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Editorial

Medical Physicists and Standardisation Work of IEC and BIS

Medical physicists work with various radiation equipment, accessories and peripheral devices used for the diagnosis, treatment and management of various diseases including cancer and other ailments. The equipment must perform optimally so that the deliveries of the services are within the set of attributes or requirements. The performance of the equipment and procedures must ensure the safety of the patients, staff, and public as well. For this purpose, standards have been devised and conformance to such standards brings quality in the services. For this purpose, IEC (International Electrotechnical Commission) was founded in June 1906 (at London) which is the world's leading organization for the preparation and publication of international standards for all electrical, electronic and related technologies. It is a global, not-for-profit membership organization, whose work underpins quality infrastructure and international trade in electrical and electronic goods. IEC, whose headquarter is presently at Geneva, brings together more than 170 countries and provides a global, neutral and independent standardization platform to 20,000 experts globally. IEC standards cover technologies in multiple areas like power generation, home appliances, office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology, marine technology etc. These standards are also often adopted by countries to become national or regional standards. IEC Technical Committee TC 62 'Medical equipment, software, and systems' formulates standards in the field of electrical medical equipment, software and systems. It has four subcommittees (SC) which are SC 62A for common aspects of medical equipment, software, and systems, SC 62B for medical imaging equipment, software, and systems, SC 62C for equipment for radiotherapy, nuclear medicine and radiation dosimetry and SC 62D for particular medical equipment, software, and systems. These Subcommittees, through various Working Groups under them, have published more than 200 standards on medical electrical equipment including the widely accepted IEC 60601 series of technical standards for the safety and essential performance of medical electrical equipment. The IEC is composed of national standard bodies of various countries. Bureau of Indian Standards (BIS) is the national standards body of India under Deptt. of consumer affairs, Govt. of India. It represents India in the International Organization for Standardization (ISO) and the IEC. It plays a crucial role in ensuring the development of harmonious standards across various sectors within the country. The work of formulation of Indian Standards in the field of medical devices, hospital planning and related aspects is being dealt by its Medical Equipment and Hospital Planning Department (MHD). It does so through 20 Technical Committees, each focusing on a specific sector of medical devices and hospital planning. These committees feature a diverse composition, comprising representatives from relevant government departments, regulators, academia, research and development institutes, industry, consumer organizations, and testing laboratories. One of these technical committees, MHD-15 is the sectional committee for electromedical, diagnostic imaging and radiotherapy equipment. MHD-15 maintains a liaison with IEC TC 62 and its SCs. It has, so far, published 100 standards out of which 94 are harmonized with IEC and ISO standards. Medical Devices Rules 2017 mandates that the medical devices shall conform to the standards laid down by the BIS. IF no relevant Indian Standards are available, ISO or IEC standards or other pharmacopoeia standards or validated manufacturer's standards shall be followed. The National Medical Devices Policy 2023 recommends expanding the scope of standards for medical devices, covering processes, products, wireless technologies, and performance to enhance standardization levels, quality, and empower the indigenous industry to compete on a global scale. Medical Physicists may play an important role in this context as there are several CDSCO (Central Drug Standard Control Organisation) categories of medical devices (including radiation related) for which standards are not available. Also, there are old standards which are to be revised considering the latest changes in technology. Medical physicists may provide their invaluable inputs on the draft standards. There is also an opportunity to contribute to the international standardization activity by being nominated as experts on technical working groups of IEC and ISO Committees.

Pratik Kumar

[**Mr. Chandan Kumar**, Scientist-C (Deputy Director), MHD, BIS is acknowledged for his extensive input for this editorial.]

APPLICATION OF ARTIFICIAL INTELLIGENCE IN NUCLEAR MEDICINE-CHALLENGES AND OPPORTUNITIES

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Artificial intelligence (AI) has emerged as a transformative technology in various fields,including healthcare and imaging sciences. In nuclear medicine, AI holds immense potential to introduce analytical image interpretation and hence add newer dimensions to diagnostic and therapeutic approaches thus enabling more precise, personalized and evidence based patient care. This article presents an overview of the application of AI in nuclear medicine highlighting its contribution to imaging, precise dosimetry and treatment planning. As such AI-powered image analysis techniques have shown remarkable advancements in nuclear medicine imaging, enhancing the accuracy and efficiency of diagnostic inference. Machine learning algorithms applied to positron emission tomography (PET), single-photon emission computed tomography (SPECT) and hybrid imaging modalities have demonstrated the ability to improve lesion detection, classification, and quantification. AI algorithms also have the potentiality to enable precise attenuation correction without realtime low mA CT imaging by using already generated attenuation map for a large cohort of patients and using the data through machine/deep learning.Additionally, AI algorithms can also aid in the identification of biomarkers, facilitating early disease detection and prediction of treatment response. Dosimetry, an essential aspect of nuclear medicine, is another area benefiting from AI integration. AI algorithms can optimize patient-specific radiation dose calculations, considering individual anatomical variations, tumor characteristics, and radiopharmaceutical pharmacokinetics. By leveraging machine learning models, clinicians can determine optimal radionuclide doses, minimizing radiation exposure to healthy tissues while maximizing therapeutic efficacy. Moreover, AI techniques are revolutionizing treatment planning in nuclear medicine. Machine learning algorithms can assist in selecting the most appropriate radionuclide therapy for patients based on their individual profiles, optimizing treatment outcomes. AI-powered decision support systems can provide insights into the expected response to therapy, aiding in the prediction of treatment efficacy and potential adverse effects. Despite these promising advancements, challenges remain in the widespread implementation of AI in nuclear medicine. Data privacy, regulatory compliance, and integration with existing healthcare systems are critical considerations as well as challenges with opportunities. Furthermore the need for large and diverse datasets, alongside robust validation studies is paramount to ensure the reliability and generalizability of AI models. In conclusion, the application of AI in nuclear medicine holds significant potential to enhance patient care through improved imaging, dosimetry,attenuation correction and treatment planning. Continued research, development of newer models and collaboration/interaction between AI experts and nuclear medicine practitioners/experts including medical physicists and radiation safety experts/dosimetrists are essential to realize the full benefits of AI in this field ultimately leading to more precise diagnoses, optimized therapies and improved patient outcomes.

ADVANCING THERANOSTICS'S POTENTIAL FOR PRECISION MEDICINE

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Introduction

A fascinating area of molecular medicine is theranostics. The theranostic method employs specialized targeted drugs for both imaging and treatment of particular cancer and is made possible by molecular imaging techniques like positron emission tomography (PET) and single photon emission tomography (SPECT). Patients with cancer may benefit greatly from its capacity to pinpoint disease subtypes that are more likely to respond to targeted therapy. And physicians are applauding its accomplishments and promise to assist them in managing diseases more effectively by matching patients with the therapies that will have the greatest impact on them. Industry leaders are strengthening the whole molecular imaging pipeline with the development of improved imaging technologies and the ongoing quest for novel tracers for targeted therapeutics. They start by giving access to developing compounds and then keep pushing the boundaries of molecular imaging with technologies like PET/computed tomography (CT) and SPECT/CT. New developments in molecular imaging technology provide substantially more imaging data for processing, as well as very sophisticated automated tools and reconstruction algorithms powered by artificial intelligence (AI) to support doctors in making challenging diagnoses. Theranostics requires molecular imaging because it enables non-invasive, repeated evaluation of the chemical uptake and characterization of the tumor tissue as well as the evolution of therapeutic response. Theranostic target pairings have been created, verified, and effectively employed to treat neuroendocrine tumors, lymphomas, neuroblastomas, and, more recently, several types of prostate cancer in this setting of abundant data. The demand for more diagnostic and treatment combinations to enhance cancer patients' quality of life and results remains high in areas like prostate and other malignancies.

Prostate cancer outcomes with theranostics

Clinically significant prostate cancer frequently has a better prognosis when it is discovered and treated early, before metastasis has taken place, using therapies including radiation and prostate cancer surgery. [2] Prostate cancer, on the other hand, is the fourth-leading cause of cancer mortality in males worldwide and the most often diagnosed male malignancy. [3] Radiation therapy and radical prostatectomy are now the most frequent treatments for prostate cancer, although these options are not always available because of the difficult procedure needed to find tumors. Current prostate cancer screening techniques include blood tests to measure prostate-specific antigen (PSA) or hormone levels.[1] Despite advancements in prostate cancer treatment, certain prostate cancer subtypes, known as castrate- or hormone-resistant, continue to spread even after the patients' hormone levels rise over the predetermined low threshold. [4] Theranostics activities are focused on treating these castrate-resistant, more deadly prostate tumors. The procedure combines a radioactive particle that is injected into the patient with a targeting substance, also known as a ligand, to specifically target the cancer cells. Prostate-specific membrane antigen (PSMA), which is strongly expressed in more than 95% of prostate malignancies, is one of the new diagnostic and theranostic biomarkers for prostate cancer detection as well as targeted therapies[5] and is a predictive biomarker for prostate cancer. [6] Clinicians keep an eye on the metabolic changes that the tumor experiences as a result of the therapy; these changes serve as a predictor of the chance that the treatment will be effective. Targeting PSMA in theranostics may have an influence on clinical treatment choices and assist identify individuals who would benefit most from targeted therapy. Based on the findings of the Phase III VISION clinical study, the FDA has authorized a novel lutetium-based treatment known as ^{177}Lu-PSMA-617. [7] Adult patients who have had androgen receptor (AR) pathway inhibition and taxane-based chemotherapy for metastatic castration-resistant prostate cancer (mCRPC) and PSMA positivity are eligible for the treatment. Numerous additional small compounds and antibodies that target PSMA have been created and tagged, including ^{177}Lu, ^{161}Tb, ^{131}I, ^{90}Y, ^{67}Cu, and ^{47}Sc, and are now being investigated in preclinical and clinical trials. [8]

Molecular imaging and radiopharmaceuticals

With the long-term success of PET imaging biomarker ^{18}F-FDG (FDG) in cancer and recently licensed medicines like ^{177}Lu-PSMA-617, many more diagnostic and theranostic biomarker discoveries are anticipated to acquire clinical approval to promote customized treatments and better outcomes. Clinical interest in novel radiopharmaceuticals grows as molecular imaging technology advances. [9] Producing and distributing these novel tracers to doctors is critical. Cyclotrons, PET radiochemistry systems, and tracer manufacturing facilities are needed to distribute FDG to many customers or supply a research program with many tracers. Having this assistance helps with clinical scheduling, research methods, and distribution needs.

Theranostics will become standard of care when molecular imaging tools such as PET/CT and SPECT/CT are paired with competent doctors to obtain, interpret, and evaluate therapy efficacy. PET imaging may scan the body for therapeutic target expression. [10] Target expression affects therapeutic response. PET imaging probes are predictive biomarkers. [11] Advances in molecular imaging devices and software enhance productivity, test length, and study interpretation. AI and deep learning help classify images. Experts feel that owing to the complexity of molecular medicine, additional training is required to incorporate these techniques into patient care and retain a positive perspective for the future of the specialty and potential in molecular diagnosis and therapy. [12]

Theranostics and precision medicine's bright future

Theranostics is an attractive and quickly developing therapy option for a variety of cancers, such as lymphoma, melanoma, neuroendocrine tumor, and prostate cancer. Nuclear Medicine equipment such as PET/CT and SPECT/CT continue to support clinicians' search for new biomarkers and therapies with data-rich, high-quality diagnostic imaging and image processing tools for tumor characterization and evaluating therapy response. Theranostics approaches, as they are transitioned to the standard of care and more widely accessible, have the potential to successfully improve the management and outcomes of patients affected by many cancers, as well as future possible applications in other clinical areas.

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Medical Physics Photo Contest

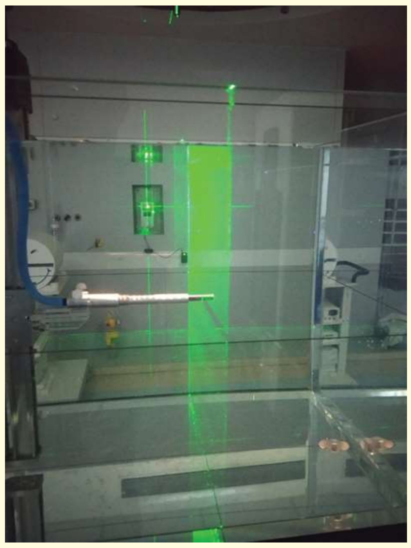
Medical Physics Gazette announced a Medical Physics Photo Contest in the beginning of the year in which AMPI members were invited to send camera-clicked photo related with the situation, concept, experiment, procedure and life related with medical physics and medical physicist. It was mandatory to send a title for the photo but optional for the brief description about the entry. The contest was free and the AMPI members were allowed to collaborate with others including non-member (of AMPI) provided the first contestant is AMPI member. This was one of its kind of contest for medical physicists and we received 19 entries altogether. The entries were coded (anonymized) and sent to 6 judges who all were oblivious to the identity of the contestants as well as other judges. Judges rated the entries the photo and the title quantitatively. Judges pointed out that five entries were not camera-clicked and rather were screen-shot (from computer) and hence were not included in the contest. I quote a judge who wrote **"**A screenshot does not qualify as a "photograph". A screenshot is an image but it is not a photograph. This is a "Photo Contest" not and an "Image Contest". To qualify as "photo" it needs to be captured with a camera.**"** The judges were **Dr Biplab Sarkar, Kolkata; Ms. Amanjot Kaur, Navi Mumbai; Dr Aruna Kaushik, New Delhi; Dr Manoj Semwal, New Delhi; Mr. Deepak Arora, New Delhi and Dr R.K. Bisht, New Delhi.** The contest revealed the innate intelligence of medical physicists related with keen perception, artistic vision, humane sensitivity and soft skill. **The first prize of Rs. 3000/-, the second prize of Rs. 2000/- and the third prize of Rs. 1000/- have been sponsored by M/S MEX India.** Following are the top ten contestants with average percentile score.

1. Dr. Ashok Kumar Arya & Dr Anuj Kumar, Agra (83.4)
2. Mr. Gourav Kumar Jain, Jaipur (80.4)
3. Mr. Midhunkumar K M, Vadodara (76.3)
4. Mr. Saju Bhasi, Trivendrum (72.8)
5. Mr. Mohamed Ashraf T, Kota (72)
6. Ms. Jeevanshu Jain, Navi Mumbai (70.1)
   Co-authors: Kunal Prajapati, Divya Patil
7. Mr. Arvind Kumar, Rishikesh (69.27)
   Amit Sharma, Abhishek Garg, Mhd. Azhar, Vijay Gautam, Salma, Merin, Swati
8. Mr. Thirumal M, Ghaziabad, U.P. (69.24)
9. Dr Rajesh A Kinnikar, Mumbai (67.4)
10. Ms. Anam Ansari, Navi Mumbai (65.4)

First Prize winner:
Dr. Ashok Kumar Arya & Dr Anuj Kumar, Agra
Pin and Arc setup for carcinoma oesophagus, posterior oblique field

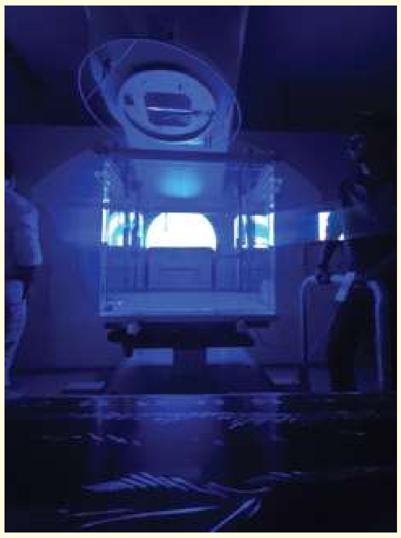
This image shows pin and arc setup for treating carcinoma oesophagus by posterior oblique field. With the help of orthogonal film and plaster of Paris bandage patient contour has been drawn. Spinal cord, vertebra and tumour have been drawn. And according to parameter obtained by contoured image, pin and arc has been set up with patient and treated.

Second Prize winner: Mr. Gourav Kumar Jain, Jaipur
The IAEA TRS-398



Experimental set up for determination of the absorbed dose to water in a high energy photon beam using 0.6 cc ionization chamber and water phantom.

Third prize winner: Midhunkumar K M, Vadodara
Blue rays of hope



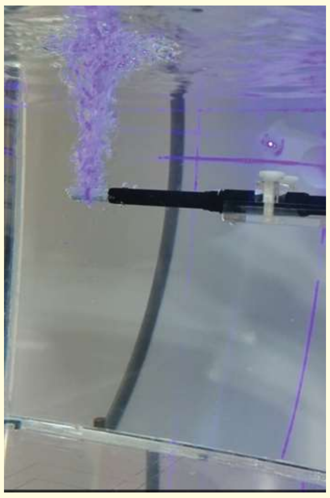
The first dosimetry measurements for a LINAC is being started at a hospital in Amritsar, Punjab. Significance of colour blue relates to Cherenkov radiation that represents nuclear power.

Editor's Pick: Saju Bhasi, Trivendrum
Meditating on a medical LINAC

In the middle of chaos, he is meditating on a medical LINAC. A scene from decommissioning of LINAC.

Editor's Pick: **Thirumal M, Ghaziabad**

The Magical Physics



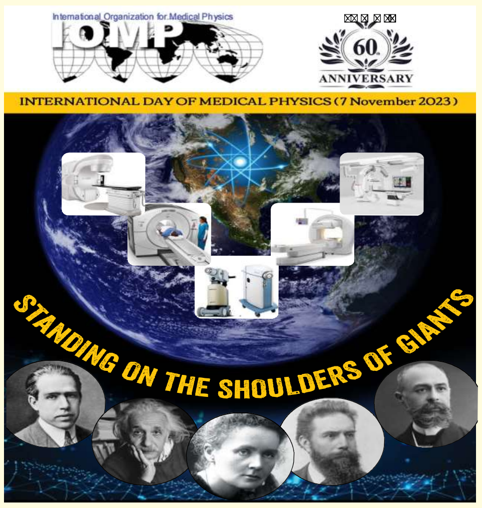
Editor's Pick: **Mohamed Ashraf T, Kota**

Ending of an era

Source drawers of decommissioned Telecobalt Machines stored for disposal at Cobalt-60 Teletherapy Sources (CTS) fabrication facility. The old work horse of the Radiotherapy department now phased out as the advanced technology prevails. Most of the senior Medical Physicist started their career with telecobalt machine and now many of the new generation Medical Physicist not even seen this machine in their career.

Who's Where

Ms. Anam Ansari has joined Cyclotron Facility, Shreeji Imaging and Diagnostic Centre, Navi Mumbai as RSO in Sept 2022.



International Organisation of Medical Physics (IOMP) organised a poster competition with the theme "Standing on the shoulders of Giants" which is the theme for International Day of Medical Physics.(IDMP) as well. The poster competition marks the 60th Anniversary of IOMP. IOMP received about 30 posters. This poster was sent by **Dr (Mrs) Kirti Tyagi, Medical Physicist, Radiation Oncology Centre & Nuclear Medicine Department, INHS Asvini, Colaba, Mumbai** as an entry.

THREE CHEERS

Dr. K. Krishna Murthy, Chief Medical Physicist, Krishna Institute of Medical Sciences, Secunderabad, Telangana has been recognised as a research guide for medical physics / physics of Osmania University, Hyderabad. He has been allotted three medical physicist for their PhD work. Congratulatons!

Prof. (Dr.) Pradeep Kumar Hota, Acharya Harihar PG Institute of Cancer, Cuttack has been appointed as a member of the Interim Commission for Allied Healthcare Professionals (ICAHP) as per the NCAHP act passed in the Parliament in 2021. He has also been appointed as the Chairperson of the Odisha State Allied Healthcare Council (OSAHC). Congratulations!

Dr Arvind Shukla has been promoted as Professor, Radiological Physics, RNT Medical College, Udaipur in April, 2023. Congratulations!

Dr Atul Mishra was awarded PhD degree in April 2023 by VBS Purvanchal University, Jaunpur for the thesis entitled **"Dosimetric evaluation of influence of heterogeneity and efficacy of various plan algorithms in IMRT and VMAT radiotherapy plans in tumors of thorax"**. He was also promoted to Assistant Professor (Medical Physics), Deptt. of Radiation Oncology, U.P. Univ. of Medical Sciences, Saifai, Etawah, Uttar Pradesh in August 2023. He was awarded AROI Medical Physics Fellowship as well as Gold Medal Medical Physics among best paper awardees during 3rd Indian Cancer Congress, Nov. 2023, Mumbai. Congratulations!

THREE CHEERS

Dr. G. Sahani, Head, Medical Applications Section (MAS), Radiological Safety Division (RSD), Atomic Energy Regulatory Board, Mumbai has been conferred Prof. A. Cyril Jayachandran Oration on "Challenges in regulation of new technology and development of regulatory requirement" in December 2022 during 26th annual conference of Tamil Nadu and Puducherry chapter of AMPI. Congratulations!