAK. A log-rank test was used to analyze survival rates using the Kaplan Meier method.

Results & Discussion: The TRAK was 0.52 cGy.m^2 for the tri-channel applicator and 0.34 cGy.m^2 for the single-channel applicator, respectively, based on treatment durations of 15.34 (10-20) days and 21.35 (6.5-28) days. Based on TRAK, the Pearson correlation for tumor, rectum, and bladder was 0.082, 0.009, and 0.032, respectively. The sensitivity, and 1-speccificity were 0.70 and 0.30. The AUC was 0.717. The survival rate was 95% and 85% for tri-channel and single channel applicators, respectively, using the log-rank test (p=0.565).

Conclusions: For tumor, rectum, and bladder, TRAK was linked to treatment duration and Pearson correlation, implying that TRAK should be considered for the proper outcomes of single channel and tri-channel applicators.

PP-03
Plan Quality Score to Evaluate the Impact of DTDC on IPSA Optimized Treatment Plans of Mupit Based Interstitial Brachytherapy in Cervical Cancer

Kalyan Mondal, Muskaan, Ankur Maurya, Sunil Choudhary, Abhijit Mandal, Ankita Singh and Lalit Mohan Aggarwal

Banaras Hindu University, Dept. of Radiotherapy and Radiation Medicine, Institute of Medical Sciences, Varanasi, India

Introduction: In this study, we have evaluated the impact of DTDC on the quality of IPSA optimized treatment plans. We have calculated plan quality scores (PQS) using various plan indices and gain factors. We have also compared IPSA treatment plans with graphically optimized treatment plans.

Material and Methods: Seventy treatment plans of 10 cervical cancer patients treated with interstitial brachytherapy using MUPIT were studied. Graphically optimized plan and multiple IPSA optimized plans with different DTDC values ranging from 0.0 to 1.0 in the step of 0.2 were generated for each patient. Various DVH parameters like D_{90}, V_{100}, V_{150}, V_{200}, V_{300} were compared to access the impact of DTDC on target coverage and high dose region inside target for different plans. Similarly, for OAR dose, D_{2cc} were compared. Various planning parameters

like CI, COIN, DHI, DNR, ODI, EI and gain factor (GF) for different OARs were calculated. Based on these planning parameters and GFs, a plan quality score (PQS) was formulated and calculated for all plans to evaluate the overall dosimetric quality of treatment plans and hence the impact of DTDC on plan quality.

Results and Discussions: We have found that target coverage is similar for IPSA and graphically optimized treatment plans. However, dose homogeneity was improved in IPSA compared to graphical optimization whereas conformity was better in graphically optimized plans. OAR dose was less in IPSA plans. High dose regions inside the target were also reduced in IPSA comparatively. However, IPSA plans optimized with various values of DTDC did not necessarily reduced high-dose regions beyond 0.6. Plan quality score (PQS) were 6.31, 6.31, 6.34 and 6.17 for graphically optimized plan, IPSA with DTDC value of 0.0, 0.4 and 1.0 respectively.

Conclusions: We found that IPSA is dosimetrically advantageous over graphical optimization. IPSA with DTDC value of 0.4 improved over all plan quality. However, DTDC value beyond 0.6 produces dosimetrically sub-optimal plans hence the use of DTDC should be very selective and limited.

Dosimetry & QA

PP-04
Liver cancer patient treated by Helical TomoTherapy (Radixact) versus Volumetric Arc Therapy (VersaHD): Dosimetric evaluation of PTV and sparing of OARs

Anson H.Y. Cheung, Jing Cai, Andy L.Y. Cheung
Department of Health Technology & Informatics, The Hong Kong Polytechnic University

Background: Dosimetry of two radiotherapy techniques were compared: Helical Tomotherapy (Radixact with synchrony) and Volumetric Arc Therapy (VersaHD with Monaco) in patients with liver cancer where VMAT plans were used as a benchmark. Material and Methods: 12 liver cancer patients previously treated in the Hospital were enrolled. Planning CT and contours of these patients were retrieved and re-planned by Radixact treatment planning computer. Dosimetric evaluations on coverage, hot spot, conformity index (CI), Homogeneity index (HI) and gradient index (GI) for plan target volume (PTV) were performed. Dosimetric statistics for specified organ at risk (OARs) included normal liver mean dose, normal liver BED2 mean dose, normal liver V50%, whole liver V30Gy, mean dose of kidneys, heart mean dose and Dmax of spinal cord, esophagus, Gastrointestinal system and ribs. The total monitor units per fraction (MU/fr) and delivery time were analysed. Results and discussion: The PTV coverage and hot spot doses of HT plans were comparable. All GTV and PTV parameters showed no significant differences between plans (P>0.05). For the evaluation of target conformity (CI) and homogeneity(HI), the mean CI was 1.30±0.18 with VMAT and 1.32±0.25 with HT. The mean HI was 1.06±0.05 with VMAT and 1.06±0.04 with HT. The differences in CI and HI were not statistically significant (P>0.05). For dose fall-off checking, the mean GI was 6.65±4.84 with VMAT and 6.38±3.98 with HT (P>0.05). For sparing of OARs, all dosimetric statistics did not

show significant difference between VMAT and HT plans (P>0.05). Lastly, HT required a larger MU per faction (p=0.002) and longer delivery time (p=0.005). Conclusion: Our study suggested that Radixact HT system can achieve similar dosimetric results, in terms of PTV coverage and sparing of OARs, compared to conventional LINAC VMAT system. But VMAT plan showed better treatment delivery efficiency in terms of MU/fraction and time.

PP-05

A Dosimetric Comparison Between Intensity Modulated Radiation Therapy and Volumetric Modulated Arc Therapy in Stereotactic Body Radiotherapy Treatment of non-Small Cell Lung Cancer Using 6mv Flattening Filter Free Technique.

Lei Man I Michelle[1], Chau Ming Chun Ricky[2], Lui Wang Ngan[3], Kwok Pui Ying[3], Chan Hiu Ying[3]

1. Oncology Department, Kiang Wu Hospital, Macau

2. Oncology Department, Kiang Wu Hospital, Macau /Medical Science and Health (Radiation Therapy) Department, Tung Wah College, Hong Kong

3. Medical Science and Health (Radiation Therapy) Department, Tung Wah College, Hong Kong

Introduction: To investigate the dosimetric difference between IMRT and VMAT in SBRT treatment of NSCLC using 6 MV Flattening Filter Free (FFF) mode.
Material and Methods: Twenty patients with early-stage Non-Small Cell Lung Cancer (NSCLC) were retrospectively selected in this study. Plans were divided into centrally (10Gy x 5fr) and peripherally (12Gy x 4fr) located tumors. Both IMRT-SBRT and VMAT-SBRT plans with 6 MV photon in FFF mode were generated and compared. Dose conformity, dose homogeneity, intermediate dose spillage (R50% & D2cm), doses to Organs- At-Risk (OARs) and Monitor Unit (MU) were evaluated. All the statistical tests would be done by IBM Statistical Package of Social Sciences (SPSS) version 23. Results &

Discussion: All plans generated met the acceptance criteria listed in RTOG0813 and RTOG 0915 protocols for both target coverage and OARs limits. For both peripherally and centrally located tumors, IMRT-SBRT showed superior in PTV Dmax ($p<0.0031$), PTV Dmean ($p<0.008$) and HI ($p<0.0144$). Dose to 1000cc and 1500cc volume of lung were also significantly lower ($p<0.0251$) in IMRT-SBRT plans. However, VMAT-SBRT were lower in skin dose (2Gy±0.3, $p<0.027$) for peripherally and centrally located tumors and D2cm (1.9%, $p<0.0316$) for peripherally located tumors. For other parameters, there was no statistically significant difference.

Conclusions: Target coverage was similar in both plans. IMRT-SBRT techniques demonstrated superior in dose homogeneity and with lower dose irradiated to 1000cc and 1500cc volume of lung but inferior in skin dose and dose falloff outside target. Significant reduction in treatment time using SBRT-VMAT with FFF mode may be a better option for treatment of NSCLC.

PP-06
Simplified sigmoidal curve fitting for 6 MV FFF photon beam of Halcyon to determine field size for Beam commissioning and quality assurance.

Min-Geon Choi[1], Mikoto Tamura[2], Kenji Matsumoto[2], Masakazu Otsuka[2], Hajime Monzen[2],

Tae Suk Suh[1]

1. Department of Biomedical engineering and Research Institute of biomedical engineering, College of Medicine, the Catholic University of Korea, Seoul, Republic of Korea, 06591

2. Department of Medical Physics, Graduate School of Medical Science, Kindai University

Osaka-Sayama-Shi, Osaka 589-8511, Japan

Introduction: Delivery of a single energy 6 MV flattening filter free (FFF) photon beam is a main characteristic of an O-ring gantry type linear accelerator (linac) Halcyon. The purpose of this study is to determine the field size of the beam through an application of the simplified sigmoidal curve fitting (SCF) to the beam profiles obtained from the preconfigured reference data of Halcyon, and then to compare its parametrization with the measured beam data from Halcyon.

Methods: After a mathematical definition of the SCF using four coefficients, the defined curves were fitted to both the reference and measured data. When a high agreement between the fitting curve and the profiles in each data, the field sizes were determined by identifying the maximum point along the third derivative of the fitting curve. The curve fitting included the field sizes for beam profiles as 2 × 2, 4 × 4, 6 × 6, 8 × 8, 10 × 10, 20 × 20 and 28 × 28 cm^2 as a function of depths (at 1.3, 5, 10, 20 cm). The results of the field size from the reference data were compared with the results in the measured data using same condition.

Results: All fitting curves show an average agreement ratio higher than 97% and the values of goodness of fit, R^2, as better than 0.99. The differences of the field size between the reference data and the measured data were within the range of 0 to 0.2 cm. The least difference of the field sizes at depth 10 cm which is a surface to axis distance was reported.

Conclusion: The current work can be useful to the beam commissioning as a countercheck methodology to the field size from the reference data in the treatment planning system of a newly installed Halcyon.

Key Words: Field Size, Sigmoidal Curve Fitting, FFF, Halcyon, Commissioning, QA

PP-07
Effect of Off-axis Ion Recombination Factor on The Beam Profile in Flattening Filter-Free Photon Beams

Tanimoto Yuuki[1,2], Yoshida Shohei[1], Nakahira Atsuki[1], Koshi Kazunobu[1], Oita Masataka[2]

1. Department of Radiology, NHO Shikoku Cancer Center, Matsuyama, Ehime, Japan

2. Graduate School of Interdisciplinary Science and Engineering in Health Systems, Okayama University, Okayama, Okayama, Japan

Background: The ion recombination factor (Ks) of a linac irradiating a flattening filter-free beam (FFF-beam) behaves differently from that of a beam with a flattening filter. This study aims to examine the effect of changing the measurement conditions on the Ks in the off-axis direction. In addition, the effect on the beam profile will be clarified.

Methods: A Semiflex-3D ionization chamber (PTW) was used. Ks was calculated by Jaffe plot and two-voltage method (TVM). The ionization chambers were placed at a 10 cm of depth and the maximum dose depth (dmax) of the 3D water phantom, and measurements were taken in the cross-line and in-line directions with irradiation field sizes of 10 × 10 cm^2, 20 × 20 cm^2, 30 × 30 cm^2, and 40 × 40 cm^2. The beam profiles were normalized at the center, smoothed, and compared by local γ analysis before and after Ks addition.

Results & Discussion: The Ks derived by Jaffeplot and TVM were not as far apart as the previous study because the applied voltage in the previous study was slightly lower, and the uncertainty might decrease in this study. It was suggested that Ks depends on DPP (dose per pulse) also affects the measurement for off-axis direction in the previous studies. As a result of local γ analysis, the γ pass rate of 6MVFFF was 100% in all conditions, 10MVFFF was less than 95% in a 40 x 40 cm2 irradiation field, and dmax was worse even in a 30 x 30 cm2 irradiation field.

Conclusions: Even on the off-axis, Ks depend on DPP, and it is necessary to take Ks into account when measuring profiles with irradiation field sizes larger than 30 × 30 cm^2.

PP-08
Gamma Knife Quality Assurance

Asad Zameer, Abdul Sattar M. Hashim

Department of Radiosurgery, Neurospinal & Cancer Care Institute (NCCI), Pakistan

Introduction: This quality assurance program is designed for stereotactic radiosurgical units (Gamma knife) to check and maintain the unit to preclude accidents and comply with current regulations.

Materials and Methods: Gamma Knife has been in use at Neurospinal & Cancer Care Institute (NCCI) for 13 years. A comprehensive quality assurance program has been developed. It includes the physics and dosimetry parameters and safety checks required by Regulatory Body. The program, based on over 13 years of experience in measurements, and used during the treatment of over 1000 patients, is separated into three aspects, namely physics, dosimetry, and safety. The NCCI program hopefully will indicate out-of-tolerance problems. Some quality assurance items are checked on a daily basis prior to patient treatment, while other aspects are checked on a weekly, monthly, and/or annual basis. A complete list of items with their respective time tables and tolerances is provided.

Results: Although experience shows very small margins of error, larger values were chosen to account for variations in equipment and techniques.

Conclusions: Items included in this quality assurance program should indicate and/or preclude problems encountered in the use of this unit. Stereotactic Radiosurgery, Quality assurance, Gamma knife

PP-09
Dosimetric Measurement of Co-60 Teletherapy Unit

[1]Miah Md. Shahidul
Department of Radiotherapy, Rajshahi Medical College Hospital, Rajshahi

Introduction: Radiation therapy is a complex process with multiple steps, each of which has an impact on the quality of treatment. The goal of the Radiation standards and Dosimetry is to ensure that the output of the Teletherapy Unit. Accurate dosimetry is a critical step during the radiotherapy of cancer patients. The aim of the study was to measure the dose rate of cobalt- 60 (60Co) teletherapy units EQX Theratron of Canada at a point for different field sizes. In the present paper, we studied the dosimetry of the Cobalt-60 (Co-60) Teletherapy unit at Rajshahi medical college hospital, Rajshahi. Radioactivity is the phenomenon of disintegration of unstable nuclides called radionuclides. Among these radionuclides, Cobalt- 60, incorporated in Telecobalt Unit, is commonly used in therapeutic treatment of cancer.

Methods and Materials: The methodology involved in the present study is the measurement of actual dose rate (Absorbed dose to water) of Co-60 Teletherapy Unit by Source to Surface Distance (SSD) technique used for the External Beam Radiotherapy followed by TRS 398 protocol, of various cancers, using the standard method. For output measuring we used PTW Electrometer (Unidos 10001#10986), Ion chamber was cylindrical farmer type (NE2571-1205 and NE2581-537). The Water phantom size was 30cm x 30cm x30 cm. And another necessary standard accessory has been used.

Result and Discussion: This study shows that actual output (dose rate) is obtained by the actual dosimetry values and the expected output values obtained source certificate. The values obtained by actual dosimetry are within ±2% of the expected values.

Conclusion: The results thus obtained in average output by actual dosimetry done regularly as a part of Quality Assurance of the Telecobalt Radiotherapy Unit and its deviation from the expected output data is within the permissible limits. This study shows a trend towards uniformity and better dose delivery. the same average adult populations during optimization

PP-10
Quality Assurance Verification of Carcinoma Breast VMAT Treatment Plans: A Retrospective Analysis of Portal Dosimetry

Bisht Jyoti[1], Gupta Meenu[1], Kant Ravi[1], Nautiyal Vipul[1], Dobhal Rishabh[1], Kumar Viney[1], Ahmad Mushtaq[1], Saini Sunil[2]

1. Dept of Radiation Oncology, Cancer Research Institute, Swami Rama Himalayan University, Uttarakhand, India

2. Dept of Surgical Oncology, Cancer Research Institute, Swami Rama Himalayan University, Uttarakhand, India

Background: This study is aimed to evaluate the effectiveness and sensitivity of the portal dosimetry system as a quality assurance tool for carcinoma breast volumetric modulated arc therapy (VMAT) plans.

Materials and Methods: Total 44 carcinoma of breast patients were planned with VMAT technique. Two partial continuous and two partial non continuous arcs were used for the VMAT planning. Total 45GY/20# was prescribed to the patients. It was assured that the patients should get 95% of the prescribed dose. Quality assurance verification plan was created using PDIP_16.1.0 Algorithm. Pre-treatment quality assurance was done for all the patients with portal dosimetry. Varian True beam 2.7 version LINAC equipped with millennium MLC (120 MLCs) and with amorphous silicon (aSi) electronic portal imaging device (EPID) 397 mm x 298 mm flat panel and matrix of 2048x1536 was used for treatment delivery and portal dosimetry. The gamma passing criteria was set at distance to agreement (DTA) and dose difference (DD) tolerances at 3.0 mm and 3.0%.

Results: All the 44 Patients of VMAT plans were different and delivered as pre-treatment quality assurance verification. In this study a single threshold (e.g., γ passing rate of 95% at 3 mm, 3%) was selected as template to analyze each portal image. A composite image analysis was done for one patient portal dosimetry. An average gamma passing criteria for DTA/DD 3.0mm/3.0% was analyzed 99.83±0.19.

Conclusion: This study shows that portal dosimetry can be used as pre-treatment verification quality assurance tool. EPID provides accurate results even with strict gamma passing criteria and the portal dosimetry system is sensitive enough to detect MLC positioning error.

PP-11
Validation of non-coplanar dosimetry of SRS/SRT using Octavius 4d dosimetry system

Mohammad Abdul fatha, Sathiyaraj, Rupesh Krishna

KMIO, Bangalore

Aim: The aim of the study is to verify the nonstandard dosimetry of Octavius 4d system with SRS1000 array detector

Materials and Methods: This study performed with srs2d array and 4d rotational phantom. The analysis software is Veri Soft version 7.2. The SRS 2d array consists of 977 liquid filled ion chambers. The volume of each detector is 2.65mm^3 located over 11x11 cm^2 area. A simple 10x10 field was created in the TPS for different range of couch angle (0, 15, 30, 45, 60, 75, 90, 270, 315, 330, and 345 degree). The same plans were delivered on 4d Octavius phantom without moving couch (ie: all delivered at zero couch). All the delivered fluences were converted according to the plan and compared same. The angular error detection efficiency also verified by giving intentional couch error of 1, 2, 3, 4 and 5 degrees. In addition, with square fields, the actual clinical cases of SRS/SRT (14 cases) were taken to verify the angular error detection of verisoft.

Results: Measured and TPS fluence of different couch angle were analyzed, the average gamma passing rate (GPR) was 99.3% (2%2mm) for square fields and 97.2% (2%2mm) for SRS/SRT plans. Intentional couch angle error was introduced and the GPR was dropped from 99.3% to

90.95% (for square fields). Similarly, for SRS/SRT the GPR was dropped from 97.2% to 87.7% (from 0 to 5 degree). We noticed the dropping pattern of GPR for both square fields and SRS/SRT plans as couch error increased. The best fit was third order polynomial and correlation between GPR and couch error was 0.9999 for square field and 0.9998 for SRS/SRT plans. The maximum error was detected at 5degree, it was 9.8% and 8.4% different from zero shift for clinical plans and square fields respectively.

Conclusion: The couch angle error detection of Veri Soft using SRS1000 array was studied for SRS/SRT cases. The percentage difference between zero shift and error introduced shift can be well differentiated for square field as well as SRS/SRT plans. The VeriSoft can identify the couch angle error and convert the fluence from one angle to another without any error.

PP-12
Dosimetric Comparison of aSi 1200 EPID and Octavius 4D 1500 Detector Array for Patient Specific Quality Assurance

Sumanta Manna[1,2], Athulya P[1], Neethu Vincent[1], Ragul T[1], Benoy Kumar Singh[2], K J Maria Das[1]
1. Specialty of Medical Physics, Kalyan Singh Super Specialty Cancer Institute, Lucknow
2. Department of Physics, GLA University, Mathura

Introduction: Patient-specific dose comparisons using γ passing rate analysis are most popularly used for the quality assurance (QA) of intensity-modulated radiotherapy (IMRT) plans. Pre-treatment quality assurance is an important process for every IMRT plan. Octavius 4D system which consists of 1500 detectors is one of the new phantoms for determining the treatment plan quality. This study aimed to examine the IMRT plans using the EPID dosimetry and Octavius 4D-1500 to determine pre-treatment quality assurance results in head and neck Carcinoma) patient

Material and Methods: IMRT QA was conducted for 30 cases of Head and Neck. The Eclipse TPS used for treatment planning. The treatment plans were then applied to the -aSi 1200-EPID an agreement of PDP predicted and EPID measured photon fluence/dose distribution were evaluated and for Octavius 4D-1500 phantom the γ-index was calculated in the VeriSoft program to evaluate the IMRT plans. The passing rates of the dosimetric tools were calculated using criteria of 2mm/3%.

Results & Discussion: The portal dosimetry mean values of area gamma, average gamma, and maximum gamma were 99.2%, 0.29, and 2.08 with a standard deviation of 0.83%, 0.13, and 1.10 for IMRT. With Octavius 4D system, on an average with 3D gamma 96.55%, 96.93%, and 97.57% of the pixels passed for the coronal, sagittal, and transverse plane with a volumetric gamma of 96.99% and standard deviation of 1.37%, 1.49%, 1.13%, and 0.84% respectively.

Conclusions: Portal imager is an efficient, accurate, and sensitive dosimetry tool for pre-treatment quality assurance and is also the basis of pre-treatment quality assurance protocol. The

overall results of patient-specific IMRT fluence verification using EPID dosimetry and Octavius 4D 1500 are comparable.

PP-13
Calibration Coefficient of a Parallel Plate Ionization Chamber in High-Energy Small Field Photon Beams

Masakatsu Takeda[1,2], Morihito Shimizu[2], Yuki Sato[1,2,3], Masanori Sato[1]

1. Department of Radiological Sciences, Komazawa University (Setagaya-ku, Tokyo, Japan)
2. National Metrology Institute of Japan, AIST (Tsukuba, Ibaraki, Japan)
3. Department of Radiation Oncology, Tokyo Metropolitan Cancer and Infectious Diseases Cancer Komagome Hospital (Bunkyo-ku, Tokyo, Japan)

Introduction: We had developed the absolute measurement method of the absorbed dose to water in high-energy small field photon beams using a graphite calorimeter and calibrated for a short Farmer-type ionization chamber (IBA FC23-C). In this study, a parallel-plate ionization chamber (Exradin A11) with the same sensitive volume as a calorimeter was calibrated. The calibration uncertainty using the Exradin A11 was compared with that using the IBA FC23-C.

Material and Methods: The absorbed dose to water at the reference point in the small field 6 and 10 MV photon beams from a clinical linac were determined using the graphite calorimeter. The field size was 2 cm × 2 cm to 10 cm × 10 cm. The Exradin A11 and the IBA FC23-C were calibrated and determined the calibration coefficients ($N_{D,w,Q}$). The volume averaging correction factor (k_{vol}) of the calorimeter and ionization chambers were evaluated by the EBT3 film.

Results and Discussion: The $N_{D,w,Q}$ of the Exradin A11 and the IBA FC23-C were increased as the irradiation field size became smaller. This is because the non-uniformity of the dose distribution at the sensitive volume increases as the field size became smaller. The uncertainty of k_{vol} of the Exradin A11 and the IBA FC23-C was of 0.2 %, and the calibration uncertainty of the Exradin A11 and the IBA FC23-C was of 0.4 % and 0.5 %, respectively. This difference came from that the Exradin A11 has same sensitive volume as the calorimeter.

Conclusions: The uncertainty of the calibration coefficients of the Exradin A11 was smaller than that of the IBA FC23-C. For the small field dosimetry, the parallel-plate ionization chamber (Exradin A11) with the same sensitive volume as the graphite calorimeter can be used as a transfer reference ionization chamber between a primary standard laboratory to a user facility.

Radiology & Imaging

PP-14
The Way Forward for Diagnostic Radiology Medical Physicists in Sri Lanka

Vijitha Ramanathan and WMIS Wickramasinghe

Department of Radiography & Radiotherapy, Faculty of Allied Health Sciences, General Sir John Kotelawala Defence University, Werahera, Sri Lanka

In last few decades, there was a vast development in diagnostic radiology. Due to the complexity of medical imaging technology and increased utilization of imaging equipment, the role of diagnostic radiology medical physicist (DRMP) is essential in order to ensure the quality of the image and the safety

of the patient and medical staff who work in radiology department. The role of DRMP has been well recognized in developed countries but it was not implemented well in developing countries. The aim of this study was to investigate the current status and future perspectives of DRMPs in Sri Lanka. The interventional radiology units were identified in all 9 provinces of Sri Lanka, and education and man power of DRMPs were accumulated by conversation over the phone, sending emails, and from official website of Sri Lanka Atomic Energy Regulatory Council. 32 interventional radiology units were identified in government and private sectors in which about 72% of interventional suites were located in the western province. And only 2 DRMPs are in Sri Lanka. The DRMPs are recruited by Sri Lanka Scientific Service. There is no any specified postgraduate degree program for DRMPs. They have to pursue MSc in medical Physics as radiotherapy medical physicists do. There is a significant shortfall for DRMPs in radiology departments. At least DRMPs should be appointed to Hospitals with interventional radiology unit as radiation exposure level is highly concern. The certification for DRMPs must be introduced according to International the Atomic Energy Agency (IAEA) recommendations. In future, all radiology centres and medical imaging equipment from across the country will be identified for further investigations.

Keywords: Diagnostic radiology, Diagnostic radiology medical physicist, Medical Imaging, Sri Lanka

PP-15
Hounsfield Unit Calibration for Radiotherapy Treatment Planning Using an In-house Phantom and a Stoichiometric Algorithm: Improved Accuracy Compared to the Conventional approach

Ebrahimi M [1], Mahdavi M [1,2], Lotfi M [3,4], Mosleh-Shirazi MA [2,5]

1. Department of Radiology, School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
2. Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
3. Medical Imaging Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
4. Department of Radiology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
5. Physics Unit, Department of Radio-oncology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

Introduction: Dose calculation in treatment planning systems (TPSs) uses mass density (ρ) or electron density (ρ_e) values obtained from Hounsfield Units (HUs) (HU-ρ or HU-ρ_e calibration). Using computed tomography (CT) images of a specialized electron density phantom (EDP) made of materials with ρ or ρ_e closer to body tissues in conjunction with a stoichiometric algorithm, the HU-ρ_e curve may be calculated more accurately than with the present commercial phantoms, which in turn can increase the accuracy of patient dose calculations.

Materials & Methods: An in-house polyethylene EDP phantom, constructed with water and seven solutions with known densities, was scanned using a Siemens SOMATOM Definition 20-slice CT simulator. The HUs of 31 body tissues were calculated using schneider stoichiometric algorithm. HU-ρ lookup tables (LUTs), one obtained from our approach, the other the conventional direct method using a typical phantom, were defined on the Prowess Panther TPS (version 5.4). The monitor units (MUs) were then computed based on the CT images of head-and-neck (3), brain (1), lung (3), and prostate (3) patients. Treatment plans were computed for

four 6 MV beams normalized to isocenter, calculated using a collapsed-cone convolution-superposition algorithm. The relative MUs from the two LUTs were compared and analyzed by t-test using SPSS software.

Results & Discussion: The mean and maximum relative MU differences were 0.79% and 1.72%, respectively. There were significant differences between the MUs obtained from the two approaches in seven out of the ten patients ($P \leq 0.05$). The greatest differences were seen in anatomical areas where higher density tissues (like bone) were within the fields.

Conclusion: Calculating CT numbers of body tissues using a specialized phantom and a stoichiometric algorithm can lead to more accurate dose calculation compared to the conventional approach.

PP-16
Benchmarking of a New Automatic CT Radiation Dose Calculator

Akyea-Larbi Kofi Okyere[1], Tetteh Mercy Afadzi[2], Martinsen Anne Catrine[3], Hasford Francis[4], Inkoom Stephen[5], Jensen Kristin[6]

1. Department of Medical Physics, School of Nuclear and Allied Sciences, University of Ghana, LG 25 Legon, Accra, Ghana
2. Department of Physics, Norwegian University of Science and Technology (NTNU), NO-7491 Trondheim, Norway
3. Department of Diagnostic Physics, Oslo University Hospital, 0424 Oslo, Norway
4. Faculty of Health sciences, Oslo Metropolitan University, N-0130 Oslo, Norway
5. Radiological and Medical Sciences Research Institute, Ghana Atomic Energy Commission, LG 80 Legon, Accra, Ghana
6. Radiation Protection Institute, Ghana Atomic Energy Commission, LG 80 Legon, Accra, Ghana

Background or Introduction: In proton therapy, the uncertainties associated with the proton range can severely reduce the agreement between planned and delivered doses, with potentially negative impacts on the treatment outcome. A range monitoring system can help mitigate some of these uncertainties, thereby improving dose conformity to the clinical target volume and potentially reducing toxicities.

Material and Methods: The Monte Carlo simulations were performed with the GATE package (version 8.2), which is based on GEANT4 version 10.5.1. To reduce the simulation time, the interactions inside the phantom were simulated once and the outgoing particles were stored in phase space using phase space actors in GATE. The slit-slat camera was evaluated using the trade-off between the signal-to-noise ratio and spatial resolution to determine the best configuration of the camera.

Results & Discussion: According to the simulation data, the system's detection efficiency for 4.4 MeV single prompt gammas is 0.01% at the middle of the defined FOV, and the axial and transaxial resolutions are 23 mm and 18 mm, respectively. There is less than 2 mm of beam positioning precision along with both the beam incidence and the transverse direction. Our proposed slit-slat camera with 2D imaging capability can be installed under the patient's couch

in the treatment room with minimum interference to the treatment process and without limiting the beam nozzle performance.

Conclusions: Prompt gamma-based imaging systems can potentially provide a real-time, in-vivo treatment monitoring method for proton therapy. The acquired data from the suggested slit-slat system was determined to be suitable for real-time range uncertainty monitoring. As a result, by integrating this information with a specified dose during the treatment process, the range and dose uncertainties in proton therapy can be revealed. Furthermore, using analytical or machine learning methods, the retrieved data may be beneficial for dose reconstruction.

PP-17
Optimizing Image Noise as a means to Improve Computed Tomography ATCM in Sri Lanka

U Hishaam[1], J Jeyasugiththan[1], AS Pallewatte[2] and S Peterson[3]

1. Department of Nuclear Science, Faculty of Science, University of Colombo, Sri Lanka.
2. Department of Radiology, National Hospital of Sri Lanka, Colombo, Sri Lanka.
3. Department of Physics, University of Cape Town, Rondebosch 7701, South Africa.

The use of automatic tube current modulation (ATCM) in CT scans has become widely popular over the past few years. This method significantly reduces patient dose by adapting the tube current during a CT scan to produce outputs with a specified target image quality throughout scans and across patients of varying sizes. Different scanners and ATCM programs modulate current using some of the following methods: angularly around the patient or based on an average attenuation along the z-axis; using a reference image and mA value or using provided noise reference levels. However, when misapplied, ATCM can subject a patient to excessive radiation doses or produce images of non-diagnostic quality. Thus, it is important to evaluate the impact different exposure parameters and other scan factors have on the image quality of CT scans across a patient population. This work evaluates image noise levels, a vital factor in judging image quality, of CT scans using ATCM taken at hospitals across Sri Lanka. Considering the default tube voltage of 120 kVp for chest and abdomen CT scans in Sri Lanka, except in very rare exceptions, a review of international papers studying various CT scan factors is included. These factors include exposure parameters such as tube potential (kVp), and pitch value, as well as patient centering. Using the evaluation of image noise levels, this work aims to establish a CT scan ATCM protocol for hospitals across Sri Lanka. International studies are used as context to establish a protocol that is highly specific to Sri Lankan patients while also considering the fact that higher noise values are tolerable for larger patients due to fat levels providing greater image contrast. The protocol will establish the CT scan factors that optimize image noise levels when ATCM is used on Sri Lankan patients.

PP-18
Protection of radiation exposure for physician's brain using a tungsten rubber flap in interventional radiology

Shota Hattori, Hiroyuki Kosaka, Mikoto Tamura, Hajime Monzen

Department of Medical physics, Graduate school of Medical sciences, Kindai University, Japan

Introduction: Radiation exposure to the brain of a physician was unclear at the left anterior oblique (LAO) position, which is commonly used in clinical in interventional radiology (IR). The purpose of this study was to clarify the radiation exposure to the brain and investigate the shielding ability of a new protective tungsten rubber flap.

Material and Methods: We developed a flap combined with a protective cap for left lateral face shield, which was made of the tungsten-containing rubber. An anthropomorphic head phantom was placed at the physician's position, and air kerma rates were measured by electronic dosimeter at three locations: left side of the head, and left and right temporal lobes with/without the protective cap and the flap in cine mode. The X-ray tube was at the lower left side of the physician, and its angle was LAO60. The tube voltage and tube current were automatically adjusted by the X-ray system. The shielding rates of the cap and flap were also obtained.

Results and Discussions: The air kerma rates at the surface of the left side of the head, left and right temporal lobes were 78.15 μGy/15s, 45.49 μGy/15s and 5.87 μGy/15s, respectively. The shielding rates at left side of the head, left and right temporal lobes with the cap were 95.96%, 3.76% and 1.70%, respectively, while those with the flap were 96.20%, 84.28% and 20.61%, respectively. The flap can reduce radiation exposure of the brain more than the cap alone.

Conclusions: In IR, the physician's brain was exposed at LAO position. The head protection cap could protect the surface of the head, while not reduce the exposure to the brain. The flap was crucial to protect the radiation exposure to the brain of the physician.

PP-19
Establishment of Local Diagnostic Reference Levels of Digital Mammography

Yadav Ram Narayan[1, 2], Azhari Hasin Anupama[4], Jeyasugiththan Jeyasingam[1], Shah Budhram[3],N Sharma[2], Nitu[1]

1. Department of Nuclear Science, University of Colombo, Sri Lanka
2. Department of Radiodiagnosis Imaging and Nuclear Medicine, BPKMCH, Nepal
3. Faculty of Science, Nepal Academy of Science and Technology, Lalitpur, Nepal
4. Director, Centre for Biomedical Science and Engineering United International University (UIU)

Background: Radiation dose optimization in digital mammography can reduce over exposure during examination of women's breasts. Dose optimization can be done by establishment of diagnostic reference levels (DRLs). This study was carried out at the radiology department of BP Koirala memorial cancer hospital of Nepal.

Objective of the study: The goal of this study is to establish local DRLs of digital mammography and compared with standard published data.

Material and method: The study is retrospective. The average glandular dose (AGD) and entrance skin dose (ESD) of more than 100 patients in both Cranio-caudal (CC) and medio-lateral oblique (MLO) views of examination were recorded from DICOM of mammography machine Neosof. The technical parameters tube voltage, tube current as well as compressed breast thickness for all views of imaging for both breasts was also recorded. The collected data was analyzed by using python and the statistical significance was set at $p< 0.05$.

Result and discussion: The average glandular dose for Cranio-caudal and medio-lateral views were 0.81±0.29 mGy and 0.98±0.35 mGy respectively. It's only mean AGD values and not a final result. That's why DRLs will be set after final analysis of all collected values. This data looks comparable to some of the published values.This is a pilot study to establish national diagnostic reference levels of digital mammography in Nepal.

Conclusion: There may be need of optimization of mammography examination in this department of radiology

PP-20
Assessment of Abdomen-Pelvis CT Protocols Based on Doses for Various Patient Sizes using Anthropomorphic (XCAT) Phantoms and Monte Carlo Simulation

Hashemi B, Khodayari E, Banaei A

Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran.

Background: A basic concern about considerable increase of computed tomography (CT) examinations is their patients' high doses. Our purpose was evaluating various abdomen-pelvis CT protocols on various patient sizes to suggest optimal protocols based on effective doses estimated with anthropomorphic phantoms and Monte Carlo (MC) codes.

Material and Methods: Six XCAT anthropomorphic phantoms, as patients' models, were simulated with different lateral sizes on which specific abdomen-pelvis CT exam protocols were done based on AAPM report 96. Lateral sizes of patient model groups 1, 2, 3, 4, 5, and 6 were: 22.1-26, 26.1-30, 30.1-35, 35.1-40, 40.1-45, and 45.1-50 cm, respectively. Using BEAMnrc MC code, a 16-slice GE scanner was simulated with 80,100,120 and 140 kVp. For a pitch of 1.0 and 5 mm slice thickness, dosimetric calculations were made using DOSXYZnrc MC code. Then, using MATLAB, all organs of interest dose were extracted. Finally, by multiplying the relevant mAs coefficient values for all protocols and tissue weighting factors based on ICRP 103 report, effective doses were estimated.

Results & Discussion: Absorbed doses to ten organs of interest (liver, spleen, stomach, kidneys, rectum, bladder, prostate, femurs, colon, and small intestine) for each protocol on various patient sizes with a 3% mean error of MC simulations were assessed. The average variances of estimated effective doses for various protocols were 11.44%, 6.27%, 82.14%, 84.30%, 61.3%, and 82.57% for groups 1, 2, 3, 4, 5, and 6, respectively.

Conclusions: Significant differences of effective doses from various protocols for various patients' sizes were observed. Our result indicated that 80, 100, and 120 kVp values with

constant parameters can be recommended for groups 1&2, 3&4, and 5&6, respectively as suitable protocols owing to their significant dose reductions. Our detailed results can be used for categorizing patients and using suitable CT protocols for them in practice.

Keywords: CT, Anthropomorphic XCAT phantom, BEAMnrc, DOSXYZnrc, Monte Carlo, Organ dose, Effective Dose.

Radiobiology & Radioprotection

PP-21
Radiation Protection of Nail with Real-time Shapeable Tungsten Rubber in the Total Skin Electron Beam (TSEB) Therapy

Yuya Yanagi[1,2] Mikoto Tamura[1] and Yuya Yanagi[1,2], Hajime Monzen[1]
1. Department of Medical Physics, Graduate School of Medical Sciences, Kindai University, Osakasayama, Osaka, Japan

2. Department of Radiology, Shiga University of Medical Science Hospital, Otsu, Shiga, Japan

Introduction: A real-time shapeable tungsten rubber (STR) can be changed shape in real time at 60 °C and maintains its shape at room or body temperature. This study aimed to clarify the shielding ability and peripheral dose with the STR for nail protection in the Total Skin Electron Beam (TSEB) Therapy.

Material and Methods: Simulated finger phantom was made from syringes filled with physiological saline of volumes 20 ml (inner diameters of 21.7 mm). Gafchromic film was attached to the phantom, and lead (thickness 1–3 mm) or STR (thickness 1–4 mm) with an area of 4×1.5 cm was covered on the film. An electron beam with 6 MeV was irradiated to the phantom and the dose profiles were obtained from the film. The source-surface distance (SSD) was 444 cm, the field size was 36×36 cm at SSD of 100 cm without an electron applicator, and the monitor unit was 2000 MU. The relationships between shielding rates and peripheral dose increasing rates were evaluated from the dose profiles.

Results & Discussion: The shielding rates were 50.1, 98.0, and 99.0% for 1, 2, and 3 mm with lead, while -14.2, 55.5, 91.4, and 100.0% for 1, 2, 3, and 4 mm with STR, respectively. The peripheral dose increasing rates were 6.3, 4.5, and -3.0% for 1, 2, and 3 mm of lead, while 30.6, 6.4, 2.1, and 3.7% for 1, 2, 3, and 4 mm of STR, respectively.

Conclusions: The STR with thickness of 4 mm had equivalent shielding ability to the lead with thickness of 3 mm and reduce the peripheral dose increasing rate adequately. STR could be used

as a protection material for the nail in TSEB therapy instead of lead safely due to its non-toxic feature.

PP-22
Application of New Aluminum-Oxide (Al2O3) Composites as X-ray and Gamma Radiation Shields Using a Numerical and Experimental Approach

Farzaneh M[1], Maziyar M[1,2], Mohammad Amin M-S[1,3], Samaneh J[1], Farzaneh R[1], Mohammad Amin H[1]

1. Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz-Iran.
2. Department of Radiology, School of Paramedical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.
3. Department of Radiotherapy and Oncology, Nemazee Hospital, Shiraz University of Medical Sciences, Shiraz, Iran.

Background: In recent years, there has been a growing focus on the approach to lead-free radiation shields mainly due to disadvantages of lead such as high toxicity, poor mechanical durability, and ergonomic considerations. To this end, this study investigated new composites consisting of polyvinyl alcohol (PVA) and aluminum oxide.

Materials and Methods: Seven different compounds with different weight percentages of aluminum nanoxide (0-50%) were selected. First, quantities such as mass attenuation coefficients, half-value layer (HVL), and effective atomic number were calculated using Monte Carlo N–Particle Transport Code (MCNP). Then, the samples were synthesized by melt-mixing method in a twin-screw extruder and immediately characterization tests such as X-ray powder diffraction (XRD) and scanning electron microscope (SEM) were performed. Finally, mass attenuation coefficients and half-value layer (HVL) in the samples were measured experimentally in a standard allocated radiation geometry.

Results and Discussion: Computational and experimental analyses indicated that the addition of the weight concentration of nano-Al_2O_3 powder to the compounds significantly improves radiation attenuation, with an acceptable agreement between the results of the two methods. Furthermore, SEM images showed a relatively uniform distribution of Al_2O_3 particles on the polymer surfaces. However, the highest increase in the concentration (50wt.%) led to the formation of some lumps. Similarly, the XRD results showed more crystallization in the structures and more reduction of the amorphous region.

Conclusion: The data in this study showed that Al_2O_3/PVA composites can show good absorption and attenuation properties against X- and gamma-rays. These composites act as good shields in the low-energy X range, and especially in diagnostic processes.

PP-23

Radiation Protection Properties of Polyethylene/Bismuth Composites: An Experimental Study

Hossein M[1], Javad M[2], Bahram S[2], Mohammad Amin H[3]

1. Department of Nuclear Engineering, Islamic Azad University, Arsanjan Branch, Arsanjan, Iran
2. Reactor and Nuclear Safety Research School, Nuclear Science and Technology Research Institute, AEOI, Isfahan, Iran
3. Ionizing and Non-Ionizing Radiation Protection Research Center (INIRPRC), Paramedical School, Shiraz University of Medical Sciences, Shiraz-Iran

Background: The use of polymer composites for protection against X-ray and gamma rays is one of the known solutions to overcome the challenges of lead products. Bismuth (Bi) has always been considered as effective and alternative element of lead due to its high atomic number and less toxicity than lead. Accordingly, this study investigated polyethylene/bismuth composites.

Materials and Methods: Six different compounds were synthesized and molded with weight percentages of bismuth micro-oxide powder (Bi_2O_3) in a grade of heavy polyethylene in a laboratory extruder. Various characterization tests such as Thermogravimetric Analysis (TGA), scanning electron microscope (SEM), as X-ray powder diffraction (XRD) were performed to accurately understand the structure of the samples. Next, the samples were placed in the presence of a cesium-137 laboratory source arranged in a standard geometry, and quantities such as linear attenuation, mass attenuation, and half-value layer were practically measured. Finally, the mass attenuation coefficients were calculated in the range of 1-10000keV using XMUDat software, and the outputs were compared with the experimental data.

Results: Symmetric distribution of bismuth oxide particles was found in polyethylene surfaces, although its quality was changed by filler concentrations in some cases. Analysis of XRD patterns showed the formation of new phases (compared to raw polyethylene) and these changes after phase detection and measurement of lattice parameters confirmed the effectiveness of bismuth in composites. Following TGA patterns in different temperature ranges (room temperature up to 600°C), improved thermal stability was observed by increasing the filler concentration, which showed good agreement with previous studies. By comparing the values of mass attenuation coefficients of the samples by two experimental and computational methods in the mentioned energy (662 keV), the maximum error was 10%.

Conclusion: This experimental study showed that polyethylene/bismuth oxide compounds can act as X-ray and gamma adsorbents.

PP-24

In-Vitro Role of Radiofrequency Hyperthermia on Cell Cycle and Assessing Appropriate Time Interval for Carrying out Radiotherapy

Hashemi B[1], Hatamian M[1], Mahdavi SR[2], Soleimani M[3], Khalafi L[4]

1. Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran
2. Department of Medical Physics, Faculty of medicine, Iran University of Medical Sciences, Tehran, Iran
3. Department of Hematology, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran
4. Omid Tehran Radiation Oncology Center, Physics Section, Tehran, Iran

Background: GLOBOCAN reported an estimation of cancer mortality and prognosis at the end of 2020. Based on this report, women breast cancer has the highest rate of cancer diagnosis for the first time. Radiotherapy is the most frequently used procedure applied for handling breast cancer after surgery. As some types of tumors are radioresistant and don't show an acceptable response to radiation, radiotherapy becomes ineffective in some cases. On the other hand, hyperthermia is a complementary method to existing cancer treatment modalities including radiotherapy, chemotherapy, surgery, etc. Tumor cells that are most resistant to ionizing radiation (such as: hypoxic cells, nutrient deprivation cells, cells at acidic pH, and cells in the S phase of cell cycle) are recognized to be the most sensitive to hyperthermia. Moreover, by considering cell kinetic after hyperthermia, such factor influences the mitotic cycle of cells and can induce cell cycle arrest and will have a delay in their molecular checkpoint. The time interval among radiotherapy and hyperthermia is the crucial factors affecting hyperthermia. Our aim was to assess the influence of hyperthermia on the cell cycle arrest at various times after hyperthermia, and also two time-intervals between the radiotherapy and hyperthermia that could be selected.

Material and Methods: MCF7 breast cancer cells were utilized to investigate the effect of 13.56 MHz hyperthermia on the cell cycle arrest. Flowcytometry assay was also carried out to evaluate the alternation in mitotic phase of the cell population.

Results & Discussion: Based on the details of our results we purpose a 24 hours' time interval after hyperthermia for radiotherapy being confirmed by our flowcytometry outputs.

Conclusions: Relying on our results, applying radiotherapy practice after 24h time interval could be a more suitable time interval relative to simultaneous radiotherapy.

Keywords: Breast cancer, Cell cycle arrest, Hyperthermia, Radiosensitivity, Time interval

PP-25
Shielding Calculation and Verification for 15MV Medical Linear Accelerator Treatment Facilities

M. U. Shemanto[1,3], M. M. Rahman[1], M. Akhtaruzzaman[2], G. A. Zakaria[3,4]

1. Department of Medical Physics and Biomedical Engineering, Gono Bishwabidyalay, Dhaka, Bangladesh

2. Labaid Cancer Hospital and Super Speciality Center, 26 Green Rd, Dhaka 1205, Bangladesh
3. South Asia Centre for Medical Physics and Cancer Research (SCMPCR), Dhaka, Bangladesh
4. Institute for Medicine and Technology, Anhalt University of Applied Sciences, Köthen, Germany

Linear accelerators are now the most common treatment units in radiotherapy departments in cancer centers. They produce high-energy x-ray and electron beams. Most models of linear accelerators produce two or three beams of x-rays and typically five electron beams, each with a different energy to facilitate a range of patient treatments. As a consequence of the penetrating nature of the x-ray beam, they need to be sited in a shielded bunker to reduce the external dose rates and annual doses to meet the constraints imposed by national and international regulations. The purpose of radiation shielding is to reduce the effective equivalent dose from a linear

accelerator to a point outside the room to a sufficiently low level. This level is determined by individual states but is generally 0.02 mSv per week for a public or uncontrolled area.

Frequently, a higher level is chosen for areas restricted from public access (i.e., "controlled" areas) and occupied only by workers; this limit is 0.1 mSv per week. The required shielding is calculated based on the weekly workload of the machine; the distance from the target or isocenter to the point being shielded, modified by the fraction of time that the beam is pointed in that direction; and the fraction of the working week that the space is occupied. The purpose of this study was to demonstrate the shielding calculation for the installation of a linear accelerator and perform a survey of the radiation shielding design goals (P) and workload (W) based on the radiation safety reports concerned with structural shielding design for the treatment room of a linear accelerator.

Radiotherapy

PP-26
Dosimetric Advantages of Volumetric Modulated Arc Therapy (VMAT) With Deep Inspiration Breath Hold (DIBH) Technique in Halcyon Linac for Left Breast Cancer treatment

Chau Ming Chun Ricky[1], Lei Man I Michelle[2], Cheung Pui Yin[2], Hung Wai Ki[3], Qiu Xi Bin[3]

1. Medical Science and Health (Radiation Therapy), Tung Wah College, Hong Kong and Oncology Department, Kiang Wu Hospital, Macau
2. Oncology Department, Kiang Wu Hospital, Macau
3. Medical Science and Health (Radiation Therapy), Tung Wah College, Hong Kong

Introduction: To investigate the dosimetric and clinical advantages when incorporating of Deep Inspiration and Breath Hold (DIBH) with Volumetric Modulated Arc Therapy (VMAT) under Halcyon in treatment of left breast cancer. A cardiac dose estimation method was developed to estimate the correlation between Mean Heart Dose (MHD) and the 3D distance of heart from the target.

Material and Methods: Fifteen left-sided breast after lumpectomy patients between Jan 2017 and Oct 2020 were selected. Three plans were generated for each patient using Eclipse Treatment Planning System (TPS) with the prescription of 50.4 Gy to the PTV and 58.8 Gy to boost PTV in 28 fractions. Comparison between DIBH and Free Breathing (FB) under Halcyon and DIBH under Halcyon and C-arm Linear Accelerator (Linac) were performed and dosimetric parameters from both techniques were compared and analyzed. A cardiac dose estimation method was developed which making use of TPS contour tool to generate 3D distance between the centroid of target and heart surface to target reference line.

Results & Discussion: Comparable result of target coverage was shown in both techniques. The average MHD, Left Anterior Descending Artery (LAD) and Left Ventricle (LV) in Halcyon-DIBH-VMAT plans were significantly reduced by 0.49 Gy, 1.19 Gy and 0.57 Gy respectively,

compared to Halcyon-FB-VMAT ($p<0.00001$). The results demonstrated a strong negative correlation between MHD and Heart Surface to PTV58.8 Centroid Distance (HS-PTV58.8CD) in both FB and DIBH group ($r = -0.801$, $p<0.001$).

Conclusions: Target coverage was shown comparable between Halcyon-DIBH-VMAT and Halcyon-FB-VMAT but DIBH-VMAT demonstrated significant dose reduction in the heart, LAD and LV. A strong negative correlation between MHD and HS - PTV58.8CD in both FB and DIBH groups was found which indicated that dose to cardiac can be estimated based on the 3D distance between surface of heart and the centroid of the target.

PP-27
Development of Infrared Marker for Thermoplastic Immobilization Tool

KimYJ[1], KimTH[2], SuhTS[1]
1. Department of Biomedicine & Health Sciences and Research Institute of Biomedical Engineering, College of Medicine, The Catholic University of Korea, Seoul, 06591, Republic of Korea
2. Proton Therapy Center National Cancer Center, Republic of Korea

Introduction: Although the thermoplastic immobilization tool is used to efficiently control of patient movement, movement of the patient's skin surface under thermoplastic immobilization tool exists. In addition, the thermoplastic immobilization tool is used as a method of covering the skin surface, which makes it difficult to visually check the skin surface movement. Therefore, the aim of this study is to develop an Infrared (IR) marker that visually checks the movement of the patient's skin surface even used the thermoplastic immobilization tool.
Material and Methods: The structure of the IR marker was consisting of a spherical IR marker, a cylindrical marker posts to be attached to the skin and a disk-shaped marker base between IR marker and cylindrical marker posts. The disk-shaped marker base has a number of holes to be combined with the cylindrical marker posts. Confirmation of the developed IR marker is performed by locating the IR marker on the patient's skin surface along with the thermoplastic immobilization tool. We also developed the IR marker motion checking program.
Results: The IR marker was developed to detect patient surface movement under the thermoplastic immobilization tool. When the IR markers were located on the patient skin surface along with the thermoplastic immobilization tool, we confirmed that it is well located on without any other problems. And we confirmed that the IR marker motion checking program detects the movement of the IR marker well. However, experiments that check the movement of the patient's skin surface were still underway, therefore no results were obtained.
Conclusions: We have developed the IR marker for the thermoplastic immobilization tool and the developed IR marker was confirmed to be suitable for our purpose. Further study, we will verify with the stereo vision that the developed IR marker detects movement of the patient's surface.

PP-28
To Evaluate Conformity Index in Ilrt and 3dcrt Plans and Analyzed Volumetric Variation in The Target Volume Obtained Ilrt Treatment in Carcinoma Lung Patients

Ravi Kant[1], Meenu Gupta[1], Jyoti Bisht[1], Vipul Nautiyal[1], Viney Kumar[1], Rishabh Dobhal[1], Mushtaq Ahmad[1], Sunil Saini[2]

1. Department of Radiation Oncology, Cancer Research Institute Swami Rama Himalayan University, Dehradun, Uttarakhand, India
2. Department of Surgical Oncology, Cancer Research Institute Swami Rama Himalayan University, Dehradun, Uttarakhand, India

Introduction: Brachytherapy is the modality used for the treatment of carcinoma lung patient as palliative intent. Brachytherapy is a precise placement of the small encapsulated radioactive source directly inside or in close proximity of the tumor to deliver localized dose to the tumor and spare the healthy tissues.
Materials & Methods: Fifteen patients of carcinoma lung were retrieved who already underwent intraluminal brachytherapy treatment and re-planned with three dimensional conformal radiation therapy (3DCRT) in the Oncentra Master Plan software intreatment planning system.The analysis was done to evaluate the target volume coverage through Conformity Index in the ILRT and 3DCRT plans and also to assess the volumetric variation in the target volume after three ILRT sessions.OARs and target volume were delineated. Dose prescription is 7Gy per fraction, total three fraction in brachytherapy and 3Gy per fraction, total 30Gy in ten fraction in 3DCRT. Target volume coverage in the ILRT and 3DCRT plans were analyzed through Conformity Index calculation. Volumetric variation in the target volume from first session to third session of ILRT was assessed through Dose Volume Histogram tool and detail table in TPS.
Results & Discussion: The analysis was done on fifteen patients of carcinoma lung. The average CI values with standard deviation are 0.862±0.056 and 0.926±0.051in ILRT plans and 3DCRT plans respectively. Average volumetric variation in the Target volume was found from 18.51cc to 13.11cc in first to third ILRT session.
Conclusion: This study showed that in fifteen patients the Conformity Index was better in ILRT plans than 3DCRT plans. It also showed that there is a signification volume reduction in the target volume irradiated with ILRT. This implies that the ILRT is better as compared to the 3DCRT technique in the lung carcinoma patient where the disease is in the primary and secondary bronchus.

PP-29
Comparison of Three-Dimensional Conformal Radiotherapy and Intensity Modulated Radiotherapy in Cervix Cancer

S Alim[1], M M Parvej[1], M A Hasnat[1], J Hosen[1], & Dr. K Raj Mani[2]
1. Institute of Nuclear Medical Physics, AERE, BAEC, Savar, Dhaka, Bangladesh.
2. United Hospital Ltd, Gulshan, Dhaka, Bangladesh.

Aim of the Study: To investigate the Dose Comparison of Three Dimensional Conformal Radiotherapy (3DCRT) and Intensity Modulated Radiotherapy (IMRT) underwent Computed Tomography (CT) simulation along with adequate immobilization and positioning devices. Target volume and Organ at Risk (OAR) were delineated slice by slice for all patients. 3DCRT treatment plans were created by photon beam of 15 MV energy using 4-fields box technique and Multi Leaf Collimator (MLC) fitted to the Planning Target Volume (PTV). IMRT plans were created by photon beam of 6 MV energy with equally distributed 7 gantry angels. We intend to deliver 50 Gy in 25 fractions for all patients. Dose to the critical structures and targets were recorded from the Dose Volume Histogram (DVH) for evaluation.

Results: Target Homogeneity for the 3DCRT and IMRT plan were comparable. Conformity Index shows that over 3DCRT low dose volumes (V5, V10 and V15) were high in IMRT, but high dose regions were comparatively less in IMRT plan, the rectal mean doses were reduced by 15% compared to 3DCRT which may result less toxicity in rectum. In IMRT plan bladder mean dose were reduced by 27% compared to 3DCRT plan.

Conclusion: IMRT shows superior OAR sparing compared to 3DCRT plan. But IMRT treatment plan is very precise so treatment center who does not have IGRT facilities they should not treat with IMRT
technique. In stand of IMRT They can use 4 field box technique using 15MV beams and PTV fitted MLC to reduce the high dose irradiation volume, which may result in low toxicity profile.

PP-30
Can True Beam Trajectory Log File Have Used as Patient Verification Tool for Rapidarc™ Treatment Delivery?

Sundaram Venugopal[1], Manjulika Bhattacharjee[1], Josmi Joseph[2]

1. Meherbai Tata Memorial Hospital, Jamshedpur, Jharkhand, India.
2. All India Institute of Medical Sciences, Jodhpur, Rajasthan, India.

Introduction: The study was performed to explore Varian Truebeam trajectory log files (Varian Medical Systems, Palo Alto, CA) to verify the end to end data transfer and quality assurance tool for Rapidarc™ patient treatments.

Materials and method: RapidArc™ plan was generated using Eclipse V15.6. and the plans delivered using Varian TrueBeam V2.7, which employ millennium 120 MLCs. Total 156 RapidArc™ trajectory log files randomly were collected and analyzed from the LINAC. TrueBeam saves file in binary format. The recorded files were extracted and analyzed using Python, Varian Offline QA software following parameters MLC positions and speed, bank A and B leaves, jaw positions (X1, X2, Y1, Y2), collimator angle, gantry angle (start and stop), couch positions, monitor units (MU), control points, dose rate, patient identification (ID), plan name, field name, field size. The tolerances for target deviations were set for leaf position is 0.1 cm, leaf speed (cm/s) is 0.5.

Results: The result of software analyzes for Trajectory log file shows maximum error in MLC leaf position were 0.0080 cm ± 0.0002, maximum error in MLC leaf speed were 0.2529 (cm/s) ± 0.0031, maximum error in average RMS error in MLC leaf position is 0.0053 cm ± 0.0002 and maximum error in average RMS error in MLC leaf speed is 0.1636 cm/s ± 0.0012. Gantry positions, MU, dose rate RMS value shows 0.04942 deg, 0.00804, (22.43777 MU/min) respectively. From the analysis results of accuracy MLC, Jaw and gantry, couch, collimator positions, bank A and B positions were well within the expected values. Prior to treatment same patients fluence verification evaluated with portal dosimetry.

Conclusion: Log file gives enough information it can be used as a patient verification tool. This analysis ensures that correct data's transferred from planning system to delivery system. Trajectory log file additionally considered as a phantom less quality control analysis. We have plan to conduct analysis over the entire course of patient treatment in near future.

PP-31
Smart Armour for Radiotherapy: Reduction of Unwanted Radiation.

BUTSON, Martin Jonathan
Butsonian Industries Pty Ltd, Mangerton, NSW, Asutralia

Introduction: The intent of Radiotherapy treatment is to provide the correct radiation dose to cancerous tissue and the surrounding PTV whilst minimizing radiation exposure to all other areas as defined by the ALARA principle. During breast cancer radiotherapy (and many other treatment sites), the contralateral breast (or peripheral regions) receives unwanted radiation dose from sources such as internal scatter, transmission and from electron contamination. The work investigates and provides a new and easy to use solution to provide superior protection to the contralateral breast or peripheral regions during radiotherapy.

Material and Methods: SMART Armour, which stands for Scalle Maille Armour for Radiation Therapy is designed and used to shield the contralateral breast or peripheral regions during treatment using conformal, field in field and IMRT techniques. Reductions in skin and subcutaneous tissue dose are measured and results are given compared to original doses without shielding used. Methods for cleaning and clinical set up protocols have been developed and will be discussed.

Results: Measurements for contralateral breast dose in phantom studies shows that substantial reductions in skin and subcutaneous tissue dose are achievable with the SMART Armour. These values are up to 80% of original dose. Cleaning techniques for SMART Armour have been successfully performed utilising decontamination, disinfection and sterilisation techniques using washing chemicals, boiling and pressure sterilisation techniques.

Conclusion: SMART armour takes little time to position during radiotherapy, can be easy cleaned, is a passive device and does not interfere with planning or treatment techniques when used appropriately. SMART Armour is capable of substantially reducing unwanted radiation exposure and thus minimizing associated risks.

PP-32
Evaluation of Radio sensitization effect of Gold and Hafnium Oxide Nanoparticles on HeLa Cancer Cells under 6 MV Radiotherapy

Hashemi B[1], *Amini Kadijani B*[1], Mahdavi SR[2], SoleimaniM[3]

1. Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran.
2. Department of Medical Physics, Faculty of Medicine, Iran University of Medical Sciences, Tehran, Iran.
3. Department of Hematology, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran.

Background: Radiotherapy is one of the major techniques of cancer treatment. Over the past decades, metal-based nanoparticles have been utilized in various studies as radiosensitizers to increase the lethal effect of ionizing radiation on tumor cells and reduce the side effects on healthy tissues. In recent years, researchers have considered the production of nanoparticles with high biocompatibility and great radiosensitization effect. The results of some investigations have shown that hafnium oxide nanoparticles can be regarded as a suitable radiosensitizer to improve the lethal effect of various radiotherapy procedures. Our aim was synthesizing coated gold and hafnium oxide nanoparticles. Moreover, we conducted this study to evaluate the non-toxic concentration and radiosensitization effect of such nanoparticles.

Material and Methods: First, we synthesized gold and hafnium oxide nanoparticles with a size of nearly 50 nm and covered them with biocompatible materials. The size of the nanoparticles were measured by FESEM and DLS. The non-toxic concentration of every nanoparticle was determined by MTT assay. Finally, the dose enhancement factor (DEF) of the nanoparticles under 6 MV ionizing radiation from commercial linac on HeLa cancer cells was assessed by using colony assay.

Results & Discussion: The DEF of the hafnium nanoparticles was significantly higher than gold nanoparticles. Furthermore, the DEF with hafnium nanoparticles was significantly increased by increasing the radiation dose, but such effect was not observed with the gold nanoparticles.

Conclusions: The concentration of hafnium oxide nanoparticles in the studied cell culture was lower than gold nanoparticles. However, the DEF of hafnium oxide nanoparticles was higher than that of gold nanoparticles.

Key words: Cell Toxicity, Gold nanoparticles, Hafnium Oxide Nanoparticles, HeLa Cancer Cell, Radiosensitization, Radiotherapy.

PP-33
Establish of dose-parameter analysis model to improve VMAT plan quality for prostate cancer

Takaaki Ito[1, 2], Wataru Omasa[2], Kazutaka Yoshida[2], Mikoto Tamura[1], Hajime Monzen[1]
1. Department of Medical Physics, Graduate School of Medical Sciences, Kindai University, Osaka, Japan
2. Department of Radiological Technology, Kobe City Nishi-Kobe Medical Center, Kobe, Japan

Introduction: We developed a dose-parameter analysis model for planners to determine upper or lower goals of dose indices in VMAT planning of prostate cancer. The aim was to improve the VMAT plan quality with this model. Material and Methods: Three regression lines were configured from 41 VMAT plans: 1. Ratio of the overlap volume between PTV and rectum to PTV vs. $D_{95\%}$ of PTV, 2. Ratio of the overlap volume between PTV and rectum to rectal wall vs.

dose indices of rectal wall ($V_{20, 30, 40, 60, 70, \text{and } 78Gy}$), 3. Bladder volume vs. dose indices of bladder wall ($V_{40 \text{ and } 70Gy}$). Five clinical plans (CPs) for prostate cancer patients who underwent VMAT were randomly selected. The VMAT plan quality as dose-volume parameters, plan complexity, and delivery accuracy of the CPs were compared with the plans recalculated by three planners (Re-plans) using the model. The plan complexity metrics were modulation complexity score (MCS_v), small aperture score (SAS), and monitor unit (MU). The point dose differences and γ passing rates (3 % / 2 mm) were also evaluated. Results: The dose-volume parameters (CPs vs. Re-plans) for PTV and bladder were no significant differences, while the V_{20Gy}, V_{30Gy}, V_{40Gy}, and V_{60Gy} for rectal wall were 82.39% vs. 75.8%, 66.08% vs. 51.88%, 46.87% vs. 37.20%, and 25.51% vs. 22.33% with significant differences ($p < 0.05$). The plan complexities with significant differences were 0.32 vs. 0.28 (MCS_v), 0.29 vs. 0.40 ($SAS_{10\ mm}$), 0.48 vs. 0.63 ($SAS_{20\ mm}$), and 476.92 vs. 580.95 (MU). There were no significant differences for dose difference (0.77 % vs. 0.97 %) and γ passing rates (97.24 % vs. 96.31 %). Conclusions: Our model provided the better dose-volume parameters. The delivery accuracy was no problem although the plan complexity was higher. The dose-parameter analysis model can improve the VMAT plan quality.

PP-34
The Basic Research for Optimizing Gantry Angle According to Differences in Hepatic Segment in Proton Therapy

Taku Tochinai, Tsunemichi Akita, Takashi Someya, Toshiya Rachi, Kazutoshi Yokoyama
Department of radiology, National cancer center hospital east, Kashiwa, Chiba, Japan

Introduction: In proton therapy treatment planning, the choice of beam angle is determined by trial and error based on the rules of thumb of the treatment planner. Therefore, the results vary depending on the treatment planner. It is not yet clear which angle should be chosen to maintain target coverage and reduce the impact on other organs. Since proton therapy has a high local control rate for hepatocellular carcinoma, it is important to optimize the treatment plan. The purpose of this study is to clarify the difference of gantry angle by liver segment.
Material and Methods: A total of 182 patients treated with proton therapy for hepatocellular carcinoma at the National Cancer Center East Hospital from May 2012 to July 2021 were included in the study. The liver was divided into segments, and data on the number of gates and beam angles used were collected. From the data, the most frequent values were determined.
Results & Discussion: In S1, 250° and 200° were used most frequently, and two-port irradiation was used. In S2, 40° and 320° were used most frequently, and two-port irradiation was selected. In S3, 0° and 280° were used most frequently, and two-port irradiation was selected. In S5, 270° and 180° were mostly used, and two-port irradiation was selected; in S6, 180°, 270°, and 320° were mostly selected, and three-port irradiation was used; in S7, 210° and 270° were mostly used, and two-port irradiation was used; in S8, 0° and 270° were mostly used, and two-port irradiation was used.
Conclusions: There was a difference in the beam angle configuration used for each tumor location. The determination of the beam angle will be discussed in the future, as it includes factors such as the distance between the tumor and the organ at risk.

PP-35

Development of a Novel Real-Time Shapeable Bolus for Electron Radiotherapy

Kazuki Wakabayashi[1,2], Hajime Monzen[1], Mikoto Tamura[1], Yoshiki Takei[1,3], Katsuya Okuhata[1], Shimpei Anami[4], Hiroshi Doi[5], Yasumasa Nishimura[5]

1. Department of Medical Physics, Graduate School of Medical Sciences, Kindai University, Osaka-Sayama, Osaka, Japan
2. Department of Central Radiology, Wakayama Medical University Hospital, Wakayama, Wakayama, Japan
3. Department of Radiology, Kindai University Nara Hospital, Ikoma, Nara, Japan
4. Department of Radiology, Wakayama Medical University, Wakayama, Wakayama, Japan
5. Department of Radiation Oncology, Faculty of Medicine, Kindai University, Osaka-Sayama, Osaka, Japan

Introduction: In electron radiotherapy, the unexpected air gap between a patient body and the bolus decreases the delivered dose to superficial tumors. We have developed a novel bolus (HM-bolus) that can be shaped in real-time by heating and maintain its shape in room or body temperature. This study investigated its ability for clinical use as a bolus from the dosimetric characteristics and adhesion to the patient.

Material and Methods: The HM-bolus is a rubber with no cross-linked polymerization, and the density (1.01±0.03 g/cm^3) was comparable to that of water (1.00 g/cm^3) and a commercial gel bolus (1.03 g/cm^3). Percentage depth doses (PDDs) for 4, 6, and 9 MeV electron beams were compared between HM-bolus and gel bolus as reference material, in water-equivalent phantom. To evaluate adhesion, the airgap volume between the bolus and phantom surface on the nose of a head phantom was evaluated from CT images. The depth dose profile along the 6 MeV electron beam axis in the head phantom was also calculated for 200 monitor unit irradiation with treatment planning system and compared between HM, gel, and virtual boluses for depth of maximum dose (d_{max}) and maximum dose (D_{max}).

Results and Discussion: The PDDs between the HM and gel boluses were in close agreement within 2%. The airgap volume under the HM and gel boluses was 3.14 and 50.35 cm^3, respectively. The d_{max} of HM, gel, and virtual boluses were 8.0, 6.0, 7.0 cm (without bolus: 12.0 cm), respectively, and D_{max} of corresponded values were 186.4, 170.4, 186.8 cGy, respectively. HM-bolus can suppress the delivered dose reduction due to minimizing the airgap.

Conclusions: The HM-bolus has equivalent dosimetric characteristics to commercial gel bolus and achieves excellent adhesion to the body surface, which can be used as an ideal bolus in electron radiotherapy.

PP-36

Assessment of Novel Developed IMRT Planning Protocols for Treating Nasopharyngeal Cancer Patients Based on the Target and Organs at Risks Common Volumes.

Hashemi B[1], Sharbo Gh[1], Bakhshandeh M[2], Rakhsha A[3]
1. Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran.

2. Department of Radiology Technology, Faculty of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
3. Department of Radiation Oncology, Faculty of Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Background: Our aim was to assess various novel developed intensity modulated radiation therapy (IMRT) and three dimensional conformal radiation therapy (3D-CRT) protocols for the treatment of nasopharyngeal cancer (NPC) patients based on the common volumes of their target and organs at risks (OARs) by using radiobiological tumor and normal tissue control probability (TCP & NTCP) parameters.

Material and Methods: Several treatment plans were carried out on the CT images of 30 NPC patients using various novel developed IMRT protocols with variable collimator (0, 5, and 10 degrees) and couch (0, 4, 8, 12 degrees) angles and also a conventional 3D-CRT technique. The TCP, NTCP, and complication-free tumor control probability (P+) parameters were estimated for the assessment of our developed IMRT protocols. Then, the ideal protocol (s) were chosen ana proposed through comparing the developed IMRT protocols with each other and also with the conventional 3D-CRT protocol based on their relevant TCP, NTCP, and P+ estimated values.

Results & Discussion: The IMRT protocol with 10° collimator and 8° couch angle had the lowest mean value of the NTCP. Significant differences were observed among the mean NTCP and P+ values of the developed IMRT and 3D-CRT protocols for the brainstem, and parotid glands. However, no significant differences were observed among the mean NTCP values for the spinal cord, optic chiasm and optic nerves among various investigated protocols.

Conclusions: Our results indicated that the 3D-CRT protocol has a good outcome for the NPC patients having a lower common volume range (from 0 to 6 cm^3) between the total planning target volume (TPTV) and OARs, while the IMRT protocols could be preferred for treating the patients having a higher range of such common volume (from 6 to 12, and > 12 cm^3).

Keywords: Nasopharyngeal Carcinoma, IMRT, 3D-CRT, Treatment Planning, TCP, NTCP, P+, Radiobiological Models.

PP-37

A Present Scenario of Radiotherapy Services in Nepal

Sah Suraj[1], Adhikari Tirtharaj[2]
1. Department of Radiology and Imaging, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal
2. Department of Radiation Oncology, Sushil Koirala Prakhar Cancer Hospital, Banke, Nepal

Background: Nepal is a developing country with about 29 million populations. Radiotherapy is one of the essential treatment modalities for cancer, for both curative and palliative intent. This study aims to find the availability of radiotherapy machines throughout the country. As Low Income country, Radiotherapy in Nepal faces significant challenges with respect to human resource, Infrastructure and Equipment.

Materials and Methods: Data regarding Radiotherapy services in the country were collected by on site visit and by telephone conversations. Data were analyzed using Microsoft excel.

Results and Discussion: There are total 8 radiotherapy centers in Nepal among them 3(37.5%) are in government and 5(62.5%) are in private sector. There are total 9 Linear accelerators, 7 HDR Brachytherapy, 3 SPECT Scan, 3 PET CT scan, 45 MRI and 1 Blood irradiator all over the country. There are total 30 Radiation Oncologist, 20 Medical Physicist and 17 Radiotherapy Technologist working all over the country. There is lack of academic institute for Medical Physics and Radiotherapy Technologist course. Nepal also lack central cancer registry database system and Radiation regulatory authority board. Government hasn't allocated enough financial support for cancer management.

Conclusions: With current cancer incidence in the low and middle income countries, IAEA suggested the need of 1-3 radiotherapy machine per one million populations that would mean in Nepal, we need at least 30 linear accelerators to cater the diverse population of Nepal. Due to prevalence of cancer burden, combined efforts of public, government and international agencies government are required to develop strategic plan and hence reduce the morbidity, mortality and improve the quality of life of cancer patients in Nepal.

Nuclear Medicine & Radiopharmaceuticals

PP-38
Medical Imaging Capabilities of Neutron-Activated Samarium-153 Polystyrene Microspheres as a Theranostics Agent After Direct Intra-Tumoural Injection on Sprague-Dawley Rats with Xeno transplanted Liver Tumours

Tan HY[1], Wong YH[2], Kasbollah A[3], Md Shah MN[4], Abdullah BJJ[2,4] Yeong CH[2]
1. School of Biosciences, Faculty of Health and Medical Sciences, Taylor's University, 47500 Subang Jaya, Selangor, Malaysia.
2. School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, 47500 Subang Jaya, Selangor, Malaysia.
3. Medical Technology Division, Malaysian Nuclear Agency, 43000 Bangi, Selangor, Malaysia.
4. Department of Biomedical Imaging, University of Malaya Medical Centre, 59100 Kuala Lumpur, Malaysia.

Introduction: Neutron-activated Samarium-153 (^{153}Sm) is ideal for theranostics applications because it emits both beta ($E_{\beta^-(max)}$ = 810 keV) and gamma (E_γ = 103 keV) radiations with a desirable physical half-life of 46.3 hours (h) and is produced by low-cost neutron activation technique. Samarium oxide loaded polystyrene ($^{153}Sm_2O_3$-PS) microspheres has been proposed for intra-tumoural theranostics treatment of solid tumours. This study aimed to evaluate the diagnostic imaging capabilities of the microspheres on tumour-bearing rats.

Materials and Methods: Three male Sprague-Dawley rats (150 – 200 g) were implanted with N1-S1 hepatoma cell line orthotopically and the rats received an intra-tumoural injection of 37 MBq $^{153}Sm_2O_3$-PS microspheres into the centre of the liver tumour. The rats were subjected to static gamma imaging at 24 h, 48 h, 72 h and 168 h post-injection using a compact gamma camera to assess the biodistribution pattern. Clinical single photon emission computed

tomography/computed tomography (SPECT/CT) system was then used to scan the rats at 120 h post-injection.

Results and Discussion: Static gamma images clearly showed the distribution of ^{153}Sm radioactivity in the tumour at 24 h post-injection with no significant leakage of the microspheres from tumour up to 168 h (nearly after 4 half-lives). The SPECT/CT images similarly displayed a high uptake of ^{153}Sm radioactivity in the liver tumour at 120 h post-injection for all the rats. Additionally, the injection site of the $^{153}Sm_2O_3$-PS microspheres was visible on the CT images. This has added to the benefit of ^{153}Sm as a CT contrast agent.

Conclusions: Neutron-activated $^{153}Sm_2O_3$-PS microspheres demonstrated excellent diagnostic imaging capabilities after intra-tumoural injection on tumour-bearing rats. Biodistribution and injection site of the $^{153}Sm_2O_3$-PS microspheres can be clearly visualised on SPECT and CT images, respectively. Further studies on the therapeutic efficacy of the microspheres are needed to evaluate its feasibility as a theranostics agent.

Keywords: Diagnostic imaging, intra-tumoural, neutron-activated, Samarium-153, theranostics

PP-39

Respiratory gated (4D) FDG-PET/CT scan for liver malignancies: Feasibility in liver cancer patient and tumour quantitative analysis.

Anson H.Y. Cheung, Jing Cai, Andy L.Y. Cheung

Department of Health Technology & Informatics, The Hong Kong Polytechnic University.

Background: To evaluate the potential role and effectiveness of respiratory gated (4D) FDG PET/CT scan for liver malignancies, relative to routine (3D) FDG PET/CT scan.

Material and Methods: Patients with history of liver malignancies who have undergone PET/CT exam were recruited. Liver lesions were compared in terms of 1) Magnitude of mis-registration, 2) Volume measurement of PET image and 3) Accuracy of maximum standardized uptake value (SUVmax and SUVmean) in the gated and ungated image sets. Statistical analysis was performed with a two-tailed, pair t-test. Ethical approvals were obtained from ethics committees of the Hong Kong Polytechnic University and Hong Kong Baptist Hospital.

Results and discussion: The study population consisted of 16 patients (9 males, 7 females; average age of 65) with a total number of 89 lesions. The quality of gated PET images were better than that of the ungated PET images. An average of 21.48% ($p<0.001$) reduction of the tumour volume measurement was also observed. The SUVmax and SUVmean of gated PET images improved by 19.81% ($p<0.001$) & 25.53% ($p<0.001$) compared to ungated PET images, respectively.

Conclusion: 4D FDG-PET/CT scan for liver malignancies in routine PET/CT examination is feasible. 4D PET/CT scan for liver malignancies can improve the quality of PET image by improving the SUV accuracy of the lesions and reducing image blurring. The improved accuracy

in identification of liver tumour with 4D-PET has led to its increased utilization in ITV and PTV delineation for liver radiotherapy planning and treatment.

PP-40
Reduction of γ-Ray Attenuation with a New Rigid Couch in SPECT

Yasunori Nakamura [1 2], Hajime Monzen [1], Mikoto Tamura [1], Takeshi Nii [2], Masayoshi Mizuta [2].
1. Department of Medical Physics, Graduate School of Medical Sciences, Kindai University, 377-2 Ohno-higashi, Osaka-Sayama, Osaka 589-8511, Japan
2. Department of Radiological Technology, University Hospital, Kyoto Prefectural University of Medicine, Kawaramachi-Hirokoji, Kamigyo-ku, Kyoto 602-8566, Japan

Introduction: Single photon emission computed tomography (SPECT) of myocardial perfusion imaging (MPI) is commonly used for the diagnosis of cardiac diseases. When SPECT imaging is performed with supine position, ^{99m}Tc uptake in the inferior posterior wall myocardial is low due to couch attenuation. The purpose of this study was to prevent the decrease of the counts of γ-rays by using a new low-attenuation rigid couch (HM-couch) for accurate SPECT examination.

Material and Methods: HM-couch (thickness of 3.0 cm) is constructed from polycarbonate foam sandwiched between two thin layers of glass fiber. A cylindrical phantom with diameter of 20.0 cm injected with 4 MBq (30 kBq/ml) of ^{99m}Tc was set on HM-couch or Carbon-couch, and the counts of the γ-rays were obtained by 360° and 180° acquisitions using myocardial protocol. Twelve circle regions of interest (ROIs) with diameter of 3.0 cm were set up in a clockwise direction with 30° increments (e.g., ROI6 was six o'clock direction) on the acquired transverse image of cylindrical phantom, and the average counts within each ROI were measured.

Results and Discussion: The minimum counts by 360º acquisition were 3730.7±63.3 at ROI6 and 3498.4±49.2 cps at ROI6 for HM-couch and Carbon-couch, respectively, which were 6.87% and 10.3% lower than the respective maximum counts. In 180º acquisition, the minimum counts were 3561.4±22.3 at ROI7 and 3416.6±53.5 cps at ROI6 for HM-couch and Carbon-couch, respectively, which were 11.4% and 12.8% lower than the maximum counts. The counts through HM-couch were 3-4% higher than those through the Carbon-couch in both 360º and 180º acquisitions significantly ($p < 0.05$).

Conclusion: HM-couch could prevent the decrease of ^{99m}Tc uptake in the inferior posterior wall myocardial compared with the conventional Carbon-couch. It enables to perform the more exact SPECT of MPI examination.

PP-41
Study on the evaluation method of ^{125}I source strength inserted in a sterilized cartridge

Shinji Kawamura[1], Masaki Katayama[2], Sunao Ookura[3], Natsuki Sakamoto[1]
1. Division of Radiol ogical Sciences, Graduate School of Health Sciences, Teikyo University
6-22, Misaki cyo, Oomuta, Fukuoka Pref., Japan
2. Department of Radiological Technology, Faculty of Fukuoka Medical Technology,
Teikyo University, 6-22, Misaki cyo, Oomuta, Fukuoka Pre f., Japan
3. Radiation Oncology Center, Kurume University Hospital 67, Asahimachi, Kurume, Fukuoka Pref., Japan

Background and Introduction: For 125 I brachytherapy source strength measurements, the AAPM recommends that at least 10% of the sources (ideally all) be measured by the medical facility However, since 125 I sources are delivered in sterilized cartridges, there are few facilities that perform source strength measurements. Therefore, we investigated a method to check the source strength of the cartridges.

Methods and materials: We used cartridges containing 5 and 15 Thera Strand-SL sources (Theragenics-Corporation). A pinhole collimator was used to capture the cartridge image. An Imaging Plate was used as the detector. The imaging time of the cartridge was set to 20 minutes. We analysed the images using Image J and MatLab. Since the pinhole images required positional pixel value correction, we u sed Monte Carlo simulation for pixel value correction.

Result s and discussion: The pixel values were corrected for positional characteristics using a quadratic function. The source strength was converted from the position corrected pixel values. The conversion factor was 0.0148 (MBq / gray value). The radioactivity of the sources measured in the single seed assay described in the product certification was 12.8 ± 0.26 MBq. The radioactivity calculated by us using the conversion factor was 12.84 ± 0.514 MBq. The standard deviation of the source strength calculated from the images was larger than that of the single seed assay.

Conclusions: We have developed an imaging method to evaluate the source strength for each cartridge, which makes it possible to estimate and evaluate the source strength for each cartridge.

PAPER INDEX

PAPER INDEX

Plenary Sessions

Invited Papers

Mini symposium Papers

Oral Papers

OP-30	Automated approach for estimation of the normal or abnormal stages of the kidney using an artificial neural network for the prediction model of the Glomerular Filtration Rate	Alamgir Hossain (BD)	127
OP-31	Radiomic prediction of distant metastasis after dynamic tumor tracking stereotactic body radiation therapy for non-small cell lung cancer: a multi-institutional analysis	Takanori Adachi (Japan)	128
OP-32	The effects of automatic segmentations on preoperative lymph node status prediction models with ultrasound radiomics for patients with early-stage cervical cancer	Juebin Jin (China)	129
OP-33	Lesion Image Synthesis Using AI-Based Sketch-to-Image Translation: A Preliminary Study on Lung Cancer CT Images	Ryo Toda (Japan)	120
OP-34	Deep Learning-Based Auto-Segmentation Of Breast Cancer: A Systematic Review Of Multi-Modality Imaging Methods	Yazid, F. N. A (Malaysia)	130
OP-35	Preliminary study on virtual cleansing by Cycle GAN in CT colonography	Isobe Yoshitaka (Japan)	131
OP-36	Influence of Post-synthesis and Post-irradiation Times on Dosimetric Properties of a VIPET-type Gel Dosimeter	Mosleh-Shirazi MA (Iran)	131
OP-37	Isodose-Shaped Scintillation Detectors for Measurement of Small Field Output Factors	Chung Hyun-Tai (Korea)	132
OP-38	Effect of Gamma Radiation-Induced Crosslinking on Long-Term Dose Response of Novel Graphene Oxide Dosimeter Using Raman Spectroscopy	Shahryar Malekie (Iran)	133
OP-39	Comparison of the different dosimetric indices for volumetric arc modulated treatment planning using two different treatment planning systems: A Feasibility study for Total Body Irradiation	Sharma Reena (IN)	133
OP-40	Dosimetric Properties of Graphene Oxide Nano-Powder After Electron Irradiation in the Range of Radiation Processing Doses (20-200 kGy)	Shahryar Malekie (Iran)	134
OP-41	The Safe Sticker: Verification Of Solar Disinfection Of Water By Solar Ultraviolet (UV) Radiation	Butson Martin Jonathan (AU)	135
OP-42	An Automated Classification Scheme of Cytological Images Using Attention-based Deep Multiple Instance Learning	Teramoto Atsushi (JP)	136
OP-43	A Study on EEG Signal Classification using Deep Learning Method	Mohammad Haekal (Indonesia)	136
OP-44	Skin Disease Detection Module through Image Processing	Sk. Saima (BD)	137
OP-45	Studies on the Propagation of Elastic Waves In Bovine Compact Bones As A Function Of Temperature	Syed Mohammed Shoaib (India)	138
OP-46	Design and Construction of a Portable ECG Machine Operated by Mobile Application for Patients	Alamgir Hossain (BD)	138
OP-47	Short-term pain management of severe osteoarthritis patient for the hip or knee joint using low-dose radiotherapy: a literature review	Ropak Roy (BD)	139
OP-48	Robust Planning Evaluation of Stereotactic Body Radiation Therapy on Hepatocellular Carcinoma	Akbar Azzi (Indonesia)	140
OP-49	Comparison of Progressive Resolution Optimizer (PRO) and Photon Optimizer (PO) Algorithms in Rapid Arc (VMAT) Delivery for Head and Neck Sib Treatments	Sundaram Venugopal (India)	140
OP-50	Evaluation of Intrafractional Prostate Displacement during Prostate Radiotherapy using Clarity Ultrasound System	MZ Nur Syazana (Malaysia)	141

Poster Presentation

Executive Committee Members of AFOMP

President
Prof. Dr. Arun Chougule

DRP, Ph.D., FUICC, FICTP, FACSU, MSRP, FCMPI, FTWAS
Senior Professor & Head, Department of Radiological Physics
SMS Medical College & Hospital, Jaipur 302004, INDIA
Dean Student Welfare [DSW] RUHS

Vice President
Prof. Dr. Eva Bezak

Prof. Eva Bezak, PhD, FACPSEM
Professor in Medical Radiation,
University of South Australia

Past President
Prof. Dr. Tae-Suk Suh

Dept. of Biomedical Eng.,
College of Medicine,
The Catholic University of Korea,
505 Banpo-dong, Seocho-gu,
Seoul, 137040, Korea

Secretary General
Prof. Dr. Hasin Anupama Azhari

Director, Centre for Biomedical Science and Engineering
United International University (UIU)

Treasurer
Prof. Dr. Kwan-Hoon Ng

PhD, MIPEM, DABMP
Department of Biomedical Imaging
University of Malaya
Kuala Lumpur,Malaysia

Education And Training Committee

Dr. Jin Xiance

Chairman of Education, and Training Committee of AFOMP
Chief medical physicist and Vice director
Radiation and Medical Oncology Department
The First Affiliated Hospital of Wenzhou Medical University, China

Professional Relations Committee

Dr. Chai Hong Yeong

Ph.D, MIPM Associate Professor
School of Medicine, Faculty of Health and Medical Sciences
Taylor's University Lakeside Campus
Subang Jaya, Malaysia.

Science Committee

Prof. Dr. Tomas Kron

Committee Chair
Director of Physical Sciences
Peter MacCallum Cancer Centre, Melbourne, Australia

Funding Committee

Prof Hajime Monzen

Committee Chairman
Graduate School of Medical Sciences
Kindai University
Japan

Awards and Honors Committee

Prof. Dr. Eva Bezak

Committee Chairman
PhD, FACPSEM
Professor in Medical Radiation,
University of South Australia

RapidPlan & MCO

Machine Learning
Human Intelligence

***Machine Intelligence: When machine learning, human intelligence and patient data unite to build optimal treatment plans.**

We're helping you take machine learning to a whole new intelligence level with RapidPlan™ knowledge-based planning and multi-criteria optimization (MCO). By integrating machine smarts, your expertise, and the data of your cancer patients, we're advancing treatment planning with what we call machine intelligence—a consistent, data-driven, easy-to-implement way to create optimal treatment plans.

See how machine intelligence can help advance your treatment planning at varian.com/rapidplanmco

Safety information: Radiation may cause side effects and may not be appropriate for all cancers.

RapidPlan knowledge-based planning and its models are not intended to replace clinical decisions, provide medical advice or endorse any particular radiation plan or treatment procedure. The patient's medical professionals are solely responsible for and must rely on their professional clinical judgment when deciding how to plan and provide radiation therapy.

varian
A Siemens Healthineers Company

INDEPENDENT X-RAY QUALITY ASSURANCE

40 years of X-ray safety & quality

X-ray Quality Assurance Test Solutions for Multimodalities

RTI offers complete quality assurance solutions for different medical X-ray modalities.

Contact us to learn more about our Ocean Next™ software and wireless Piranha and Cobia meters - Bluetooth connection up to 100 m.

Fast, easy checks and unrivaled control!

www.rtigroup.com

RTI Group APAC
3791 Jalan Bukit Merah
#08-10 E-Centre @ Redhill
Singapore 159471

sales@rtigroup.com

Gentle and precise – targeted effectiveness for breast cancer treatments

ZEISS

Seeing beyond

Local precision during tumor bed sterilization

Directly combining surgery and irradiation into one step

Proven performance with a strong evidence base in radiotherapy

Truly personalized treatments

www.zeiss.com

Find out more about ZEISS INTRABEAM 600

PICO™

First & Only Accredited
Biomedical Calibration Facility
in Bangladesh

UKAS QUALITY MANAGEMENT

ISO 9001 BUREAU VERITAS Certification

SCOPES OF DEVICE UNDER TEST (DUT)

ICU Equipment
- Defibrillator
- Bi-PAP
- Infusion Pump
- Vital Signs/Patient Monitor
- Syringe Pump
- Ventilator

Radiology & Imaging
- CT
- Fluoroscopy
- Mammography
- Radiotherapy
- X-ray

OT Equipment
- Anesthesia machine
- Autoclave
- Electrosurgery Unit
- Endoscopic Insufflator
- Flow Meter
- OT Lamp
- Oxygen Regulator
- Pacemaker
- Pressure Gauge
- Suction Device

Safety
- Electrical Safety
- Medical Gas Leak Detection

OPD
- Sphygmomanometer
- ECG Machine
- Pulse Oximeter
- Weight Scale

Laboratory
- Centrifuge
- Balance
- Pipette

NICU
- Incubator
- Phototherapy Machine
- Radiant Warmer

As per the WHO's Medical equipment maintenance programme overview,

we have the complete solution, including testing devices and calibration service to evaluate the performance and safety of the medical devices.

PICO LABS LIMITED

Islam Plaza (6th Floor), Plot-7, Main Road-3, Section-7, Pallabi, Mirpur, Dhaka-1216, Bangladesh

+8801977426696 +8801977426642 info@pico.com.bd www.pico.com.bd

UNITED INTERNATIONAL UNIVERSITY

ACBSP GLOBAL BUSINESS ACCREDITATION
ACBSP ACCREDITED

IEB ACCREDITED

www.uiu.ac.bd

Admission Spring 2022

Apply Online admission.uiu.ac.bd

Programs

BBA || BBA in AIS || BS in Economics || BSc in CSE || BSc in EEE
BSc in Civil Engineering || BSS (Hons.) in Environment and Development Studies
MBA || EMBA || MSc in CSE || MS in Economics || MDS || MIHRM

- Transportation available from major locations of Dhaka city
- Hostel accommodation Available
- Credit Transfer & Exchange Program facility
- Strong faculty line up with 56 full time Ph.D. faculty members
- Result based 25% to 100% scholarship in every semester

For details of tuition waiver and scholarship policy please visit:
https://www.uiu.ac.bd/admission/tuition-fees-payment-policies/

TOP 500 QS WORLD UNIVERSITY RANKINGS
Ranked by QS Asia in 2019, 2020, 2021 and 2022

THE IMPACT RANKINGS SDG8 DECENT WORK AND ECONOMIC GROWTH 2021 TOP 40
Impact Ranked by Times Higher Education in 2020 and 2021

United City, Madani Avenue, Badda, Dhaka - 1212
01759039498, 01759039465, 01759039451, 01914001470

09604-848 848
(Ext-1301-4)

MADE TO PERFORM.

PTW THE DOSIMETRY COMPANY

BEAMSCAN™

Automated • Wireless • Fast

Perfect for Halcyon™ User

World's First & only RFA with Smartphone operations

SRS
SBRT
SGRT

RUBY One Phantom. All Tasks.

Elekta Unity
Varian Halcyon

- Comprehensive testing of the entire treatment Chain with one single phantom
- Complete end-to-end tests with one single insert
- Verification of CT/MRI image registration
- System alignment checks, including 6D couch QA
- Automated Winston Lutz testing with IsoCheckepid
- Patient plan verification, including non-coplanar treatments, with film and detector

● SYSTEM QA ● LINAC QA ● PATIENT QA

PTW DOSIMETRY INDIA PVT. LTD
ACE Towers, 2nd Floor, 73/75,
Dr. Radhakrishnan Road, Mylapore, Chennai - 600 004.
Ph: 044 - 4207 9999 Telefax: 044 - 4207 2299
Email: info@ptwdosimetry.com
Web: www.ptwdosimetry.com

Distributor:
TRADE HOUSE
House 60/1, Road 4A, Dhanmondi
Dhaka - 1209, Bangladesh
T: +88 02 9631713, +88 02 9666473
Email: info@tradehouse.com.bd
Web: www.tradehouse.com.bd