MEDICAL PHYSICS GAZETTE

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Editorial

Medical Physics and Covid-19: A tale of two years

Covid–19 pandemic which was declared so by WHO on 11th March 2020 came a bit late in India in around March 2020 and has virtually affected everybody in the world within last two years as this was first reported in Wuhan city, China in early December 2019.

Its various mutations have caused severe distress among the population and still have potential to cause the wave of havoc. Though we have learnt to live with it or still learning, it is clear that getting to the normal pre-pandemic situation may be still away as various parts of India as well as the world report sporadic surges spaced in time and geography due to unpredictable mutations. Medical Physics education and services all over the world were tweaked and re-moulded to take the challenges of Covid-19. Majority of these were shifted to online mode and with limited staff wherever it was possible. Remote monitoring, singular handling and online interaction become the norm. It seems that it is the time to take stock of the situation as we are about to complete two years of the outbreak. Many of us have developed the infrastructure and penchant for remote planning and its verification, online transfer of QA data, online discussion and meeting and remote help from the experts for smaller machine repair and management. A few hospitals have reported incidental findings of Covid-19 in CT or CBCT images of planning. Deep learning and AI based automatic detection have been reported to differentiate between Covid-19 induced infection and the community acquired pneumonia. Probably these must be consolidated further and such expertise may be augmented as the enhancement of the skill. Some of the positive byproducts (like better work-life balance due to saving on time on commutation, lower cost to employer due to work from home etc.) may have to be set off against negatives like lack of in-person interaction, diminishing trust and respect among colleague due to less interaction and probable compromise in quality of care. Pandemic affected the training and education badly and few were happy with the quality of the online examinations. However, some of us resorted to the small group discussions in place of hands-on experience to salvage the situation while others developed the software to monitor the eye-movement of the online examinees to ameliorate the scenario.

Medical Physics Gazette also fell behind in its publication in this turmoil and we are publishing the three combined issues for July 2020, January 2021 and July 2021 rolled into this one issue to catch-up with the lost time. This issue is dedicated to the indomitable spirit of medical physicists who managed to not only providing the services to the patients but helped in carrying out the researches keeping the exigencies at hand in mind. These range from the debatable low dose single fraction radiotherapy of lung to contain Covide-19 induced pneumonia, UV sterilization technique for erstwhile limited mask, PPE etc. to the application of artificial intelligence in the imaging to diagnose Covid-19 infection. Many associations and departments (like AAPM, EFOMP etc.) came up with the appropriate guidelines and launched online sites for related interactions among the medical physicists. We feel that this is the time to review the situation and be ready for the future.

Pratik Kumar

FROM THE DESK OF THE PRESIDENT, AMPI

Respected colleagues and fellows of AMPI,

Namaskar! The Association of Medical Physicists of India (AMPI) conducted its another successful election in 2020 for electing members of the Executive Committee, Board of Trustee and Board of CMPI for the three years term April 2021 to March 2024. My sincere thanks to the election officer (Dr. Nirmal Painully) as well as the members of the association for peaceful and successful conduct of the election even though we all were passing through a painful time of our life due to CoVID-19 pandemic. In addition, I would like to express my personal gratefulness to all of you for electing me as Executive Committee Member fifth time with popular and record votes. This has given me additional strength to contribute for the profession as well as for the society. I am also thankful to my executive committee members for bestowing their trust in me and electing me as President of the Association for the second time. In the recent past we have noted a number of challenging developments mainly related to professional issues. The parliament has passed the Bill for constituting the National Commission on Allied and Healthcare Profession which will look into the various aspects of professional aspects and developments. In deed we were sceptic on introduction of this Bill but felt later that we have to represent our case and make the things happen for us. The executive committee deliberated the content of the Bill and come to a conclusion for making a representation. Opinions of members of the associations were also invited and ultimately a representation was made to the concerned authority. In addition, we have noted anomalous quoting of the qualifications of medical physicists by different governmental institutions/agencies and prompt corrective actions were initiated to erase all such anomalies. I would like to assure you that the association will be taking up all such issues promptly which is generic in nature. However, individual specific matters should be dealt with by the individual with the required support of the association. For dealing with all such cases, a constant support of all the members are required. The association, in collaboration with Karnataka Chapter and HCG Hospitals, is organizing its 42^{nd} Annual Conference (AMPICON 2021) in Bangalore during 7 to 9 January 2022. The theme of the conference is very important "Artificial Intelligence - An Emerging Trend in Medical Physics" and it is expected that it will generate a lot of excitement in the scientific community. In addition, we are also organizing ESTRO-AMPI workshop on Advance Medical Dosimetry. A number of experts from India and abroad are expected to share their knowledge and experience during the conference and the workshop. All of you are requested to participate in large numbers to make AMPICON-2021 a grand success both scientifically and socially. Indeed it is the opportunity after a gap of two years to meet and greet each other and take home something which is beneficial for the institution and the society. Looking forward to meet you all in Bangalore during AMPICON-2021.

Sunil Dutt Sharma
President, AMPI

WHO'S WHERE

Dr Kuldeep Singh Jheeta joined the Department of Radiological Physics, SMS Medical College and Hospitals Jaipur as Associate Professor and Head.

Mr Pawan Kumar Jangid joined the Department of Radiological Physics, SMS Medical College and Hospitals Jaipur as Assistant Professor.

Dr Mary Joan joined the Department of Radiation Oncology Physics, Christian Medical College and Hospital Ludhiana as Associate Professor.

FROM THE DESK OF THE SECRETARY, AMPI

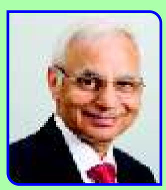
Dear Members of AMPI,

Warm Greetings! At the very outset, I am so thankful to the general members and executive committee members of AMPI for having faith in me and elected for the second term as Secretary of AMPI for the year 2021-2024. It is my great pleasure and honour to work as Secretary of AMPI. Indeed, it is the responsibility and commitment towards the professional development of Medical Physics in India. With all your support and co-operations, I assure that I try my level best to deliver the results on professional activities and matters upto your satisfaction. From the beginning of the year 2020, the COVID-19 virus has had an unparalleled global pandemic situation on all aspects of our lives. The COVID-19 pandemic has also made significant challenges on medical physics clinical practice, education, training, and research in the recent past and now we are slowly in the path of normalcy. AMPI, as a professional body, has also adapted to the situation of the day and continuing our focus and energy on the agendas of AMPI towards the professional development. The executive committee of AMPI is actively working in deliberating and taking decision on various aspects of the professional developmental matters pertaining to Medical Physicists such as National Medical Commission (NMC) and National Commission for Allied Health Professions (NCAHP), University Grant Commission (UGC) issues to name a few.

It is also to share that due to COVID-19 pandemic, the annual conference of AMPI has been postponed to 7-9^{th} January, 2022 and the AMPI organizers are taking their full efforts to make the AMPICON2021 conference successful. On behalf of AMPI, I would like to extend our warm welcome all to AMPICON2021 and invite to witness the rich scientific and social programs in AMPICON2021at Bangalore. Thanks again.

Dr. V. Subramani
Secretary, AMPI

THREE CHEERS



Dr. Madan M. Rehani, life Member of AMPI, has been appointed Emeritus Member of ICRP Committee 3 for life. This is a coveted recognition as ICRP has awarded emeritus membership to only 23 persons during the past 65 years and only 7 in medical radiation protection and Dr. Rehani is the 8^{th} person. His contribution to ICRP Committee 3 is immense as he chaired 4 task groups that produced Annals of ICRP number 87, 102, 117 and 129. In addition, he was member of 5 other task groups which produced publication 85, 113, 120, 121 and 135. Earlier he worked for 11 years at IAEA and was credited with improving radiation protection of patients and staff in over 70 countries. He established the IAEA website on radiation protection of patients and conducted wide survey of eye lens dose to the interventionalists. His other notable contributions are the development of a new concept of Acceptable Quality Dose, tracking of the patient dose, optimized imaging in children and women etc. Currently he is the Senior Editor of Br. J. Radiology and Assoc Editor of Eur J Medical Physics. He is the recipient of at least dozen awards from various national and international bodies and has published about 200 papers in reputed Journals. His Google Scholar h-index is 42 and i10-index of 120. At present, Prof. M. M. Rehani is the Director of Global Outreach for Radiation Protection at Massachusetts General Hospital, Boston, USA. Congratulations !!

IMPORTANCE AND IMPLEMENTATION OF QUALITY ASSURANCE FOR DOSIMETRY EQUIPMENT

Ms. Amanjot Kaur, Sr. Medical Physicist and RSO, Mahatma Phule Charitable Trust Hospital, Navi Mumbai

The goal of radiotherapy is patient dose delivery within ±5% accuracy, as per International Commission of Radiation Units (ICRU). Medical Physicists ensure this accuracy by carrying out necessary absolute, relative dosimetry and patient plan Quality Assurance (QA). The dosimetry instruments used in radiotherapy are Farmer 0.6 cc ionization chamber, 0.125 cc ionization chamber, electrometers, coaxial cable, diode, well type ionization chamber and many more. The performance parameters of these dosimetry instruments need to be complaint with certain tolerance limits as specified by International Electrotechnical Commission (IEC) 60731.

Manufacturer of dosimetry equipment ensure that their products are IEC complaint and provide technical specifications of these equipment in user operating manual. With technological advancement, new dosimetry manufacturers are emerging in market that brings challenge for users to check if these new instruments comply with the need of radiotherapy or not. Instead of starting using dosimetry instruments directly for measurements, these must be thoroughly checked for IEC compliance and set of tolerances provided by manufacturer and worldwide accepted reports and guides. As the measurements done by these equipment directly affect the patient treatment doses, therefore, these instruments should be periodically tested for all the performance parameters that are possible to be checked in our radiotherapy department. The baseline values for performance parameters such as stability, linearity, leakage and other parameters can be set while acceptance testing of these dosimetry instruments and must be documented so that response of detector can be checked and compared with respect to baseline values, if in case equipment gets malfunctioned, repaired or damaged in future. The instruments must be re-checked, when received back in department after repair or calibration or any other similar reason to ensure the chamber response has not been affected by the transportation.

Atomic Energy Regulatory Board (AERB), Mumbai (India) specifies in AERB Safety Code No. AERB/RF-MED/SC-1 Rev01 “Radiation Therapy sources, Equipment and Installations” that measuring equipment must be periodically checked that includes deviations from baseline values for linearity, venting, extra-cameral signal (stem effect) or stem leakage, chamber leakage, recombination, collecting potential, polarity effect, diodes for energy dependence and redundancy.

AAPM Task Report 40 report mentions the tolerances and tests that should be done for dosimeters before initial use and following malfunction and repairs. In situation of measurements not complying with IEC, manufacturer should be contacted back for necessary corrective action. Every year on periodic basis, these measurements need to be repeated and should be compared with the baseline values.

The acceptance testing & QA of radiation measuring instruments are briefly explained below:

a) Visual Check: The ionization chamber should appear same as shown in diagram provided in technical manual.

b) Repeatability: The relative standard deviation can be calculated from ten successive measurements in different intervals and the same should be less than tolerance 0.5%.

c) Linearity: For MU range low (>10MU) to high (~500MU), measure charge collected (nC) with dosimeter. The charge collected per MU vs. MU delivered is plotted, the variation for which should be less than ±0.5%

d) Extracameral Signal / Stem Effect: This can be calculated by difference in charge measured with ionization chamber in radiation field and charge measured with ionization chamber with its stem in radiation field. For example, open 5 cm × 30 cm field size. Place chamber along 5 cm for measurement with chamber and place chamber along 30 cm for measurement with chamber along with its stem.

e) Polarity Test: It is performed as described in TRS 398 by measuring charge with both +ve and –ve polarities of voltage bias.

f) Angular Dependence: For (1) Charge collected vs. gantry angle with chamber axis perpendicular to beam axis and (2) charge collected vs. gantry angle with chamber axis parallel to beam axis, charge collected vs. gantry angle is plotted. The variation should be within ±0.5%.

g) Ion Collection Efficiency: Ion collection efficiency is calculated for both –ve and +ve voltage polarities using two voltage method as provided in IAEA TRS report 398. It should be better than 99.5%

h) Pre-irradiation Leakage: Charge collected by dosimeter is measured without applying bias for 300 sec time and leakage current is calculated by dividing charge collected by time.

i) Post-irradiation Leakage: Deliver 200 MU and note the time ‘x’ sec. required to deliver 200 MU using stop watch. Start charge measurement for 200 MU and note the charge collected say ‘A’ on completion of delivery of 200 MU. Do not stop measurement and continue measuring for another ‘x’ sec. and note the charge collected say ‘B’.

   Post-irradiation Leakage (%) = [(A-B)/A) × 100]

   The tolerance is < 0.2%

j) Venting: This can be checked by measuring charge for different temperature and pressure and calculate the response variation. This will check if venting is working or not.

k) Stability Check: This is done by using a constant long half life check source such as Sr-90 or Co-60. The change in response will reveal any change in the chamber volume, break or crack in graphite cap, or malfunction in chamber or electrometer. A check source can show whether results in agreement with a baseline measurement within tolerance < 1%.

Detector checks are very important before starting relative beam profiles measurements and absolute measurements to ensure its precise response while measurement. This article is not giving detail on checks and QA to be done for each and every detector but emphasizes need to do acceptance testing of dosimetry equipment, setting up baselines and performing periodic QA. Our careful practice can ensure accuracy with which we are treating patients.

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RADIOBIOLOGICAL MODELS IN TREATMENT PLANNING

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The clinical outcome of radiotherapy treatment in terms of tumor control and normal tissue complications is always linked to some degree of uncertainty. This is partly because two different doses per fractionation of the same beam configuration are not the same since nature of dose deposited by radiation are stochastic at a microscopic level. Furthermore, patient to patient and cellular radio sensitivity variations are generally unknown. For these reasons, the expected outcome of a treatment is expressed in terms of probability of certain effect. Radiobiological treatment planning estimates these probabilities for target and organ at risk of a given clinical case based on dose distribution and available radiobiological data. Modern radiotherapy treatment techniques like intensity Modulated radiation therapy is capable of providing conform dose distribution to target and sparing on organ at risk as compared to conventional treatment planning also known as forward planning. However, a true optimization of radiation therapy requires use of true clinical treatment objectives that will provide a closer estimation of the desired treatment outcome. In radiotherapy the objective functions can be either physical meaning that the aim of optimization is to achieve desired dose distribution or biological where the desired dose distribution is determined by the dose response characteristics of tumor and normal tissues so that the quality of life of patient can be improved. Dose volume histogram (DVH) is a 2D presentation of 3D dose distribution and has certain limitations for defining clinical outcome.

Limitation of DVH based plan evaluation

The ultimate goal of radiotherapy treatment planning is to find a treatment that will yield a high tumor control probability (TCP) with an acceptable normal tissue complication probability (NTCP). Yet most treatment planning today is not based upon optimization of TCPs and NTCPs, but rather upon meeting physical dose and volume constraints defined by the planner. It has been suggested that treatment planning evaluation and optimization would be more effective if they are based on biologically and not dose/volume (DVH) based. In modern radiation therapy, physical dose indices, such as mean doses, dose-volume histograms (DVHs), and isodose distribution charts, are often used for treatment plan evaluation. DVHs provide dose volume coverage information. However, they fail to provide information regarding hot spots and dose homogeneity. When reviewing physical dose indices, the resulting biological objectives, such as tumor control rate and normal tissue complication probability, must be indirectly estimated based on clinical experience and knowledge. In some competing plans, it is possible that a similar mean dose, maximum dose, or minimum dose might have significantly different radiobiological outcomes. To facilitate the direct and accurate comparison and ranking of treatment plans, radiobiological models for treatment plan evaluation have been introduced. These radiobiological models are based on the idea that the radio-sensitivity of different organs should be taken into account. As a result, the physical dose delivered to an organ is directly associated with the dose–response probability of inducing complications in normal tissues.

Need for biological objectives in treatment planning

Presently, Treatment plan evaluation is based on volumetric distribution of the absorbed dose within patient. However it is rarely possible to measure dose distribution directly in patients treated with radiation. Beam data during commissioning of equipment is entirely derived from measurements in water phantom usually large enough volume to provide full scatter condition. These basic data used in dose calculation algorithm which performs dose calculation by considering different tissue heterogeneity to predict dose distribution in an actual patient.The clinical outcome of a radiotherapy treatment in terms of tumor control and normal tissue complication is always having some degree of uncertainty. This is because two treatment fractions of the same beam configuration are not the same since the nature of radiation beams are stochastic at a microscopic level. For this reason, the expected outcome of treatment is expressed as the probability of having a certain treatment effect. Radiobiological treatment planning estimates these probabilities for each target and organ at risk of a given clinical case based on dose distribution of radiobiological data. With the invention of intensity modulation inverse planning it is possible to achieve desired dose distribution in target and sparing organ at risk. The response of tumor (target) to radiation depends on many factors, which are not taking into account while plan evaluation. Such factors are density of clonogenic cells, the hypoxic cell fraction within tumor volume, redistribution of cells within cell cycle, repopulation and reoxygenation of the cells. Similarly response of the various organs to radiation depends on many other factors that are currently not taken into account during treatment planning process. Such factors are volume dependence of the organs to radiation, the internal structural organization of the functional subunits for normal tissues and dose per fractionation. In order to take this information into account in the planning of the treatments one needs to use radiobiological models, which describes the response of tumor and normal tissues to radiation according to radiobiological characteristics. A variety of dose-response models for tumor and normal structures are available and can be broadly characterized as either mechanistic or phenomenological. The mechanistic models describe the underlying biological processes, whereas the phenomenological or statistical models simply intend to fit the available data empirically. Mechanistic models are often considered preferable, as they may be more rigorous and scientifically sound. However, the underlying biological processes for most tumor and normal tissue responses are fairly complex and often are not fully understood, and it may not be feasible to accurately or completely describe these phenomena mathematically. On the other hand, phenomenological models are advantageous since they typically are relatively simple compared to the mechanistic models. Their use obviates the need to fully understand the underlying biological phenomena. Further, it may be somewhat risky to extrapolate model predictions beyond the realm within which the model and parameter values were evaluated and validated. Recently phenomenological models were introduced in the currently available Biological based TPS e.g. Monaco, Eclipse, Pinnacle and Raystation due to their simplicity in implementation.

The aim of radiobiological models (RB) is to predict the radiation response of biological systems. The aim of radiotherapy is to give sufficient dose to the tumor to achieve local control without introducing severe complications in the surrounding normal tissue. These conflicting objectives can be quantitatively described by dose-response curves defined as tumor control probability (TCP) and normal tissue complication probability (NTCP) as shown in fig(a). While early approaches based on TCP and NTCP modeling. Newer developments exploring their volume dependence and the relative biological efficiency (RBE) of radiation with high linear energy transfer (LET). In treatment planning, radiobiological models may be applied with different intentions:

1. Transfer of one treatment regime to a biologically iso-effective new regime or new radiation modality without predicting absolute values for TCP or NTCP.
2. Calculation of TCP or NTCP values to compare either competing treatment plans for an individual patient or different treatment techniques for a specified clinical application. In this case, the TCP/NTCP values are not expected to be completely correct in their absolute values, but it is believed that they can be used as rationale to prefer one treatment plan (or technique) over another.

3. Prediction of absolute TCP or NTCP values for individual patients.
4. Integration of TCP/NTCP models into the cost function of the dose optimization algorithm to generate biologically optimized treatment plans.

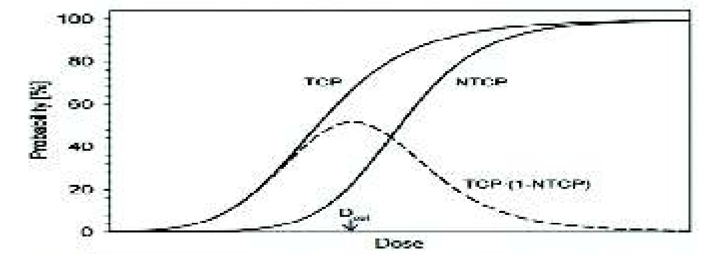

Fig. (a) Dose-response curve for tumour control probability (*TCP*) and normal tissue complication probability (*NTCP*). The maximum probability for tumour control without normal tissue complications (*dashed line*) is reached at the optimum dose (D_{opt})

TCP models

The situation for TCP models is much more complicated than for NTCP, since tumor response is influenced by various dynamically changing factors. While the radio-sensitivity of normal tissues within an individual patient may be considered to be constant in time, the sensitivity of tumors strongly depends on factors such as oxygen status and the amount of angiogenesis. Moreover, these conditions can be different for different parts of the tumor and may furthermore change, even in the relatively short time of the radiotherapy course. Because of these limitations RB models for TCP predictions are not well accepted by the scientific community. Some examples of TCP RB models are Poissons model, Zaider-Minerbo , The Martel model, Niemerko model, Web Nauham model etc.

NTCP models

The NTCP models aim to describe the complication probability in normal tissues in terms of dose-response curves. There are extensive evidences that, the radiation response of normal tissue depends on the amount of dose received by normal tissue. The irradiated volume is included as an additional important parameter. The extent of the volume effect is dependent on the architecture of the respective tissue and several models have been proposed. While some of them are only of phenomenological nature, others include more basic bio-statistical principles. The NTCP models presented a good extent of reliability by many authors in their study. Clinical validations of NTCP outcome were evaluated and tested by individuals and in multi institutional studies. Some examples of NTCP models are LKB model, relative seriality model, the critical volume model, Niemerko model, the parallel architecture model etc. Radiobiological models are essential components of modern radiotherapy. They are increasingly applied to optimize and evaluate the quality of different treatment planning modalities. They are frequently used in designing new radiotherapy clinical trials by estimating the expected therapeutic ratio of new protocols. Estimation of TCP/NTCP is currently based on the deterministic and simplistic linear-quadratic formalism with limited prediction power. Because of complex and stochastic nature of the physical, chemical and biological interactions associated with living tissues, Monte Carlo (MC) simulation may provide better estimates of TCP/NTCP for radiotherapy treatment planning and trial design. MC has demonstrated superior performance for accurate simulation of radiation transport, tumour growth and particle track structures; however, successful application of modelling radiobiological response and outcomes in radiotherapy is still hampered with several challenges.

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REPORT ON NC-AMPICON-2020

S.N. Sinha, Nayati Cancer Centre, Mathura

Nayati Cancer Centre, Nayati Medicity, Mathura and NCAMPI (Association of Medical Physicist of India, Northern Chapter) conducted successfully the 13th Northern Chapter - Association of Medical Physicist of India Conference in the Land of Lord Krishna, Mathura during 22nd to 23rd Februray 2020. Ms Niira Radia, CMD , Nayati Healthcare, extended her support and full cooperation to the organizers for successful conduction of the conference. Nayati Healthcare being the fastest growing healthcare organization in northern India also prioritizes largely on the cancer management. She mentioned about the pivotal role of medical physicist in cancer care in the world class advanced Nayati Cancer center. Dr.(Prof) Santanu Chaudhuri , Chairman, Center of excellence for Oncology, Nayati Healthcare mentioned that the Nayati Cancer Center chain has established premium cancer care, high technology, research and education in cancer, predominantly in smaller cities of northern India and metros too. Mr S K Narula, was the Chief guest, Dr.(Prof) Santanu Chaudhuri , Chairman, Center of excellence for Oncology, Nayati Healthcare and Organizing Chairman, Mr S N Sinha , Chief Medical Physicist, Nayati Healthcare and Organizing Secretary, Dr Amit Bhargava, and Dr Ravi Kant Arora, the Co-Chairman of the organizing committee, Dr Sanjeev K Gupta, the Joint Organizing Secretary, NCA-MPICON-2020 handed over the Dr N C Singhal Oration Award to Prof P S Negi. Prof. Negi talked on "Physical & Radiobiological Challenges of Hadron Therapy". Prof. Negi said, "I feel honoured for the Dr NC Singhal oration award bestowed on me by NC-AMPI. I started my career in JK Institute Radiology & Cancer Research Kanpur in 1966. I wish a successful innings for all medical physicists where ever they are working." The platform was shared by the experts in radiation science, oncology and medical physics. Around 120 delegates attended the conference. The theme of the conference was "Medical Physics for Safety, Quality and Precision in Radiation Medicine". Delegates from northern, southern and western part of India participated in delivering talks and panel discussions. The conference had invited talks and panel discussions which was appreciated by the participants and also had oral and poster presentation by young medical physicist. The invited talks were "Nano particle aided radiation therapy" by Dr. S. D. Sharma, Head, Medical Physics Section, RPAD, BARC; “Role of medical physicist in nuclear and radiological emergencies by Dr. Arun Chougule, President, AFOMP; “Dosimetric advantages and challenges with proton therapy” by Dr Dayananda Shamurailatpam, Head, Department of Medical Physics, Apollo Hospitals, Chennai; “Clinical commissioning of first proton therapy facility in India, Dr Dayananda Shamurailatpam; “Medical Physics in the Era of Artificial Intelligence (AI), Machine Learning (ML) and Big Data” by Dr Arabinda Kumar Rath, Chairman and MD Hemlata Hospitals, Bhubaneshwar; “Radiomics - application on mammography images - a pilot study” by Mr S N Sinha, Chief Medical Physicist, Nayati Cancer Centre, Mathura; “^{3}H2AX Foci as a biomarker of double-strand breaks: Techniques & our experience with CT dose” by Dr Ajai Srivastava, University college of medical sciences & GTB Hospital. A panel discussion on the topic “Expectations from Medical Physics in Radiation Oncology: Indian Perspective” was moderated by Dr Manoj K Semwal, Chief Medical Physicist at Army Hospital (R&R), Delhi with the panelists Dr Arbinda K Rath, Dr Pramod K Sharma, Dr Abhinav Dewan, Mr Maninder Bhushan Mishra, Dr Neeraj Gupta. The panelists provided the overall international and national perspective on the topic and highlighted the crucial role played by the medical physics community in ensuring safe and precise radiation delivery as well as in teaching and training of budding radiation oncologists and radiotherapy technologists. How Medical Physics can help improve the standards of care and contribute in R& D in the field was also deliberated. It was brought out that the teaching and learning is a reciprocal process between the clinical and medical physics colleagues. Another panel discussion on “Are we moving away from Brachytherapy?” was moderaded by Dr Lalit Mohan Agarwal, Professor (Radiological Physics), Institute of Medical Sciences, Banaras Hindu University, Varanasi. The discussion included the decline in Brachytherapy use due to popularity of IMRT although IMRT cannot replace brachytherapy in

many aspects of clinical outcome. Various challenges in the use of brachytherapy were discussed, like poor brachytherapy training of residents, anesthesia issues, complexity and so on. It was concluded that brachytherapy is a must in a clinical oncology department and its promotion is required. Panel Discussion on Management of Ca cervix was moderated by Dr Sanjeev Gupta, Consultant Clinical Oncologist, Nayati Cancer Centre, Mathura with the panellist Dr S Hukku, Dr. Rajesh Vashistha, Mr R K Munjal, Dr Atul Tyagi, Dr Than Singh Tomar, Dr Akhil Jain. Different case studies were highlighted like Carcinoma Cervix FIGO IB1, Carcinoma Cervix FIGO Stage IIIC2, Ca Cervix IIIB post CTRT with isolated hepatic metastasis and the optimal line of management were discussed and the different types of radiation planning with Brachytherapy and external beam radiotherapy were also discussed. Panel Discussion on Management of Ca head and neck was moderated by Dr Akhil Jain, Consultant Medical Oncology, Nayati Medicity, Mathura with the panellist Dr A K Anand, Dr Amal Roy Choudhury, Dr Rajender Kumar, Dr Radhakrishnan B Nair, Dr R K Bisht , Dr Kailash Mittal. Different Head and Neck cases were taken up and the diagnostic approaches were discussed and the opinion of the panelist were taken for the treatment sequence for surgery chemotherapy and radiotherapy. The challenges faced by the physicists in whole planning and the technical aspects during radiotherapy planning and execution were also discussed. Panel Discussion on management of Ca Breast moderated by Dr Ravi kant Arora, Director , Surgical Oncology, Nayati Medicity, Mathura with the panelist Dr Surabhi Gupta, Dr Hemant Goyal, Dr Manoj Sharma, Dr Kamalesh Passi, Mr Lalit Kumar. The clinical discussion took place with different cases of Ca breast cases. The scientific convener Dr. K J Maria Das, co-convener, Dr. Teerthraj Verma along with their team members selected abstracts for oral and poster session from the abstracts sent from all over India. The best oral presentation award was given to Mr Gaganpreet Singh and the best poster presentation award was given to Mr Shubham Singla. Dr Sagar Tuteja, Executive Director, Nayati Healthcare handed over a donation cheque to Dr N K Painuly, Chairman, NC-AMPI to express the appreciation of NCAMPI activities.

ENGAGEMENT WITH EPIDEMIC: STORY OF MEDICAL PHYSICS FROM JAIPUR

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The department of Radiological Physics, SMS Medical College and Hospitals, Jaipur is providing medical physics services to the departments of radiotherapy, radio diagnosis and other departments utilizing ionizing radiation for diagnosis and treatment. The medical physicists carry-out the radiotherapy treatment planning, dosimetry, radiation safety and protection of patients and personnel and quality assurance of radiation equipment in the hospital along with academic and research activities. The SMS Medical College and Hospitals, Jaipur is one of the largest tertiary care medical colleges of the State of Rajasthan: the largest Indian state by area and seventh largest by population. In addition to the patients from the State, SMS Medical College and Hospitals provides healthcare services to the patients from bordering States of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Gujarat. More than 50 lakh outpatients, more than 2.5 lakh surgeries and more than 8000 new cancer patients were treated last year. In December 2019, the new respiratory tract infecting agent emerged in Wuhan city of China and the WHO declared COVID-19 a global pandemic on 11th March 2020. India reported the first confirmed case of the Corona virus infection on 30th January 2020 in the State of Kerala. The first case of the COVID-19 pandemic in the Indian State of Rajasthan was reported on 3rd March 2020 in Jaipur. Before 3rd March, India had 3 cases of Corona virus in Kerala all of which were treated and discharged. On 3rd March, India’s 4th case was diagnosed in the State of Rajasthan and it was later found that this patient had infected 17 other tourists from Italy who were on a trip to India. These 21 COVID-19 infected patients were admitted in SMS Medical College and Hospitals, Jaipur. The SMS Hospital was the main COVID-19 treatment center in Rajasthan since the first incidence of COVID-19 infection. Early March, all COVID-19 infected patients in Rajasthan were treated in SMS hospital, Jaipur and a fully equipped OPD facility and isolation wards were established in the hospital. Later, when the COVID-19 positive patients’ influx increased, the Prime Minister of India declared lockdown across the country on 21st March 2020. All facilities in the SMS Medical College and Hospitals were also utilized for COVID-19 treatment thereafter as the regular patient inflow was reduced to very minimum. The situation was same for radiation oncology patients too. The radiation therapy continued on outpatient basis with few inpatients that required hospitalized care. The cancer patient cohort is one of the most vulnerable to serious implications if infected with COVID-19 as they are elderly and immunosuppressed. Hence radiotherapy was one of the most challenging essential services amidst the pandemic. As radiological examinations such as Chest X-rays and CT scans were one of the primary modalities for diagnosis and treatment evaluation in COVID-19 management, more attention was given to radiology also. A number of new X-ray machines and mobile X-ray units were procured to cater to the urgent needs of the huge no. of COVID-19 positive patients. Commissioning of these units fulfilling the regulatory requirements to ensure optimum radiation safety was also carried out swiftly by the department of Radiological Physics. The faculty and paramedical staff of the department of radiological physics played an important role in the implementation of regulatory guidelines to establish X-ray imaging facility and obtaining regulatory permissions. his unique situation gave rise to many professional and personal challenges to all healthcare professionals including medical physicists in our institute. Carrying out the routine as well as additional radiological physics services was demanding considering the existing hospital situation and social circumstances. Other than the radiation treatment delivering facility and a small ICU for cancer patients; all other facilities of radiotherapy and radiological physics departments were utilized for COVID-19 patient management. Medical Physics is a unique workforce characterized by a large variety of relatively complex tasks. Compared to radiation therapists, nurses, radiation oncologists, radiographers and radiologists, a physicists' direct contact to patients is limited. But, the COVID-19 pandemic and associated life style and social modifications and restrictions put forth a variety of challenges in the personal domain rather than the technical ones. Lockdown initiated lack of means of public transport, closing down of public canteens and mess facilities also affected the lives of medical physicists in our department. Many religious festivals and associated holidays came and gone without anyone even realizing. Establishment of procedure protocols for radiography and radiotherapy treatment delivery, maintaining the quality of the diagnostic and treatment system with optimum machine performance, achieving high through-put in minimum possible time, managing the workload with reduced workforce due to implementation of quarantine, the increased working hours and continuous duty schedules per individuals to accommodate the prescribed quarantine after duties, social stigma towards medical professionals and associated disputes in the personal front, use of PPE and lead aprons in the scorching hot climate of Jaipur going up to 50 degree Celsius in April, May and June are some of the challenges to list a few. When lockdown was initiated in March end and COVID-19 was declared as a pandemic, there were four medical physicists in our institute, two of them in vulnerable group one being a senior citizen and another being pregnant. We have evolved ourselves to cope with the professional and personal challenges in the most effective and best possible way. Handing over the department space for COVID-19 management, safeguard and maintain the equipment and infrastructure, re-arrangement of radiation physics equipment and facilities to ensure optimum work efficiency, unhindered patient services; cancer as well as COVID-19 were all achieved by co-ordination and tireless efforts of the physicists team lead by Dr Mary Joan during the lockdown. The shock of the pandemic was transient and the department of radiological physics took a leading role in assimilating information on management of cancer patient's treatment, optimal execution of radiological procedures, diagnostic radiological imaging, radiotherapy dose delivery and treatment protocols, personnel and patient protection and communicated among all to equip ourselves better. This helped greatly in optimizing a plan of action and departmental protocol in the midst of confusion. It was highly exacting to coordinate all the activities of the department due to the pandemic externalities. Each and every team members training and experience helped me to handle them effectively. Two new physicists joined our department in August. Narrated below are the personal experiences and professional challenges of two women medical physicists of our institute, one already working and another newly joined, in aiding unperturbed radiological physics services to all radiological procedures at this challenging time of COVID-19 pandemic.

Ms. Priya Saini is working as medical physicist in Radiological Physics department of SMS Medical College and Hospitals since 2018. Let us listen to her experience. "During lockdown period, I was posted on cobalt teletherapy (Bhabhatron-II) and brachytherapy. My major work was to do treatment planning, treatment time calculation, radiation safety monitoring, QA after repairs, routine radiotherapy treatment equipment calibration and treatment plan reviews, teaching and research. In early March (starting phase of the COVID-19 pandemic), when number of patients were less, COVID isolation wards were made in, one or two departments in our hospital. Our hospital was the main COVID-19 treatment center. With the increasing number of patients, our cancer wards and other department's wards were also converted into isolation wards. And our departments' facilities (physics and dosimetry) were also vacated and occupied for doctors and nurses treating COVID-19 patients. At that time only one room was left with us for conducting our routine works. Early phase of the COVID-19 pandemic, I found so many difficulties in managing patients because of lack of awareness and fear of this virus. Then I spent extra time in reading the available instructions and followed the guidelines given by WHO and slowly, I overcame my fear. Under normal conditions, the department used to treat 100-120 patients per day on Bhabhatron-II telecobalt machine. But with lockdown, the number of patients declined rapidly, to 50-60 patients per day on Bhabhatron-II telecobalt machine. This happened initially because it was difficult for patients to travel to the hospital as during lockdown there was no public transport and travel by ambulances was not affordable to everyone. Some patients had already left the hospital for their hometowns or villages, as there was uncertainty about the guidelines to be followed for treatments and difficulties with local accommodation in Jaipur. Those patients who were admitted in the hospital wards and staying in the hospital periphery received the remaining fractions of their radiation treatments. Also patients those were recommended for surgery were also transferred to radiation therapy. So workload in our department slowly increased. For certain cases', including some patients with early stage cancer, radiation was delivered over a shorter period of time. The main reason for indicating hypo fractionated treatments during the COVID-19 pandemic was to minimize the viral exposure and risk of contamination of patients without reducing the effectiveness of the treatments. Our aim was to establish a better way to treat all patients who can benefit from radiotherapy; not to delay the start of treatment of any patient whose deferral may worsen the prognosis of their disease. After lockdown, as the necessity of regular medical services to the general public became essential, our hospital resumed normal activity by shifting the COVID -19 patients to the university hospital and radiotherapy treatments continued normally again. Patients who survived the lockdown came back to the hospital for their remaining treatments. For those who had already received some radiation fractions, the gap was calculated and dose was managed accordingly. Every day, healthcare workers were seen screening patients with thermal scanning before registering them for treatment and providing them with hand sanitizers. I made one separate box in manual treatment planning room. Every patient is advised to keep her/his treatment documents in that box. In this way, we could be able to avoid the cross contamination of the virus. After 4-5 treatment calculations, to protect myself and others from infection, I washed my hands with soap or used an alcohol based hand rub.

Also, I instructed the security guard to send only one patient at a time inside the manual treatment planning room and every patient is advised to maintain physical distancing of minimum one meter (three feet) from each other. Before starting the treatment, every patient was verified to be COVID-19 negative. In brachytherapy treatment console, at the time of treatment execution three persons used to be present; one technologist, one resident doctor and myself. We three maintained physical distancing from each other. We did not allow patient/ patient comforter to come in treatment planning room or console. We interacted with patient and patient comforter while maintaining one meter distance outside the minor OT. PPE kits were used while treating the patients. Personal protective equipment has become an important and emotive subject during the current corona virus (COVID -19) epidemic. Personal protective equipment was an important component, but only one part, of a system protecting staff and other patients from COVID - 19 cross -infection. Appropriate use significantly reduced the risk of viral transmission. During the lockdown period the Jaipur temperature varied up to 46 °C. That time as per guidelines; we were not using centralized air conditioner (AC) for preventing the spread of virus through air circulation. So that it was very difficult for us to wear PPE kit while treating the patients. And it was unfit for us also.

In case of intraluminal brachytherapy, there was direct interaction with patient while taking the measurements for planning. During such instances I used to wear PPE kit. After completion of treatment, the PPE kits were discarded properly and wash my hands and face with soap. We pasted some notices on the treatment planning room, calculation room and other room doors with necessary messages in local language (no entry without mask, maintain social distancing, do not enter without permission etc.) to make awareness of COVID-19 to the patients and others. We used to ask all treatment ongoing patients about corona symptoms and other health related issues. If patients are found symptomatic then they were sent for COVID-19 test. During this period, I created brachytherapy treatment plans for about 70 patients. In addition to the treatment planning, I was involved in quality assurance and quality control of the machines in the department and teaching. We did mechanical QA of both machines weekly and dosimetry QA monthly. Before starting the QA we used to sanitize treatment room and control console. In this way, we could prevent the spread of contamination of COVID-19 virus. During this period we became more conscious about hygiene. During this period, few resident doctors of my department were also became COVID-19 positive and I had interacted with one of them two days back. This got scared and I started to pay more attention to improve my immunity. I did self-assessment for 3-4 days and consulted with a general physician also. Following that, two technologists posted in Bhabhatron tele-cobalt machine tested positive for COVID-19. As per the institutional COVID-19 protocol, they were home quarantined for 14 days. After quarantine they were tested negative for COVID-19 and rejoined the hospital. Frequent issues with the machines were raised during treatment delivery. I was also engaged in troubleshooting of machines. To resolve machine related problems we had to do more hard work as the engineers were unable to reach hospital. We did solve out the problems by online contact with engineers and troubleshooting via team-viewer. As per local government instructions, from lockdown until now, the paramedical undergraduate students were taught on online classes via Zoom. The class attendances are recorded regularly. There are 5 postgraduate paramedical students and they joined back for regular classes after lockdown. I took many classes for them maintaining proper distance in department seminar room. I also instructed them regarding hospital protocols, necessity to follow proper hygiene and not to sit together without mask or not maintaining social distancing. Recently one of the post-graduate student got severe symptoms similar to Covid -19. He was asked to do COVID-19 test and not to come for classes until negative report. The other four students were asked to self-quarantine. After 24 hours he got negative report and was allowed to take rest for 3-4 days to recover from weakness."

In August beginning, a new physicist from Kerala, Ms Meenu Stephen joined our department. Her experience with the pandemic in her words: "I just completed my master degree in Medical Physics and internship from KMIO, Bangalore, Karnataka in February and was searching for a job from my home in Kannur, Kerala. While staying at home I realized several things. With an increasing number of corona virus cases, the government locked down transport services, closed all public and private offices, factories and restricted mobilization. The use of face mask was promoted and schools and colleges were closed. All the religious groups were told to cancel gatherings to encourage social distancing and undue spread of COVID-19 virus. The people were only allowed out of their houses to provide essential services or buy essential goods. The police officers were regularly patrolling public places and markets to make sure people stayed apart and to inform people about the importance of social distancing, wearing masks and gloves etc. For students who are at the juncture of their academic career or professional courses and their parents, the lockdown heightened their anxiety, as it has affected their education and job opportunities. Educational institutes have been forced to depend on online learning. I was using social media to get connected, caring and communicating through mobile phones. These electronic gadgets have become the need of the hour in the pandemic. This lethal corona virus pandemic has not just created a medical emergency but also an employment crisis across the country. Since the outbreak of COVID-19 so many hospitals cancelled job interviews. They were not ready to call for new vacancy and were trying to manage with existing workforce. The absence of flights, trains and other modes of public transport during the lockdown made it impossible otherwise also. After 6 month of my course completion, two vacancies were advertised for Medical Physicist in SMS Medical College, Jaipur. The interview was scheduled on 7th July 2020. The main problem that I faced was attending the interview on that day as there was no proper transportation during that time. Travelling from one state to another state was a big deal. Also different states were having different traveling rules according to their current COVID-19 situation. At that time the only way to reach Jaipur was through flight. The airline services were very few and there were so many procedures to do to get cleared for interstate travelling. The first mandatory step for flying is to install arogyasetu, a central government app that uses location trackers and bluetooth technology to assess the risk of the user catching COVID-19. Airlines won't allow passengers on flights if the app shows their status as red. The temperature check was carried out all entry points where as self-check in and remote bag drops was the new mandate now to ensure avoiding clustering of people. On the day of the interview, all candidates were aware of the current pandemic situation and the hospital administration conducted the interview according to the COVID-19 protocol. All candidates attended the interview with face mask and maintaining the social distancing. After interview I was not able to go back home due to lack of airline services. According to the Kerala government guidelines for air travelers coming to the state at that time, all should be home quarantined for 14 days from the date of arrival. As per the guidelines, all the passengers have to register their details with the COVID-19 JAGRATHA web portal. After undergoing medical screening for any symptoms of COVID-19, asymptomatic persons shall undergo home quarantine. Pick up vehicles for arriving passengers will be permitted to enter airport with one person (excluding driver of the vehicle) at a designated place subject to social distancing norms. If the people who pick up the passenger come in physical contact with the traveler, they shall also remain home quarantined for 14 days. After reaching back home I was in quarantine for 14 days. The other family members were not supposed to visit me. The health workers used to come to my home every day and inspect everything. The police officers also used to come home daily to inspect and I was asked to call them for any need including food, grocery etc. After quarantine days, I joined SMS Medical College and Hospitals as a senior demonstrator

Dosimetric QA of Tele-Cobalt Machine

(Medical Physicist) on 4th August 2020. The distance from my home in Kannur to Jaipur was nearly 3000 kms. During initial days, one of my major problems was speaking in Hindi, the local language in Jaipur. My mother tongue is Malayalam and understanding spoken Hindi by people wearing face mask was a challenge. With time, I got adjusted and interaction with colleagues and patients improved a lot. Accommodation and food and daily travel to department were other concerns, but I got an accommodation nearby hospital within a week and that solved the commutation problem also. Since, restaurants and canteens are closed; I had to make arrangements to cook also immediately. COVID-19 situation made me more conscious of personal and public hygiene. People started taking personal hygiene more seriously. The ritual of washing hands, sanitizing things before use, that started as a compulsion slowly became a habit. At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments. WHO is continuously providing updates and necessary information."

The personal narrations above of Ms Priya Saini and Ms Meenu Stephen give us a glimpse of how each and every one individually contributed to the collective efforts of the department of radiological physics for the flawless pandemic management. The COVID-19 pandemic affected everyone globally and the department of Radiological Physics, SMS Medical College and Hospitals is not an exception. We are striving for keeping ourselves, our dear and near safe while continuing the medical physics services to all radiological facilities of the institute, without compromising the international standards. The academic arena has taken a new face with frequent webinars, virtual meetings and online examinations. Research has gained due recognition in the clinical medical physics also. Many e-books and documents were made free online during this pandemic, which gave a boost to the academic learning too. The department of Radiological Physics was planning to celebrate the International Medical Physics Week (IMPW) in Jaipur during 11-15 May 2020 which could not materialize due to the COVID-19 pandemic. The Senior Professor and Head of the department of Radiological Physics, Professor Arun Chougule has taken initiatives as President, Asia-Oceania Federation of Organizations for Medical Physics (AFOMP) and Chair Education and Training Committee–International Organization for Medical Physics (ETC-IOMP) in organizing regular webinar series in medical physics and popularizing them. Prof Chougule spearheaded drafting and publishing of comprehensive AFOMP guidelines on radiation oncology operation during COVID-19 and diagnostic radiology services during COVID-19 pandemic-medical physicists' perspective. In this challenging time we had a very proud moment as the department of Radiological Physics when Prof Arun Chougule was recognized as one of the AFOMP outstanding Medical Physicist on the occasion of the 20th anniversary of AFOMP. Many international medical physics conferences which were scheduled during this time are either postponed or are being conducted virtually. These subtle changes in academics, research and professional relations and development will hopefully lead us to a better tomorrow. The radiological physics team of SMS MC and H, Jaipur during the pandemic outbreak was consisted of Arun Chougule, Mary Joan, Rajni Verma, Priya Saini, Meenu Stephen and Gourav Jain.

QUALITY ASSURANCE FOR 3D PRINTED BOLUS: EXPERIENCE IN A BUSY SERVICE

D Basaula, E Ungureanu, M Wright, B Hay, T Kron

Peter MacCallum Cancer Center, Melbourne Australia

Radiotherapy treatment regimes often use bolus when treating uneven area of a patient to compensate for missing tissue and sometimes to provide build-up to the skin surface. The ideal bolus should exhibit water equivalent radiological properties, be flexible to conform to patient surface, durable over the course of radiotherapy and cost effective. Some commonly used bolus materials in radiotherapy include wet gauze or combine, super-flab and wax blocks. Since the introduction of 3D printers, they have been widely used in medical environment and one of the example of such applications is their use of printing bolus (Robar, Moran et al. 2018). Peter MacCallum Cancer Centre (PMCC) which consists of 5 campuses across Victoria in Australia and treats ~7000 radiotherapy patients established a system of 3D printers to print bolus in 2017. It is used for patient treatments in order to improve the treatment conformity and geometric accuracy. A significant amount of development work went into optimisation of the bolus manufacturing process and a more formal 3D printed bolus program in the department was commissioned in 2018. It has been in use since. The typical work flow of printing bolus *(shown in Figure 1)* involves contouring of required bolus in patient radiation therapy treatment plan and generating .STL files. They are exported to Autodesk Netfabb for minor repair and mesh manipulation followed by transfer to simplify 3D program for slicing and prepared for printing. The printed bolus is then used on patient during their treatment. It is important to check these printed bolus are as intended to ensure patient dosimetry is not compromised. In order to check any potential anomaly during print, routine quality assurance (QA) of 3D printers and filament materials is necessary. Thus, we aim to report our institutional QA program that is currently being used for 3D printed bolus.

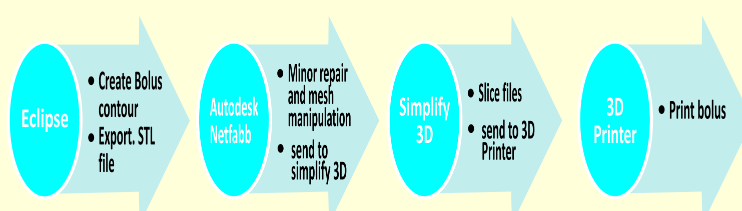

Figure 1: Schematic of typical workflow of bolus printing

Since June 2018 when a proper record keeping system process was established and initiated, 683 patient specific bolus have been printed using 3D printer. Each patient specific bolus is embossed with the patient ID number to ensure these are correctly identified and used on patient during treatment session. Our institute uses Pro2 Dual extruder 3D printer (Raise 3D Technologies, Inc. CA, USA) with natural Polylactic Acid (PLA) filament (Esun industrial Co.Ltd, Shenzhen, China) to print bolus. For routine QA, each printer prints a QA wedge (shown in Figure 2). The geometrical measurement of each printed QA wedge is measured using a calibrated micrometer. We also record the weight of each printed block. These values are compared with baseline. Additionally each QA wedge is further scanned in a Philips Brilliance CT scanner using consistent CT parameters for evaluation. A visual inspection for any variation in filament density is evaluated from CT images and average CT number of the QA block is recorded.

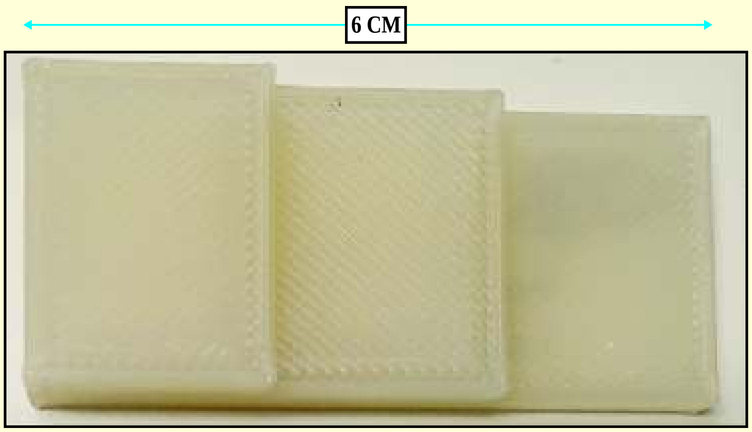

Figure 2: Photo of a QA wedge printed from 3D printers

We have printed 63 QA block since November 2018. The average length and weight (± one standard deviation (1SD)) of the QA wedge was found 60.01 ± 0.15 mm and 22.42 ± 0.53 g. All other geometric measurement of QA wedge were in excellent agreement with baseline values. CT images (140kVp Philips Brilliance) of each QA wedge showed consistent density visually and the average CT numbers (±1SD) were found 138.7 ± 17.3 HU as shown in *Figure 3*. This is equivalent to a density variation of approximately ±3% on a 95% confidence level, which results in similar variation in attenuation as the variation in dimension observed for the smallest thickness.

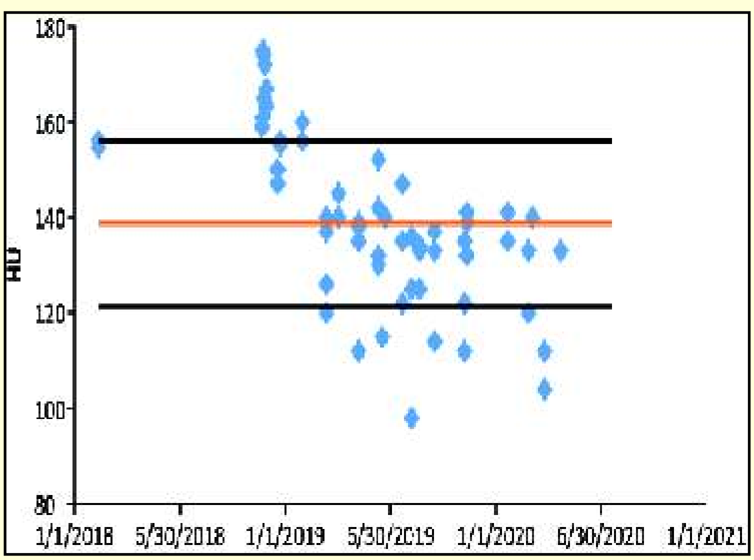

Figure 3: Plot of CT number of 3D printed QA wedge since November 2018. Red line indicates the average CT number and black lines Indicating standard deviation (1SD) above and below from mean.

The measured results demonstrate that the 3D printed QA wedge is accurate in geometries with minimum uncertainties. *Figure 3* shows the plot of the CT number with date it was printed with majority of samples lies within one standard deviation from mean. The data that lies outside the upper and lower line are caused by multiple identifiable issues associated with printing such as interruption of printing and change in filament material. It is important to note that the CT number of QA block are derived by contouring the entire wedge in Eclipse treatment planning system by various users. This slight larger standard deviation is primarily attributed by inter observer variation to delineate QA wedge contours when auto contouring tool was not used. However the dosimetry impact of such variation in CT number is negligible (Davis, Palmer et al. 2017). Printing of bolus takes typically over-night and our institution utilises 3 separate printers to cope with workload. In contrary to conventional bolus, 3D printed bolus takes significant time to produce which needs to be considered in clinical setting. If patient treatment has to commence before the bolus is ready we allow up to 3 fractions of treatment with super-flab which has a similar CT number but typically worse conformity. It would be ideal to taper the edges of the bolus in the case of VMAT head and neck treatments for better conformity however our attempts to date did not succeed due to design, workflow and manufacturing problems. We have established the workflow of printing bolus using 3D printer, which has replaced the conventional method of producing bolus in our department. We find it efficient and accurate as well as conformal to the patient surface. Also use of 3D printer has helped the department to accommodate producing large number of bolus as the printer can be run overnight. However some of the issue that may be encountered during printing such as run out of filament material in the middle of scan, which can have significant effect on the printed bolus. As such, it is important to visually inspect the printed bolus for any obvious inconsistencies. Uninterrupted power supply should be considered in the event of the power failure so that continuous printing can be achieved. Also each time when the software is updated and any preventative maintenance work is performed on printers, it may inadvertently alter commissioned printer settings. As such routine QA becomes critical to pick potential errors. We thus suggest to run the frequency of test at least monthly basis for each printer and additional QA when there is software/firmware update and upgrade. Also printing material affect the radiological properties; thus it is important to ensure that consistent printing filament is used and checked. By checking CT number consistency, it ensures that the radiological properties of the bolus is consistent with baseline. QA program should be performed each time when filament batch is changed. As 3D printers are used in clinical setting, QA testing of its functional and consistent performance is key to ensure printed bolus are accurate and as intended. Our department has established simple and quick QA program that is not resource intensive but pick of any potential performance issue with printers and printed materials.

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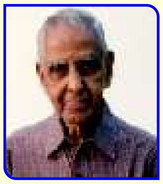
OBITUARY



Dr. P.S. Iyer
(22.09.1935 – 16.06.2021)

Dr. P Seshadrinatha Iyer, former Head of Radiological Physis Division (present Radiological Physics and Advisory Division), BARC passed away on 16th June 2021 in Tripunithara, Kerala where he had shifted after retirement. He is survived by his wife Dr. P. Bhama Iyer.

He joined the Division of Radiation Protection, DRP, AEET (present BARC) in 1959 after post-graduation from Kerala University. After doing Ph.D. from Kansas University, USA, he took charge of the Hospital Physics Group of DRP. Rapid developments in radiotherapy practices, medical physics and radiation safety requirements necessitated progressive interaction with radiotherapy centres across the country. Apart from the Divisional activities towards this objective, Association of Medical Physics of India (AMPI) was established in 1976. Dr. Iyer was a founder member of the association and he contributed significantly for its upliftment, working as Secretary, Treasurer and President. He worked as Member/Secretary/Chairman of several National and International Committees dealing in Medical Physics and Radiation safety. His expertise and management skills were instrumental in streamlining safety aspects related to radiation applications. He was recipient of the prestigious Ramaiah Naidu Memorial Award in 2002. He retired as Head, Radiological Physics Division (RPhD), in 1995 after a meritorious service of over 35 years. He continued his association with AMPI and worked as the Chief Editor of the Journal of Medical Physics, the official journal published by AMPI, for almost a decade. Dr. Iyer had the flair of getting work done without putting pressure and it helped to create a cordial ambience among his associates. He was a good leader and is fondly remembered as a humble, caring and helpful personality, liked by one and all. May his soul rest in peace.

THREE CHEERS

Prof Arun Chougule, President AFOMP, Senior Professor Department of Radiological Physics, SMS Medical College and Hospitals Jaipur is awarded with one of the most prestigious recognitions of medical sciences in India **'Fellow of National Academy of Medical Science' (FAMS)**. He is the first medical physicist to receive this distinguished honour in the 60 years long history of National Academy of Medical Science (NAMS) India. He also recognized as one of the **AFOMP outstanding Medical Physicist** on the occasion of the 20th anniversary of AFOMP. Congrats !!

THREE CHEERS

Dr. A. Saravana Kumar has been promoted to Assistant Professor & Sr. Medical Physicist Grade 1, Department of Medical Physics, PSG Institute of Medical Sciences and Research, Coimbatore in July 2020. Before this, he received Best Poster Presentation Award with cash prize at Joint ICTP-IAEA DRL in Medical Imaging workshop training, International Centre for Theoretical Physics (ICTP), Trieste, Italy in November 2019. Congrats!!

Dr. Suresh Yadav, Assistant Professor Medical Physics, Department of Radiotherapy, Gandhi Medical College, Bhopal, Madhya Pradesh has been awarded Ph.D. degree by Rabindranath Tagore University, Raisen (Madhya Pradesh) in July 2020. The title of his thesis was "**Analysis of physical radiation dose distribution based on 3D CT image in HDR brachytherapy applications**" Congrats !!

Dr Abhijit Mandal has been promoted to Professor (Radiological Physics), Department of Radiotherapy & Radiation Medicine, Institute of Medical Science, BHU, Varanasi in August 2020. Congratulations !!

Shri Pradeep Goswami, Scientist D, Institute of Nuclear Medicine & Allied Sciences (INMAS), DRDO, New Delhi has been awarded Certificate of Appreciation for his immense contribution to Indo-Israel Programme (Open Skies) organised at Delhi from 28th July - 6th August 2020. The programme was related with the rapid testing of COVID-19. Congrats !!

Dr. S. Ebenezer Suman Babu, CMC, Vellore has been awarded Ph.D. by The TamilNadu Dr. M.G.R. Medical University, Chennai in December 2019. The title of his thesis was "**Investigation of different gel dosimeters for quality assurance in radiation therapy**". Congrats !!!

Dr P. Mohandass, Chief Medical Physicist, Fortis Hospital, Mohali, Punjab has been awarded PhD degree by Karunya University in September 2020. The topic of his thesis was "**Evaluation of Different Dosimetric Parameters in Volumetric Modulated Arc Therapy Treatment Planning and Delivery Systems for Various Clinical Sites**". Congrats !!

Dr. S. P. Mishra, Deptt of Radiation Oncology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow received the prestigious "Ramaiah Naidu Oration Award" for 2020 which was conferred in March 2021 at the annual conference of AMPI held at BARC, Mumbai. The topic of oration was "**Evolution of medical physics over the past four decades and the emerging new paradigms**". Congrats!!

Dr. Athiyaman M has been awarded Ph.D degree in Radiological Physics by Rajasthan University of Health Sciences (RUHS) Jaipur. The topic of his thesis was "**Analysis of effective area and monitor unit calculation methods for complex fields used in linear accelerator**". Congrats !!

Dr. Hemalatha A has been awarded Ph.D degree in Radiological Physics by Rajasthan University of Health Sciences (RUHS) Jaipur. The topic of his thesis was "**Dosimetric study for risk assessment of radiation induced secondary cancers following radiotherapy**".

MEDICAL PHYSICS FUN TIME