South Asia Centre for Medical Physics and Cancer Research

SCMPCR

Newsletter

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QUALITY EDUCATION AND HEALTH SCIENCE FOR PATIENT BENEFIT

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Editor's Notes

Centers in South Asian countries do not lag behind in bringing the latest technology in radiation treatment soon after their introduction in the western countries. There are plenty of examples to this effect. Today, patients from these countries do not have to travel far and away to distant places for receiving treatment by any advanced technology. What is heartening is that these advanced treatment options are available in the South Asian countries at a fractional cost of what it would otherwise cost in the western countries.

However, it is a matter of concern that when it comes to patient safety, we need to improve ourselves compared to our western counterparts. I will substantiate my statement with two simple examples: (i) It has been a decade since AAPM published its report of the Task Group 100. We have hardly seen any center sharing its experience on applying modern risk-based analysis techniques to the complex radiotherapy process and designing the center's quality management (QM) activities. There may be one or two rare exceptions. This stands in stark contrast to the practice standards in advanced countries. Centers make use of TG 100 recommendations, especially so in putting new technology into clinical practice. Needless to say that they learnt invaluable lessons in patient safety; (ii) Centers in south Asia, for some strange reasons, do not come forward readily to implement a paperless workflow, little realizing that in the process we are compromising on patient safety. The Radiation Oncology Information Systems (ROIS) in our region are largely used as simple Record and Verify (R&V) systems citing innumerable reasons.

When highly complex treatments are carried out routinely in the centers in this region, the need of the hour is to ensure patient safety in every possible way. We, medical physicists have a major responsibility in educating our fellow colleagues on improving the safety standards and take leading role in implementing the relevant practices.

Sincerely,

Prof. Tharmarnadar Ganesh, Editor-in-Chief

Dear all,

Greetings to everyone from the Editor's Desk. It gives me great pleasure to meeting you all once again through this Newsletter

Highlights

- If the whole world can do it, why not we? And why don't we?.........
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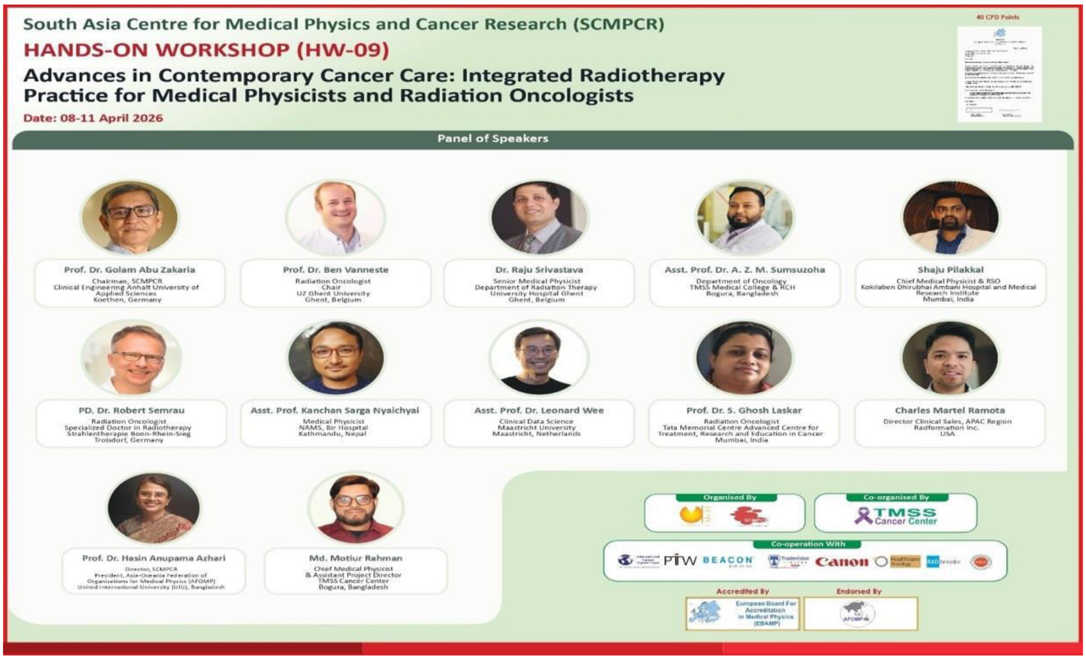
Advances in Contemporary Cancer Care: Integrated Radiotherapy Practice for Medical Physicists and Radiation Oncologists

Md Jabidul Islam, South Asia Centre for Medical Physics & Cancer Research (SCMPCR)

Introduction

The 9th Hands-on-Workshop (HW-09), titled "Advances in Contemporary Cancer Care: Integrated Radiotherapy Practice for Medical Physicists and Radiation Oncologists." was held from April 8–11, 2026 at the TMSS Cancer Center in Bogura, Bangladesh organized by the South Asia Centre for Medical Physics and Cancer Research (SCMPCR). The workshop was designed to bridge the gap between theoretical knowledge and practical clinical application in modern radiotherapy. The program addressed the critical need for integrated practice between medical physicists and radiation oncologists to ensure precision and safety in cancer treatment.



The workshop's academic and clinical depth was driven by a prestigious international faculty representing leading institutions from Germany, Belgium, the Netherlands, India, and Nepal. Led by Prof. Dr. Golam Abu Zakaria, the Chairman of SCMPCR, the panel included global experts such as Prof. Dr. Ben Vanneste, PD. Dr. Robert Semrau, Asst. Prof. Dr. Leonard Wee, Prof. Dr. S. Ghosh Laskar, Mr. Shaju Pilakkal, and Asst. Prof. Kanchan Sarga Nyaichyai among others.

Reflecting its academic rigor, HW-09 was accredited by the European Board for Accreditation in Medical Physics (EBAMP) and awarded 40 CPD points to successful participants. The event was further endorsed by the Asia-Oceania Federation of Organizations for Medical Physics (AFOMP).

The workshop's success was made possible through the strategic cooperation of several international and national partners, including the International Cancer Expert Corps (ICEC), PTW, Beacon Pharmaceuticals PLC, Tradevision, Canon and Radformation.

Day 1: Wednesday, 8 April 2026

The first day of HW-09 focused on establishing a strong theoretical and clinical foundation for modern precision radiotherapy. The day was strategically divided into technical lectures, the formal inauguration ceremony, and specialized sessions on emerging technologies like Artificial Intelligence.

Figure 1.1: Inaugural Ceremony & lectures of Day-1

The program commenced at 09:00 AM with the registration of participants. Medical Physicists and Radiation Oncologists from various prestigious institutes across the country gathered at the TMSS Cancer Center, Bogura. This was followed by a brief networking session over Hi-Tea, allowing the national and international faculty to engage with the attendees before the formal sessions began.

Day 2: Thursday, 9 April 2026

The second day of the workshop shifted the focus toward the intricate clinical workflows and advanced planning strategies required for high-precision radiotherapy. The sessions were designed to promote a deeper understanding of how modern technology translates into better patient care through meticulous planning and data-driven decision-making.

Figure 1.2: Both online & offline lectures of Day-2

Day 4: Saturday, 11 April 2026

The final day of HW-09 was dedicated to measuring the educational impact of the four-day program and providing a prestigious conclusion to the collaborative efforts of the participants and faculty. The day focused on validating the knowledge gained and gathering critical feedback to ensure the sustainability of future training initiatives.

Final Examination and Program Evaluation. The morning session commenced at 10:00 AM with a comprehensive Examination followed by Evaluation. This assessment was led by the core academic leadership, including Prof. Dr. Golam Abu Zakaria, Dr. Robert Semrau, and Prof. Dr. Hasin Anupama Azhari. The examination was designed to test the participants' grasp of integrated radiotherapy workflows, contouring precision, and Tomotherapy physics.

Simultaneously, participants completed detailed evaluation forms. These surveys provided essential data on the effectiveness of the hands-on clinical modules at the **TMSS Cancer Center** and the quality of the international lectures. This feedback loop is a cornerstone of the SCMPCR educational model, ensuring that each workshop evolves to meet the specific needs of the South Asian oncology community.

Figure 1.3: Evaluation, Certificate Distribution & Closing Ceremony of Day-4

The workshop culminated in a formal **Closing Ceremony** held at the Conference Room of the TMSS Cancer Center. The event served as a celebration of the successful partnership between **SCMPCR** and **TMSS**, as well as the successful completion of the intensive training by the delegates.

Topic of Discussion

Day 1	Day 2	Day 3
• Medical & Clinical Aspects of Tomotherapy. • The Physical and Technical Aspects of Tomotherapy Machines: How Tomotherapy is Different from Conventional Radiotherapy Machine. • Multimodality Imaging Integration (CT–MRI–PET) for Precise Target and OAR Delineation • Why Internal Tumor Motion Matters in Radiotherapy? • Artificial Intelligence in Radiation Medicine • Adaptive Radiotherapy: Rigid & Deformable Image Registration for Clinical Applications	• Dosimetry, QA & Planning for Total Body Irradiation (TBI) Technique • Radiobiological Considerations in Hypofractionation, SRS, and SBRT: Clinical Implications for Planning and QA • Commissioning and Routine QA for Tomotherapy • SBRT Protocols for Head-Neck & Pelvis • Head And Neck Contouring: Delineation For SRS, SRT and SBRT Cases and Associated Issues • Contouring of Breast and Pelvic Malignancies: Target Volumes, Nodal Regions, and Organ-at-Risk Delineation • Paradigm Shift in Radiotherapy: A Comparative Analysis of Surface-Guided versus Marker-Based Patient Positioning	• Automation in Radiotherapy • Group-A: Practical: Contouring for Radio Oncologists • Group-B: Practical: Tomotherapy Commissioning & Routine QA for Medical Physicist • Group-A & B: Practical: Plan Evaluation **Day 4: Examination followed by evaluation**

Conclusion: The successful execution of HW-09 represents a major achievement for the cancer professional community in Bangladesh and the broader South Asia region. By transforming theoretical knowledge into measurable clinical skills, the program has directly contributed to elevating the standard of cancer care and treatment precision.

Figure 1.4: Group Photo

If the whole world can do it, why not we? And why don't we?

Tharmarnadar Ganesh, Ph.D., DABR
Former Chief Medical Physicist, Manipal Hospitals, New Delhi, India

The last few decades saw several significant technological advances happening in the field of radiation oncology. The multileaf collimators (MLCs), initially introduced for simple field shaping in 3-dimensional conformal radiotherapy, soon evolved into a tool for delivering intensity modulated radiotherapy (IMRT). Within years IMRT delivery technology further expanded to include volumetric modulated arc therapy (VMAT) in which again MLCs play the most important role. Dose calculation algorithms became stronger, accurate and faster with the introduction of better algorithms based on first principles and powerful computers. Treatment delivery through stereotactic methods became a norm and saw several modern gadgets like Gamma Knife, linac-based radiosurgery units like CyberKnife, and ZAP-X radiosurgery system. The current century saw the introduction of O-ring gantry linacs like Tomotherapy, Halcyon, etc. The practice of image-guided radiotherapy (IGRT), started in the early 1990s with ion chamber-based portal imaging, has advanced today into various practice forms with most modern solid state detector technology. Image guidance theory has grown by leaps and bounds to incorporate online adaptive radiotherapy (ART) which is the buzz word today. There are MR-guided treatment delivery machines like Unity and other advanced technologies available for the purpose. Particle radiotherapy using protons, once confined only to research facilities, has reached several clinics across the world. Lately, artificial intelligence (AI) has made its presence felt in every step of the radiation oncology workflow - be it in triaging, contouring, automated treatment planning, plan evaluation, plan check, adaptive treatment planning, AI has made a big impact in every area of the treatment process.

The radiation oncology community in South Asia has been quick enough to adapt all these technological advances in radiation oncology within no time of their inventions and make them available to the common public across wide regions. In this regard, the reach of image-guided IMRT and VMAT is a good example. These advanced treatment technologies are so widespread in this region that almost every patient from these countries has easy access to them. While there are Tomotherapy units available in India, Bangladesh, Pakistan, Sri Lanka, Nepal CyberKnife and MR-guided linac facilities are available in multiple centers in India and Pakistan. India otherwise has been in the forefront in bringing advanced technologies like proton therapy, and ZAP-X radiosurgery unit with many more facilities slated to come up in the near future including three new proton centers.

However, if there is one simple technology which is found grossly lacking in this entire region, it is the simple paperless workflow in radiation oncology. Unlike in the western world, where every center works on paperless environment, the South Asian radiation oncology centers have simply opted to ignore them, barring a few exceptions in India. This is in spite of the fact that every center has invariably a radiation oncology information system (ROIS), like MOSAIQ or Aria or their equivalent. The hard-to-digest truth is that in these centers the ROISs are used like 'improvised' record and verify (R&V) systems. In this way the system is used more or less in the same way it was used way back in the early eighties when R&V systems first appeared in the radiation oncology field.

If a properly designed survey is ever to be conducted, it would for sure go on to reveal how naive radiotherapy personnel in the South Asian region are when it comes to knowing about the true potentials of a ROIS. Beyond the routine scheduling and handling of all treatment and imaging sessions, the capabilities of a ROIS are hardly known to anyone.

The biggest challenge in any radiation oncology department is the chase behind the physical radiotherapy file (simply known as RT file) by one and all. It is needed at multiple locations by multiple people - by the radiation oncologist in the review room; by the therapy technologist in the treatment room; by the physicist in the treatment planning system's (TPS) room; and by the radiation oncology nurse in the preview/vitals room - all at the same time. Being a physical chart, it is obvious that such a chart cannot be omnipresent everywhere! The chart contains, besides other things, basic demographical data of the patient, patient's diagnosis, clinical workup notes, referring physician's remarks, clinical notes from other departments if any, histopathological reports, all radiological investigations, blood chemistry reports, radiation dose prescription, daily treatment records, cumulative dose until date, daily vitals, progress notes by treating physicians, details of previous treatments if any, morbidity chart, printouts from TPS, discharge summary, etc. The American Society of Radiation Oncology has stressed the importance of converting this chart as an electronic health record (EHR) in its publications (Safety is No Accident, 2012, and 2019).

How can we make a physical chart into a EHR? How can we make it omnipresent and obviate the need for its physical presence everywhere? Answer: Go the ROIS way! Not only that each of the information mentioned above can be entered into ROIS making the physical chart redundant, but also being a computerized record, it is available in any computer at any location. There is no need to run behind the physical file. Further, access to data can be restricted based on the operating person's credentials, thus enhancing patient data privacy. For example, while the treating physician would have unrestricted access to all the data, a radiation oncology nurse would have access only to the demographic data, daily vitals section and perhaps progress notes.

The diagnosis entry in ROIS is where one enters every detail of the disease. Depending on the disease site, the diagnosis entry page has extensive provisions for entering International Codes of Diseases (ICD), T(umor) N(odes) M(etastasis) staging, descriptions on details of tumor size, location, lymph node involvement, etc., that can prove valuable at the time of patient data analysis. Reports of the radiological and pathological investigations, blood chemistry reports, if properly configured, can be directly imported from the hospital information system (HIS) in the highly preferred soft format, or in the hard format in the form of scanned documents. Users can raise investigation requests from within ROIS (like blood chemistry, radiological, etc.,) as and when the need arises, thus making the use of HIS or form-based requisitions unnecessary. Every instance of patient's visit to the hospital, every footfall within the department can be captured electronically and record kept forever. One can go on to 'build' intelligent forms, using simple customized dropdown menus, radio-buttons, checkboxes, free-text entries, to address the needs of the departmental workflow and enforce the same for strict compliance. For example, the whole process of mould preparation, chart-check by physicists, the second-check by radiotherapy technologists (RTTs), etc., can be enforced on staff through mandatory filling-up of forms. These forms will go as part of the patient's electronic medical record (EMR). By thoughtfully configuring the forms and enforcing their digital filling at right locations in the electronic workflow, patient safety is enhanced.

The ROIS can also be used to manage patients, manage availability of physicians, physicists, and therapists in the department through incorporation of their leave schedules. Besides that, the system can also manage facility infrastructures like usage statistics of thermoplastic masks, vacuum cushions, slot-booking for hospital's common facilities like outpatient department (OPD) rooms, seminar room, etc. These valuable features of ROIS prevent confusions and oversights that can result from manual workflow.

'Paperless' is a big misnomer for ROIS. Calling it 'paperless' often shifts the focus from its main advantages, viz., enhanced patient safety and valuable data mining, to its trivial gain of saving paper sheets, making people to wonder why should so much efforts be made for the sake of saving a few sheets of paper. Indeed, the correct way is to call it either 'electronic health record' or 'electronic medical record' and the system should always be referred as 'radiation oncology information system'. The radiation oncology workflow is one of the most complex ones involving several human interactions and information exchanges extending over a wide time scale. A complex workflow that relies heavily on paperwork and person-to-person interactions makes it vulnerable to human errors. If it is converted into an electronic one, enabling introduction of appropriate forms/checklists at various stages in the process to plug all the loopholes, it will prevent errors from reaching the patient. This also will enable mining of precious data which otherwise go down the drain unharnessed. For example, it is possible to know 'How many patients did we treat today / this week / this month / this year?', and split those numbers according to machine, treatment energy, treatment technique, treating consultant, from a few mouse clicks. It is also possible to generate data on treatment statistics like 'How many are supposed to start treatment today?', 'how many computed tomography

(CT) simulations done today?', 'how many patients would complete their treatment on a particular day, or during a specific window period?' through minimum efforts. Data mining can be further expanded to capture machine downtime and the reasons thereof, which can add valuable insight into downtime analysis, thus enabling timely preventive measures.

One of the 'bottlenecks' often faced by radiation oncology staff is the correct and timely update of the 'white board', showing the current status of the treatment planning process for each patient. Missed out and delayed updates often lead to delayed treatment and patient dissatisfaction. This happens mostly because of improper communications, overlooking assigned responsibilities, delays in task completions, etc. The ROIS can effectively replace your departmental white board. Its care path tracking feature can remove all these bottle necks. Once the demographics data of a patient, slated for receiving radiotherapy course, are entered into the system, the entire care path for that patient - mould room task, CT simulation task including image exporting to the TPS, image importing and adding structure sets in the TPS, contouring, adding dose constraints and dose prescription by the physician, treatment planning task, patient specific quality assurance task, adding treatment and imaging sessions in the ROIS, completion of treatment and generation of discharge summary report - every step in the radiation oncology workflow can be automatically added in the patient's care path along with the responsible person and the specific timeline for completing each task. Upon completion of each task, it is the responsibility of the concerned person to change the status of the task in ROIS to 'COMPLETED' status which will shift the responsibility automatically to the next assigned person in the care path queue. In this way everyone becomes aware of his/her pending responsibilities and the respective due dates. The ROIS opening screen for everyone can be configured to display 'white board' showing the progress status of the care paths for all patients, along with the currently pending task and the name of the responsible person. This makes it easier for everyone to view the whiteboard from his/her own desktop and also its live update.

The ROIS can be configured to improve patient's experience in the hospital in many ways. For example, when the patient arrives in the department for daily treatment, all that he/she has to do is to simply scan a barcode affixed on the appointment card. This simple action will record the arrival time of the patient in the hospital and make it known to everyone in the department that the patient has arrived and is waiting. It is also possible to fetch data on the waiting time spent by patients on each day of their visits and address issues related to long waiting time.

In the routine workflow verbal instructions are often given and at times such instructions are missed due to oversight resulting in deficiency in timely clinical care provided to the patient. Such instructions can be issued over ROIS making it mandatory for the concerned staff member to acknowledge the same through digital sign.

In spite of all these advantages, radiation oncology centers in the South Asian countries have not yet adapted this simple technology. There are a few exceptions in India, but they are negligible in numbers. The hard truth is that more than 99% of the centers are still relying on paper-based workflow, compromising efficiency and patient safety in many respects. There are multiple reasons for not adapting ROIS-based workflow by clinics in this region:

1. One of the important impediments is the lack of awareness among radiation oncologists, medical physicists, radiotherapy technologists and radiation oncology nurses about the capabilities of ROIS. Many of them still consider it as a simple record and verify system to deliver treatments correctly and do not explore the ways to effectively use the system for improving the workflow.
2. In many centers it is mandatory for departments to follow HIS, which is either in-house developed or purchased. The hospital's management issues compulsory instructions that all clinical notes, clinical history, all investigation requests must be entered/initiated through HIS only. The radiation oncology department is no exception to these instructions and staff in the department do not like to double their responsibilities by duplicating their work on both HIS and ROIS. They simply stop at HIS and choose to ignore ROIS. The onus is on the radiation oncology team to educate the hospital management that (i) the radiation oncology workflow is unique and different from others; (ii) both HIS and ROIS are hospital information systems and ROIS, in addition to being a HIS, can address many unique needs of oncology workflow which cannot be met by a simple HIS; (iii) the two systems can be configured to exchange information mutually between them as per specific needs; (iv) following ROIS-based workflow will enhance patient's safety and patient's experience and (v) valuable data can be generated from ROIS which otherwise will down the drain.
3. The radiation oncology staff are unwilling to come out of their comfort zone - i.e., the paper-based workflow. They have to know that once they are used to ROIS-based workflow, they will start to wonder how all these years they lived without it!
4. The lack of infrastructure is another stumbling block. Neither the required licenses, nor the required number of additional workstations are bought by the centers.
5. The lack of coordination between hospital's information technology (IT team) and the radiation oncology team. Often the hospital's IT team fails to grasp the intense needs of the radiation oncology department and consider it one among all other departments.
6. The need for having a robust mechanism for backing up the ROIS data.

It is high time that the radiation oncology centers in the South Asia realized the true potentials of a radiation oncology information system like MOSAIQ or Aria and adapt this simple technology into their practice. Even more importantly, these centers should appreciate the inherent hazards associated with the paper-based system that is in wide practice currently in this part of the world. Time has come for us to ask ourselves: If the whole world can do it, why not we? And why don't we?

My PhD Journey

Dr. Suresh Poudel, PhD, DIMPCB
Medical Physicist, BPKMCH, Bharatpur, Chitwan, Nepal

It was in March 2018, while I was working as a Medical Physicist at Nepal Cancer Hospital and Research Center (NCHRC), Lalitpur, Nepal, I went to Bangladesh to attend and present my work on ICMPROI-2018. There I had an opportunity to meet and talk with Prof. Dr. Golam Abu Zakaria sir and Prof. Dr. Hasin Anupama Azhari madam about my interest for higher studies. They were my professors at Gono University, where I studied MSc Medical Physics. Prof. Zakaria, who is the founder of Department of MPBME at Gono University, is a leading figure for development of medical physics education in Bangladesh, is not just my professor but is a source of inspiration for many aspiring medical physicists. He is pivotal in creating learning opportunities for many radiation professionals and students in the region. While Prof. Anupama, to whom I have a huge respect as my teacher, was chairman of faculty of Physical Sciences and dean of Gono University, Bangladesh then. With them I discussed largely about my interest for PhD. It was indeed my initial step for undertaking PhD education.

As Prof. Zakaria keeps wide vision to support for the development of medical physics for South Asia, and there was a collaboration between Heidelberg University, Germany and Gono University, Bangladesh, to encourage and support PhD education under a sandwich program, I would get recommendation for PhD training in Germany under DAAD scholarship provided I get admission in PhD program in South Asia.

As I had deep interest to pursue PhD, the following stanza describes my mental state after having the conversation with the professors during ICMPROI-2018.

……And there is a belief still alive

……A consistent voyager keeps

…After traversing miles distance

…….Will reach a firm ground

……Might it be a lonely land

…….But shall be rich in its beauty and shall be calm

Soon after returning to Nepal from the conference, I started exploring opportunities to get admission in PhD program. After weeks of exploration, I came across a PhD admission announcement in Amity University, India. Without delaying I applied to it, sat for and cleared the entrance exam, and took admission at Amity University, Lucknow, India. Meantime, as I was recommended for the PhD training in Germany, I started preparing for that. Prof. Dr. Asita Kulshrestha, HOI, ASAS, Amity University appreciated the effort and facilitated the process in Amity University matters.

PhD training in Germany started on August 2018, there in the beginning; I had opportunity to observe dosimetric work at Mannheim Medical Center. The chief medical physicist Dip-Ing Volker Steil at UMM helped me on different matters. I also had opportunity to learn about 3D printer there and also attended few vendor sessions. Also, I used to have frequent conversation with Prof. Golam Abu Zakaria on finalizing the research area. We had a lot of brainstorming on that. One fine day, Prof. Golam Abu Zakaria, Prof. Guenther H Hartmann, DKFZ professor and me had a long conversation at Heidelberg on possible research avenues. Finally, I decided to choose a topic on Monte Carlo Simulation, and both professors from Germany and Prof. Asita Kulshrestha from Amity University would support me in my PhD work. Thereof I started learning on Monte Carlo calculation methods with Prof. Hartmann and I was regularly communicating with Prof. Zakaria and Prof. Kulshrestha on my progress. By the end of December, 2018, I had made a sound understanding of Monte Carlo methods and it has been crucial in finalizing my research topic. Finally, my PhD research topic evolved as **"Monte Carlo Simulation of Silicon diode detector in Megavoltage Photon Beam".** We modified few Monte Carlo programs necessary for our research work and ran the codes with some representative sample data we had at that at the time.

Thereafter, I returned from Germany at the end of December 2018, and started coursework in Amity University, Lucknow, India in January 2019. After clearing coursework exams and getting the final approval of the topic from research committees of the University, I undertook the practical part of the PhD research. It was followed by measurements with different small field detectors, which I received directly from PTW, Germany upon request from my Professors. It took me sometimes to get the custom clearance, but as soon as I received them, I performed the measurement and collected data. Meantime, better understanding dosimetry techniques particularly on small field dosimetry and Monte Carlo codes and their uses were made through extensive literature surveys and research works. While I was doing research directly under the guidance of Prof. Kulshreshtha and Prof. Golam Abu Zakaria, regular communication, suggestions and support from Prof. Hartmann had been very helpful throughout.

Every six month, I presented my progress at university, and in between, somehow, Covid outbreak slowed the work progress but I kept the pace as far as possible. I presented the work in SFO Kathmandu, AOCMP Bangladesh, AOCMP Thailand and AOCMP Malaysia where I was awarded with **Professor Sung Sil Chu AFOMP Best Student's Publication Award**". I have been able to publish two quality papers in Radiation Physics and Chemistry Journal and Polish Journal of Medical Physics and Biomedical Engineering in 2023 and 2025 respectively. Thereafter, initially I prepared Long Abstract, got it Plagchecked and did pre-PhD viva, only then I prepared the final report, again got it Plagchecked and finally defended in November, 2025. In every step, suggestions from the guide, co-guide and Prof. Hartmann had been crucial.

My PhD work is particularly significant as it has been able to simplify Monte Carlo dose profile calculation with a novel "**Hypothetical In-Air Profile** Method", at the same time could suggest profile correction factors for different detectors, could develop Analytical function for profile correction factors to minimize extensive MC calculation in clinical settings.

The PhD journey which I started on 2018 ended on December 6, 2025 as I was awarded PhD degree during a Convocation Ceremony at Amity University, Noida, India, which was conferred in the glorious presence of university academicians, Union Minister of India Mr. Piyush Goyal and eminent scholars. I feel proud to stand as the **second medical physicist with PhD degree** working in the country. I am thankful to Prof. Golam Abu Zakaria, Prof. Guenther H Hartmann and Prof. Asita Kulshrestha for their unwavering academic guidance and support, while I thank Prof. Hasin Anupama Azhari for her kindness and support in my journey. I thank DAAD Germany for the prestigious scholarship, German Cancer Research Center (DKFZ), Germany for the resources and PTW Germany for the detectors, Mannheim Medical Center, Nepal Cancer Hospital and BPKMCH being the part of the journey. I highly acknowledge Amity University and its staffs for being there along with me in the journey. I value the perseverance and belief of my parents, wife, family members, relatives and friends to wait to see for the success. With the accomplishment, on one hand, I can feel a sigh of relief and on the other hand, a greater sense of responsibility and eagerness to undertake new research, scientific and academic activities.

To conclude, as in aforementioned stanza, my belief is still alive to work more on research, scientific and academic activities. The PhD journey was as long as miles long journey but I have reached to the state of transient calmness after being conferred with PhD degree. Now I landed on a firm ground as a second medical physicist working in Nepal with PhD. Nevertheless, my doubt about whether it be a lonely land will not be lonely anymore, as more medical physicists will embrace the path to celebrate each-others' success and do justice to medical physics profession and then serve patients, nation and above all the humanity. Now, I can tell everyone that my PhD journey was truly beautiful.

A Step into Medical Physics: The Beginning of a New Journey

Safwan Araf Alvey
Medical Radiation Physics, University of Adelaide

Physics is a diverse subject having its sub-branches spread across various fields of application. Medical Physics is one of its sub-branches which applies physics principles to medicine for disease prevention, diagnosis, and treatment, focusing on areas like radiation oncology (cancer therapy), diagnostic imaging (X-rays, MRI, CT, ultrasound), nuclear medicine, and radiation safety. Despite being a student of Physics, my interest in medical science developed early, during my sophomore year. I was fascinated by how physics could be applied to directly improve patient care. While exploring this direction, I discovered the field of medical physics, and reading research articles in radiation medicine further motivated me to pursue this path.

After graduating from the Department of Physics, University of Dhaka, I got myself admitted into the "Master of Medical Radiation Physics" program at the University of Adelaide in July, 2025. The initial step of this journey was not very smooth for me. Adjusting myself in a new environment, managing everything on my own, while maintaining a busy class schedule often felt very exhausting. Regardless of these difficulties, I was very much thrilled to learn new aspects of Medical Physics such as radiation interactions, imaging physics, and the fundamentals of radiation oncology. These experiences strengthened my understanding of the clinical responsibilities of medical physicists.

In Australia, medical physicists play a vital role in both diagnostic imaging and radiation oncology. They are essential members of hospital teams, responsible for treatment accuracy, patient safety, quality assurance, and the clinical implementation of advanced technologies. Following completion of the Master's degree, structured residency training is required to practice clinically, reflecting the profession's strong emphasis on competency and accountability.

In October, 2025, I came to know about SCMPCR and their activities. I also attended the E-Learning Program (ELP-10) organized by them, which provided valuable exposure to contemporary topics in cancer research and radiation medicine. The program covered areas such as patient-specific QA software, surface-guided radiotherapy, 3D printing, artificial intelligence, digital image processing, Monte Carlo dose calculation, and radiotherapy optimization. Importantly, ELP-10 also addressed practical leadership skills and the scientific publication process, supporting my development as an early-career medical physicist.

With a strong interest in radiation oncology, I hope to contribute to the advancement of cancer care through precise, safe, and innovative applications of medical physics, ultimately improving outcomes for cancer patients. In conclusion, I want to say that stepping into a new field like Medical Physics may feel challenging at the beginning, however, the pleasure of acquiring new skills far outweighs the struggles and hardships in the long run.

SCMPCR Newsletter

General Article

AI Ethics Perspective: Sparing the Role of Medical Physicists in the Era of Artificial Intelligence

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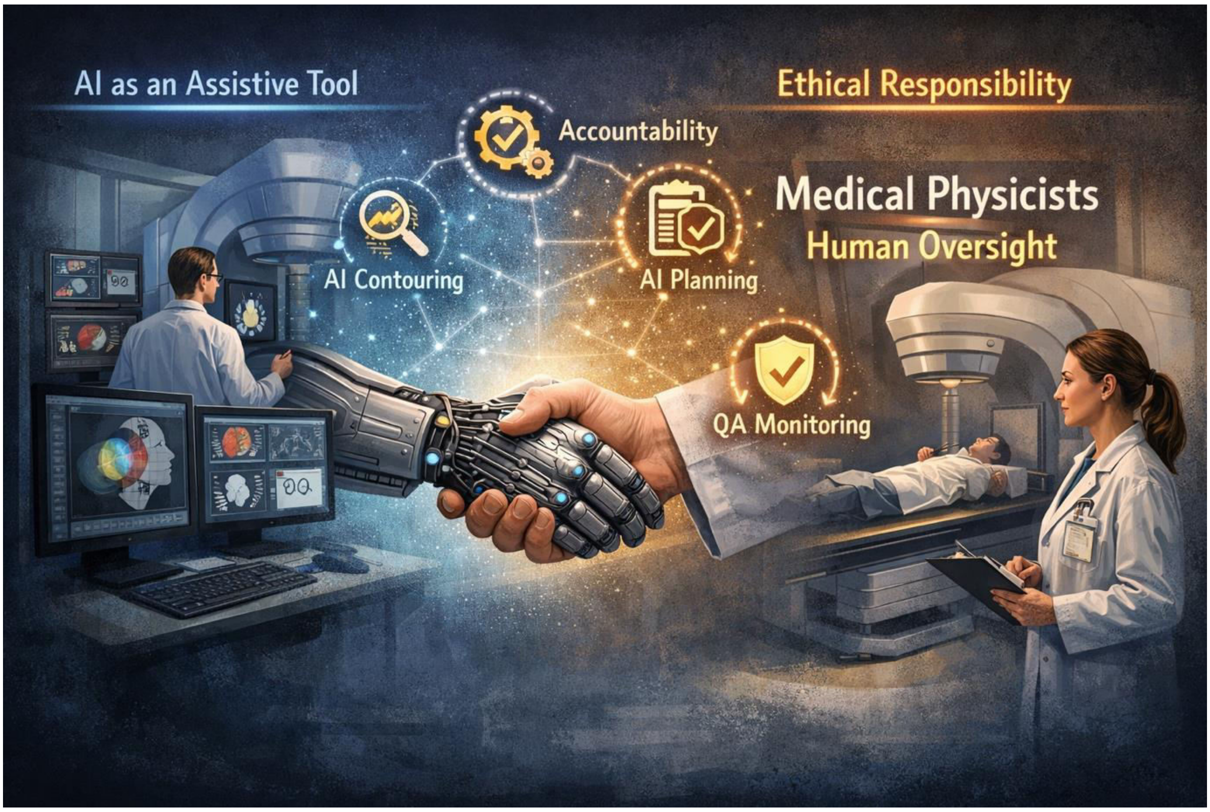
In the past decade artificial intelligence has given us a wide spectrum of applications in the field of medical physics, including auto contouring, quality assurance, toxicity prediction, heart dose prediction, and treatment planning. Along with this advanced application, there are some risk factors, such as data privacy. If anything goes wrong, then who will be responsible? AI will replace the medical physicist? All these answers will be unfolded by AI ethics principles. In this article, we will focus on some AI ethical principles, such as accountability, fairness, and equity. The ethical principle of fairness and equity emphasizes that AI technologies in healthcare must provide equal opportunity for all populations, ensuring that innovations in radiotherapy do not remain limited to high-income countries but are accessible and beneficial to low- and middle-income countries (LMICs) as well. The principal of fairness and equity may not be successful in the case of AI technology distribution in LMIC countries, possibly due to its higher cost. So that, medical physicists will have to work as before.



The ethical principle of accountability is "Who should be blamed when AI causes harm?" Whenever any AI product comes on the market, there are several stages said to be an AI life cycle. This AI cycle includes the researcher, software engineers, manufacturer, service provider, and end user (medical physicist or radiation oncologist). All AI products used in clinical practice are essential to going through a well-defined AI life cycle. This cycle begins with researchers who design algorithms and select training data, followed by software engineers who implement models into usable systems. Manufacturers then integrate these systems into commercial platforms, often embedding them into treatment planning or imaging workflows, while service providers are responsible for installation, updates, and maintenance within clinical environments.

Finally, the end users, such as medical physicists or radiation oncologists, use these tools in radiotherapy. Accountability in this life cycle is not isolated to a single actor; rather, it is distributed across all stakeholders, each bearing responsibility appropriate to their role. Researchers must ensure scientific rigor and representative datasets, manufacturers must validate performance and communicate limitations transparently, and service providers must maintain system integrity. After this the end-user role has emerged; medical physicists hold a uniquely critical position as the final gatekeepers, who will be responsible for validating AI outputs, performing independent cross-checks, and determining whether AI-generated contours, plans, or QA results are clinically acceptable. This human-centered role will be performed by a medical physicist; they can analyze loopholes in AI-based treatment planning and automation. Ethical AI, therefore, does not remove responsibility from clinicians (medical physicist or oncologist); instead, it clarifies and reinforces their role.

Hence, healthcare is changing as a result of artificial intelligence, but medical physicists' vital role must be protected by its ethical integration; as AI systems function primarily as assistive or decision-support tools rather than autonomous decision-makers. Medical physicists provide the human judgment, contextual knowledge, and accountability that guarantee patient safety and treatment precision, even while AI can speed up data analysis and increase efficiency. AI should be used to strengthen medical physicists as stewards of trust, innovation, and equity in healthcare rather than to replace them, maintaining their crucial role in promoting ethical, patient-centered care.

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SCMPCR Newsletter

General Article

The Evolution of Healing: From Ancient Remedies to Quantum Artificial Intelligence

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Tracing the journey of medicine from historical practices to the frontiers of Agentic AI, AlphaFold, and Quantum Computing.

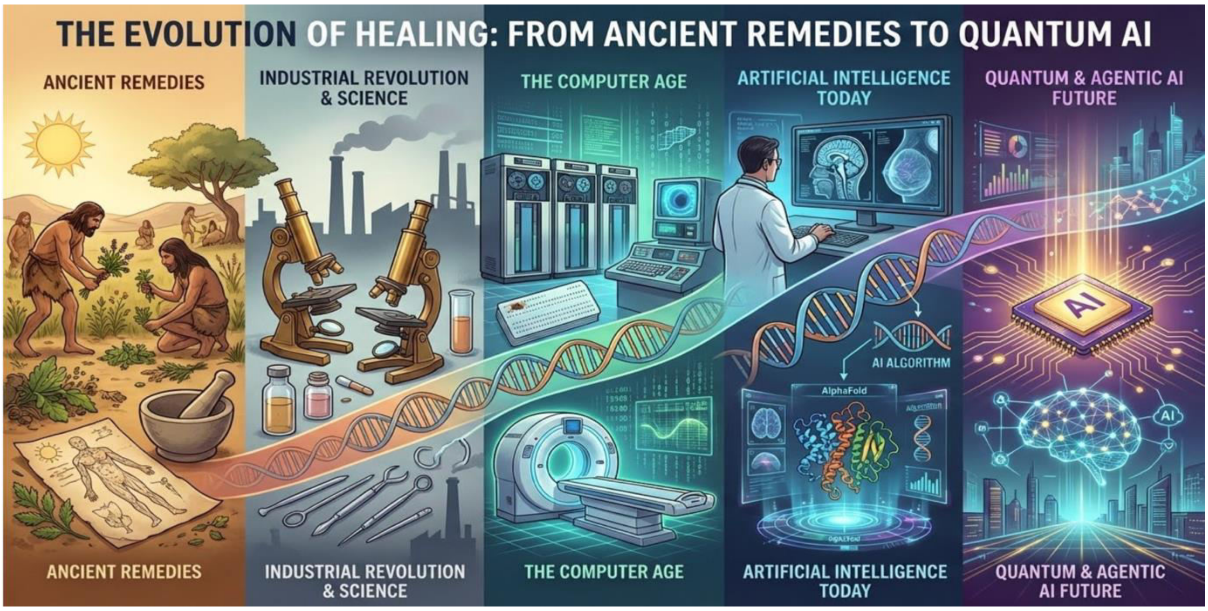


Fig.1: A visualization tracing healthcare's remarkable chronological transformation, from historical remedies and early standardization to the frontiers of Agentic Systems, AlphaFold, and Quantum Artificial Intelligence.

Healthcare is one of the most remarkable stories of human progress. From our earliest ancestors gathering medicinal leaves in the wild to modern supercomputers simulating molecular structures, our quest to cure diseases and extend life has never stopped. Today, we stand on the edge of a new era powered by Artificial Intelligence (AI) and quantum computing. To understand where healthcare is going, we must first look at how far we have come.

The Ancient Period: Survival and the Dawn of Medicine

In the ancient world, human survival was an everyday struggle against predators, harsh environments, and mysterious diseases. Early medical treatment was based on trial, error, and deep observation of nature. Ancient healers discovered that certain herbs, roots, and barks could relieve pain or stop bleeding. Over time, ancient civilizations in Egypt, Greece, India, and China began to document these practices. Medicine was often intertwined with spiritual beliefs, but it laid the essential foundation of observing symptoms and applying treatments to help the body heal.

Fig.2: A historical illustration showing trepanning, an ancient surgical technique. [Source: Wikimedia Commons / Public Domain] Link

The Industrial Revolution: The Shift to Modern Science

The Industrial Revolution in the 18th and 19th centuries transformed society and radically changed how we treated illness. As people moved into crowded cities, the rapid spread of diseases forced a shift in medical thinking. This era gave birth to the germ theory, proving that microscopic organisms caused infections. Mass manufacturing allowed for the widespread production of medical instruments like stethoscopes, syringes, and microscopes. Hospitals became standardized, sanitation was prioritized, and the first vaccines and anaesthetics were developed. Medicine evolved from a local, natural practice into a structured, science-based discipline.

The Computer Age: Formulas and Algorithms The next major leap occurred in the late 20th century with the invention of computers. As technology improved, the healthcare industry began using machines to store patient records and manage hospital operations. Medical researchers developed mathematical formulas and early algorithms to assist in diagnostics.

Machines like CT scanners and MRIs use complex calculations to let doctors see inside the human body without surgery. Healthcare became data-driven, relying on vast electronic databases and evidence-based medicine to standardize patient care across the globe.

Fig.3: A historical illustration showing a vintage surgical table and tools. [Source: iStock / Royalty-Free] Link

The Present: What Artificial Intelligence Can Do Today

Today, Artificial Intelligence is no longer just a futuristic concept; it is an active, life-saving partner in clinics and hospitals. As of 2025 and 2026, AI breakthroughs are fundamentally reshaping patient care:

1. **Early Detection:** AI models can now analyze medical imaging with incredible precision. For example, AI tools deployed in intensive care units can predict the onset of life-threatening conditions like sepsis hours before human doctors can spot the clinical symptoms. Similarly, AI in mammography can detect breast cancer far earlier than traditional methods.

2. **Solving Rare Diseases:** Generative AI models, such as the recently developed "PopEVE," are being used to analyze human genomes to pinpoint harmful genetic mutations. This is helping doctors solve rare genetic diseases that previously left families searching for answers for years.

Fig.4: A historical photo of the first CT scanner prototype being operated by its inventor, Godfrey Hounsfield. [Source: Wikipedia / Public Domain] Link

3. **Unlocking Biology with AlphaFold 3:** AI has unlocked the very building blocks of life. Google DeepMind's recent release of **AlphaFold 3** has fundamentally changed structural biology. While earlier versions solved the "protein folding problem" for single proteins, AlphaFold 3 can accurately predict how proteins interact with DNA, RNA, and small drug molecules (ligands). It models the entire "cellular soup" simultaneously, giving researchers an incredibly accurate 3D map of how diseases function at the molecular level.

4. **Clinical Companions:** AI-powered decision-support tools are acting as real-time assistants for doctors. They instantly search millions of medical journals to provide evidence-based treatment recommendations, ensuring doctors have the latest research at their fingertips.

5. **Agentic AI:** Autonomous AI agents are taking over heavy administrative burdens, from clinical coding to patient scheduling. This reduces burnout among nurses and doctors, giving them more time to focus on actual patient care.

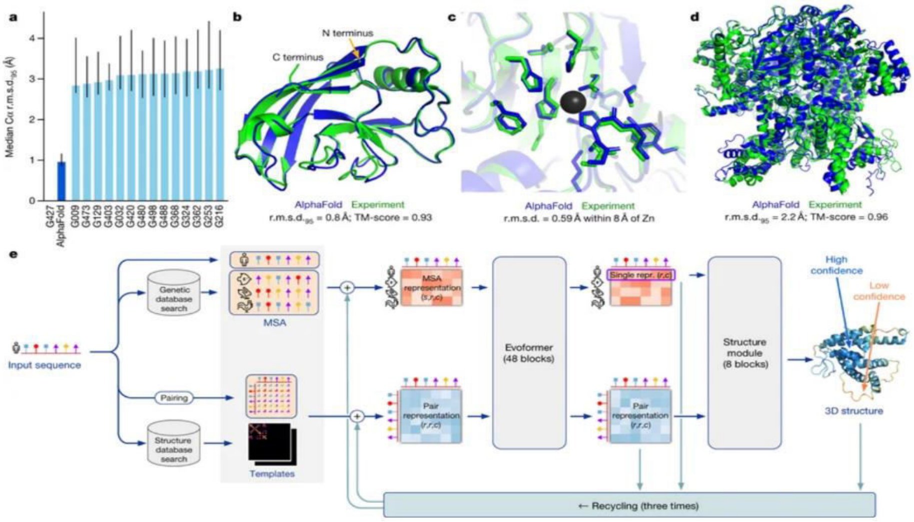


Fig.5: A graph and molecular diagrams showing the breakthrough accuracy performance of AlphaFold on the protein structure problem. [Source: Jumper, et al. (2021) / Licensed under CC BY 4.0] [(Check full reference) [LINK](#)]

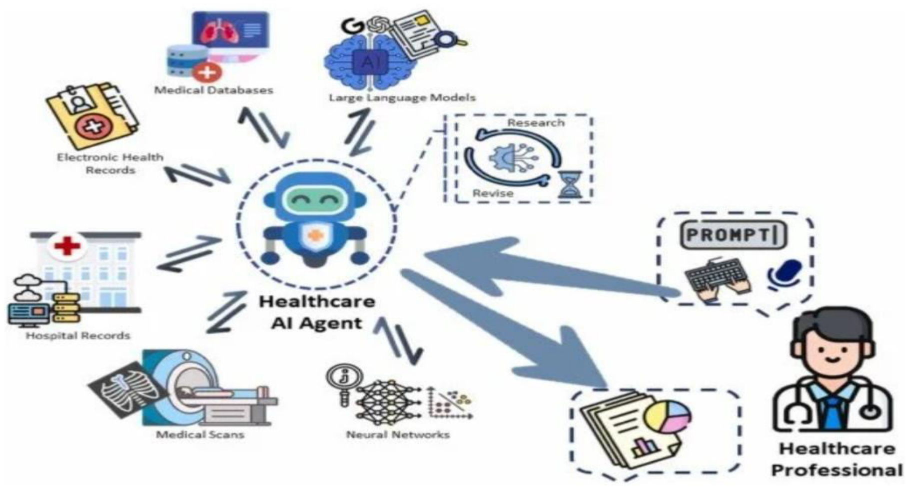


Fig.6: A diagram illustrating a conceptual multi-modal Healthcare AI Agent workflow. [Source: ResearchGate / Licensed under CC BY 4.0] [Link](#)

Perhaps the most groundbreaking development happening right now is the convergence of Large Language Models (LLMs), Agentic AI, and advanced computer vision frameworks like the Segment Anything Model (SAM) in medical imaging. Traditionally, diagnosing complex oncology cases like lung cancer required a radiologist to manually evaluate hundreds of slices from a CT scan. Today, we are seeing the rise of **Agentic workflows,** autonomous AI systems capable of multi-step clinical reasoning.

In practice, a medical vision model utilizing SAM can instantly isolate and segment a lung nodule down to the exact pixel, regardless of its irregular shape. To mathematically measure the accuracy of these AI segmentations, researchers rely on the Dice Similarity Coefficient (DSC), which calculates the exact pixel overlap between the AI's prediction (X) and the actual ground truth of the tumor (Y):

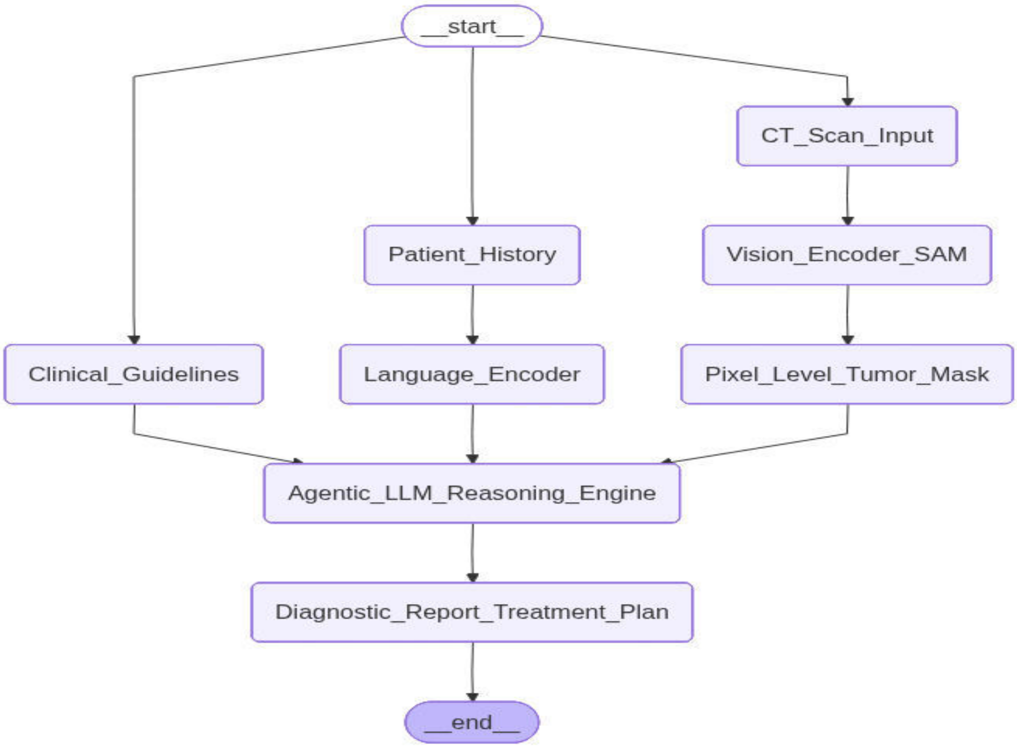
$$DSC = \frac{2|X \cap Y|}{|X| + |Y|}$$

Once isolated, this highly precise visual data is passed directly to a specialized LLM. Utilizing advanced data mining techniques, the LLM acts as a central reasoning engine, cross-referencing the tumor's visual characteristics with millions of historical clinical records.

Simplified Architecture of an Agentic Medical AI

```
builder = StateGraph(MedicalAIState)

builder.add_node("CT_Scan_Input", ct_scan_input)

builder.add_node("Vision_Encoder_SAM", vision_encoder_sam)

builder.add_node("Pixel_Level_Tumor_Mask", pixel_level_tumor_mask)

builder.add_node("Patient_History", patient_history)

builder.add_node("Language_Encoder", language_encoder)

builder.add_node("Clinical_Guidelines", clinical_guidelines)

builder.add_node("Agentic_LLM_Reasoning_Engine", agentic_llm_reasoning_engine)

builder.add_node("Diagnostic_Report_Treatment_Plan", diagnostic_report_treatment_plan)

builder.add_edge(START, "CT_Scan_Input")

builder.add_edge("CT_Scan_Input", "Vision_Encoder_SAM")

builder.add_edge("Vision_Encoder_SAM", "Pixel_Level_Tumor_Mask")

builder.add_edge("Pixel_Level_Tumor_Mask", "Agentic_LLM_Reasoning_Engine")

builder.add_edge(START, "Patient_History")

builder.add_edge("Patient_History", "Language_Encoder")

builder.add_edge("Language_Encoder", "Agentic_LLM_Reasoning_Engine")
```

```
builder.add_edge(START, "Clinical_Guidelines")

builder.add_edge("Clinical_Guidelines", "Agentic_LLM_Reasoning_Engine")

builder.add_edge("Agentic_LLM_Reasoning_Engine",
"Diagnostic_Report_Treatment_Plan")

builder.add_edge("Diagnostic_Report_Treatment_Plan", END)

graph = builder.compile()

print(graph.get_graph().draw_mermaid())
```



Instead of simply highlighting a potential mass on a screen, this combined system generates a comprehensive, evidence-based diagnostic report and suggests personalized treatment pathways.

The Future: AI Meets Quantum Computing

While AlphaFold 3 is a masterpiece of classical AI, quantum computing will take drug discovery to an entirely new dimension. Because traditional computers process information in standard bits (0s and 1s), quantum computers use “qubits,” which can exist in multiple states at once. This allows them to perform complex calculations millions of times faster than our best supercomputers. When you combine this immense processing power with AI (creating “Quantum AI”), the possibilities for healthcare are staggering:

- **Instant Drug Discovery:** Developing a new drug usually takes over a decade of expensive laboratory trials. Quantum AI can simulate how drugs interact with human proteins at the atomic level in a matter of seconds. This will drastically accelerate the creation of cures for complex diseases like Alzheimer's and cancer.
- **Hyper-Personalized Medicine:** Quantum AI will be able to instantly process a patient's entire genetic code, medical history, lifestyle, and environment to create highly personalized treatment plans. Instead of a "one-size-fits-all" approach, medicines will be tailored specifically to your unique biology.

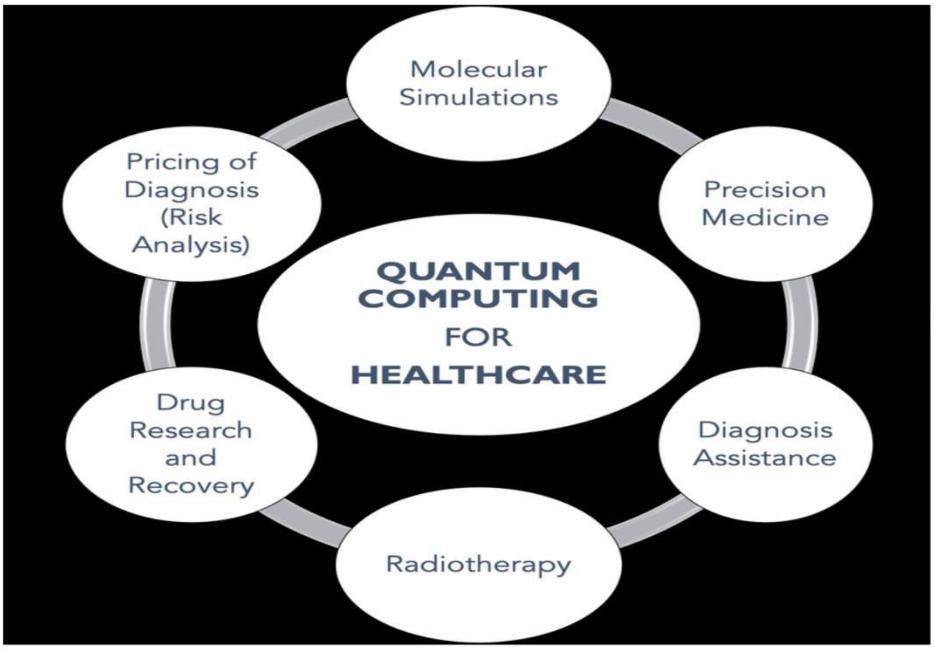


Fig.7: A conceptual diagram of potential applications of quantum computing in healthcare. [Source: ResearchGate / Licensed under CC BY 4.0] Link

The Ethics and Data Privacy Challenges of "Healing AI

As we integrate these immense computational powers into healthcare, we may face unprecedented ethical challenges. Despite its incredible promise, the combination of quantum computing and AI brings severe ethical challenges and security threats that society must address:

- **The Threat to Data Privacy ("Q-Day"):** Quantum computers are so powerful that they could eventually break the encryption methods currently used to protect sensitive global data. In healthcare, this means personal health records could be exposed to cyberattacks unless we urgently transition to "quantum-resilient" security systems.

- **The "Black Box" Problem:** Classical AI is already criticized for being a "black box" meaning it is hard to tell how the machine arrived at its conclusion. Quantum algorithms are even more complex and probabilistic. If a Quantum AI system makes an error that results in an incorrect medical diagnosis, figuring out why it made that error, and who is legally responsible, will be incredibly difficult.
- **Amplifying Bias:** If AI models are trained on biased data, they produce biased results. The massive scale of quantum computing could amplify these biases, potentially leading to unequal healthcare treatments for marginalized communities.
- **Regulatory Gaps:** Current medical laws are struggling to keep up with traditional AI, let alone Quantum AI. Policymakers face the immense challenge of creating global regulations that ensure these powerful systems are safe, transparent, and equitable, without stifling innovation.

Conclusion

From ancient herbs to quantum algorithms, humanity's goal has remained the same: to heal, protect, and extend life. The convergence of Agentic AI workflows, predictive models like AlphaFold, and quantum computing offers the most powerful toolkit we have ever possessed to achieve this goal. However, as we step into this new frontier, we must ensure that our moral frameworks, data privacy laws, and ethical standards evolve just as quickly as our technology. If guided responsibly, the future of healthcare will be more precise, personalized, and equitable than ever before.

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Reflection

Beyond the Numbers: Lessons that continue to shape my journey

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Some journeys end when we return home. Others quietly continue, shaping the way we think, work, and see the world long after they are over. On 4 August 2019, I arrived in Germany to begin my research fellowship at the University Hospital Würzburg under the DAAD Fellowship. I could never have imagined then that, nearly six years later, I would still look back on that day with such gratitude. What began as an exciting opportunity soon became one of the most transformative journeys of my personal and professional life.

When I left Jaipur as a PhD student from the Department of Radiological Physics, SMS Medical College & Hospitals, my goal was straightforward to strengthen my research, learn advanced dosimetry techniques, and complete the experimental part of my PhD. What I did not anticipate was that those few months would reshape not only my research but also my perspective on science, learning, and life.

Although I had previously travelled to Europe for scientific conferences, living and working there as a research student was a completely different experience. Conferences offered brief academic interactions; the fellowship immersed me in a research culture where curiosity, collaboration, and responsibility were part of everyday life. Looking back, I realise it became far more than an academic opportunity—it was an education in science, independence, and personal growth.

Looking Beyond the Numbers

University Hospital Mannheim

Like many young medical physicists, I once believed our profession was mainly about operating sophisticated equipment and understanding advanced technology. The fellowship taught me otherwise.

Working with Prof. Frank Hensley and his team, I learnt that every measurement carries uncertainty and every number represents a physical reality that deserves to be understood rather than simply accepted. Medical physicists are not merely users of technology; they question it, validate it, improve it, and sometimes even help create it.

What impressed me most was the culture of scientific discussion. Ideas were valued not because of who proposed them, but because they were supported by evidence. That environment encouraged me to ask "why" instead of simply following established methods. Rather than relying solely on software outputs, I learnt to understand the physics behind them, think critically, and look for better solutions. It was a shift in mindset that has stayed with me ever since and continues to shape the way I teach my own students today.

Learning Independence

The fellowship taught me science, but perhaps its greatest lesson was independence.

Many of my experiments were carried out late at night in the brachytherapy room located in the hospital basement. Reaching it meant walking through long, silent corridors where motion-sensor lights switched on only as I passed. During my first week, it honestly felt like a scene from a horror movie. Before long, however, those quiet evenings became my favourite time to work. They taught me patience, self-reliance, and a lesson that has stayed with me ever since—confidence grows quietly, one small challenge at a time.

Medical Physics Team at the University Hospital Würzburg, Germany

Another memorable lesson came from Patrick, a postdoctoral physicist, who noticed me spending hours analysing large datasets manually in Excel. Instead of watching me struggle, he wrote a simple Python program that completed the task in minutes. His only request in return was a small cake from a nearby bakery. That simple exchange grew into a lasting friendship and reminded me that good science is not always about working harder it is often about thinking smarter and helping one another.

I was equally inspired by Dr. Sonja Wegener. Her expertise in dosimetry was exceptional, but what impressed me most was her outlook on life. Outside the laboratory, she volunteered with the Würzburg Fire and Rescue Service. Watching her balance scientific excellence with community service challenged many of my own assumptions. She showed me that confidence comes from choosing your own path and staying true to your values a lesson that has influenced me both professionally and personally.

Learning Through Challenges

Living in a new country also meant learning to adapt. The language was unfamiliar, everyday conversations required extra effort, and even the computer keyboards had a different layout.

One incident from my first week still makes me smile. While trying to download a document, I accidentally printed the same file three times on the printer outside the Head of Department's office. I received a gentle but firm reminder about avoiding unnecessary printing and respecting environmental responsibility.

At the time, I instinctively missed the familiarity of home, where students often learn through such mistakes with a little more leniency. Over time, however, I came to appreciate a different perspective. Accountability was not criticism—it was part of a culture that valued responsibility, respected resources, and expected everyone to contribute thoughtfully. It was a simple lesson, but one that stayed with me long after the embarrassment had faded

A Lasting Impact

Nearly six years have passed, yet I still reflect on those months with gratitude. The fellowship gave me far more than technical knowledge—it changed the way I think. I learnt to question before accepting, to analyse before concluding, and to understand the science behind every measurement rather than simply trusting the numbers on a screen. Today, whenever I teach treatment planning, quality assurance, or research methodology, I encourage my students to ask one simple question: **"Why?"** More often than not, meaningful learning begins there.

Just as importantly, I remember the people who made the experience so meaningful. I remain deeply grateful to Prof. Frank Hensley for his guidance and for helping me develop a deeper understanding of dosimetry, detector physics, and their clinical applications—knowledge that became an important foundation of my PhD research.

A memorable moment with the SCMPCR team, mentors, fellow students and medical physics colleagues at the University Hospital Mannheim, Germany.

My heartfelt thanks also go to Prof. Arun Chougule, Prof. Golam Abu Zakaria, Prof. Anupama Azhari, Prof. Otto Sauer, and the entire SCMPCR family. Through their vision and commitment, they have quietly created opportunities that have shaped the careers of many young medical physicists across South Asia. I feel privileged to have been one of those students and hope to carry forward the same spirit of mentorship in my own career.

Looking back, I realise the fellowship was never simply about completing a research project or working in another country. It was about learning to think independently, embracing challenges with confidence, and understanding that being a medical physicist means much more than operating sophisticated technology. We are scientists, problem solvers, and lifelong learners, with a responsibility to question, improve, and continually advance our field.

Today, when I stand beside my own students in the laboratory or encourage them to question a result instead of simply accepting it, I often realise that I am passing on lessons that were once shared with me. In many ways, that fellowship never truly ended—it continues through every student I teach and every opportunity I have to mentor the next generation.

My hope is that more young medical physicists will embrace opportunities that challenge them to step beyond their comfort zones. The true value of such experiences is measured not only by the experiments completed or the papers published, but by the confidence they build, the friendships they create, and the perspective they leave behind.

Some journeys last only a few months. Their lessons can last a lifetime.

SCMPCR Newsletter

Scientific Article

Deep Learning Approaches for Lung Cancer Classification Using Computed Tomography: A Comparative Review

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Abstract

Lung cancer remains one of the leading causes of cancer-related mortality worldwide. Early and accurate diagnosis is critical for improving patient outcomes. Computed Tomography (CT) has become a primary imaging modality for lung cancer screening. In recent years, deep learning methods have shown strong potential for automated lung cancer detection and classification. This review examines recent advances in deep learning-based approaches for lung cancer classification using CT imaging. We focus on convolutional neural networks, vision transformer models, and hybrid architectures that combine both approaches. The strengths and limitations of each approach are discussed based on reported performance metrics and methodological design. This review aims to provide a structured overview for researchers and clinicians seeking to understand current trends and challenges in AI driven lung cancer diagnosis.

Keywords

Lung cancer, computed tomography, deep learning, convolutional neural networks, vision transformers, medical image analysis

1. Introduction

Lung cancer is one of the most common cancers. It is also one of the deadliest worldwide. The American Cancer Society reports about 1.8 million lung cancer deaths each year. Lung cancer remains the leading cause of cancer related death globally (Siegel et al., 2024). Early detection improves survival. Many cases are still found late as early disease often has no symptoms. CT has become the primary imaging modality for lung cancer screening and diagnosis due to its high spatial resolution and sensitivity. Large scale screening programs, such as the National Lung Screening Trial, have demonstrated that low-dose CT can significantly reduce lung cancer mortality (Aberle et al., 2011). However, manual interpretation of CT scans is time consuming and subject to interobserver variability.

Artificial intelligence (AI), particularly deep learning, has emerged as a powerful tool to assist radiologists in interpreting medical images. Deep learning models can automatically learn discriminative features from large volumes of imaging data. It helps in accurate classification and detection of lung abnormalities. Over the past decade several deep learning architectures have been proposed for lung cancer analysis, including convolutional neural networks (CNNs), vision transformers (ViTs), and hybrid models.

This review summarizes these approaches. We focus on the method, the reported results, and clinical relevance. The goal is to help clinicians and researchers understand AI for lung cancer diagnosis.

2. Literature Search Strategy

A structured literature search was conducted. The following search query was used:

("lung cancer" OR "lung nodule") AND ("computed tomography" OR "CT") AND ("deep learning" OR "convolutional neural network" OR "vision transformer" OR "hybrid model")

Studies were included if they met the following criteria: Focused on lung cancer or lung nodule classification using CT images, Employed deep learning-based methods, Reported quantitative evaluation metrics and Published in peer-reviewed journals.

Studies focused exclusively on segmentation or non-imaging data were excluded.

3. Deep Learning Approaches for Lung Cancer Classification

3.1 Convolutional Neural Networks

Convolutional neural networks have been widely adopted for lung cancer classification due to their ability to learn hierarchical spatial features. Early studies demonstrated that CNNs could outperform traditional machine learning approaches based on handcrafted features.

Setio et al. (2017) evaluated multiple CNN architectures on the LUNA16 dataset and reported strong performance in distinguishing malignant from benign pulmonary nodules. Similarly, Shen et al. (2017) employed multi-scale CNNs to capture nodules of varying sizes, achieving improved classification accuracy. Ardila et al. (2019) further demonstrated that deep CNNs trained on large-scale CT datasets could achieve performance comparable to expert radiologists. However, CNNs may struggle to capture information in complex anatomical structures.

3.2 Vision Transformer Models

Vision transformers use self-attention to learn patterns across the entire image. Unlike CNNs, transformers process images as sequences of patches. Dosovitskiy et al. (2021) introduced the Vision Transformer, which demonstrated competitive performance with convolutional models when trained on large datasets. Later studies applied transformers to lung CT and reported improved classification performance (Tang et al., 2022). However, transformer-based models often require large annotated datasets and substantial computational resources, which can limit their applicability in clinical settings.

3.3 Hybrid CNN Transformer Models

Hybrid models use CNN layers for feature extraction and transformer blocks to combine information across the image. These models aim to overcome the limitations of purely convolutional or transformer-based approaches. Recent studies have shown that hybrid architectures outperform standalone CNNs and transformers in lung cancer classification tasks. Li et al. (2023) demonstrated that hybrid CNN transformer networks achieved higher accuracy and better generalization across multiple datasets, suggesting their suitability for complex medical imaging tasks.

Table 1. Comprehensive summary of various studies focused on lung classification

Reference	Model Type	Dataset	Task	Performance
Setio et al., 2017	CNN	LUNA16	Nodule classification	AUC = 0.89
Shen et al., 2017	CNN	LIDC-IDRI	Nodule classification	Accuracy = 85–87%
Ardila et al., 2019	CNN	NLST CT	Lung cancer screening	AUC = 0.94
Dosovitskiy et al., 2021	Vision Transformer	ImageNet (transfer)	Image classification	Competitive accuracy
Tang et al., 2022	Transformer	Lung CT	Cancer classification	AUC = 0.92
Li et al., 2023	Hybrid CNN Transformer	Multicenter CT	Lung cancer classification	AUC = 0.94

4. Discussion and Conclusion

The reviewed studies demonstrate that deep learning has significantly advanced lung cancer classification from CT imaging. CNN based models remain strong performers, particularly when training data are limited. Vision transformers offer improved modeling but require larger datasets and computational resources. Hybrid approaches combine the strengths of both architectures and often achieve superior performance. Despite these advances challenges remain. Model generalizability across institutions, data heterogeneity, and limited explainability continue to hinder clinical adoption. Deep learning has transformed lung cancer image analysis by enabling accurate and automated classification from CT scans. While convolutional neural networks remain a strong foundation, transformer-based and hybrid architectures offer promising improvements. Continued research focusing on interpretability, robustness, and clinical validation will be essential for translating these methods into routine clinical practice. Future work should improve robustness across populations and validate models in prospective clinical studies.

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SCMPCR Newsletter

Scientific Article

A Study on Anatomical Changes during Intensity Modulated Radiotherapy for Head and Neck Cancer

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Abstract- The anatomy of a patient's tumor can change significantly during the course of radiotherapy. This study aims to evaluate the impact of anatomical changes on pre-treatment planning during intensity modulated radiotherapy (IMRT) for head and neck cancer. A total of 60 head and neck cancer patients treated with weekly cone beam-computed tomography (CBCT) **g**uidance were included in the study. Digimizer^{TM} software was used for image processing to assess anatomical deviations at the C1 and C5 vertebral levels. CBCT images from the first day, mid-day, and the last day were analyzed. The highest mean slice surface area deviations were 4.8% at the C1 level and 10.1% at the C5 level. The mean highest lateral neck diameter deviations were 4.7% at the C1 level and 7.8% at the C5 level. Significant deviations in both parameters suggest the need for adaptive radiotherapy planning in IMRT to address progressive anatomical changes, ensuring optimal therapeutic outcomes.

Keywords- Cone beam computed tomography, Head and neck cancer, Intensity modulated radiotherapy, Linear accelerator

INTRODUCTION

Squamous cell carcinoma of the head and neck is the seventh most common cancer globally[1]. It accounts for approximately 660,000 cases and more than 325,000 deaths worldwide each year[2]. Lip-oral cavity cancer is one of the most common cancers among males in Sri Lanka[3]. IMRT is the most common type of external beam radiotherapy used for head and neck cancer. Both IMRT and three-dimensional conformal radiotherapy (3D-CRT) are widely practiced in head and neck cancer treatment in Sri Lanka[4].

The IMRT treatment plan is typically developed based on a single computed tomography (CT) scan obtained one or more weeks before treatment. Radiotherapy doses are calculated using this scan, and treatment plans are rarely amended during treatment due to the increased workload caused by a growing number of cancer patients[5]. However, the shape and position of target volumes and organs-at-risk (OARs) can change between radiation treatment planning and delivery, as well as throughout the radiotherapy course. These changes, often caused by weight loss or tumor shrinkage, may result in subtle or significant alterations in the size, shape, and location of the tumor and OARs, potentially affecting the accuracy of radiation dosimetry.

This conventional approach, based on a single planning CT dataset, does not account for anatomical changes or variations in patient positioning during the typical 5-7 weeks of treatment. As a result, even highly conformal IMRT plans may lead to unexpected complications or marginal geographic misses of the target volumes. To mitigate these effects, safety margins are traditionally applied around the clinical target volume to ensure adequate coverage. However, this also exposes surrounding healthy tissue to high radiation doses, increasing the risk of unacceptable side effects.

In IMRT, radiation doses must be delivered precisely to the target volume while ensuring that doses to OARs do not exceed their tolerance levels. Accurate patient positioning is crucial and should replicate the setup during the CT simulation procedure. Verification of patient anatomy is achieved using electronic portal imaging or cone-beam CT (CBCT) before treatment. CBCT images or radiographs can be compared with digitally reconstructed radiographs (DRRs) generated from the treatment planning system[7]. The imaging dose from kV radiographs and kV-CBCT scans is substantially lower than that from conventional MV portal imaging. Using kV imaging improves image quality and reduces patient radiation exposure compared to MV imaging.

Image guided radiotherapy (IGRT) involves acquiring images of the patient's anatomy in the treatment room, comparing the tumor's position during treatment with the planned position, and correcting for deviations. While IGRT is widely used in clinical practice, it assumes that target shapes and OAR doses remain relatively unchanged. However, anatomical changes such as weight loss, posture variations, tumor regression, or differential motion between the primary tumor and involved lymph nodes often challenge these assumptions[6].

The primary goal of Adaptive Radiotherapy (ART) is to deliver radiotherapy precisely and account for anatomical changes during treatment. ART employs an imaging feedback loop to quantify these changes and adjust the treatment plan accordingly. Current ART approaches rely on in-room megavoltage CT or CBCT images acquired before daily treatment. The aim of this study is to evaluate planning target volume (PTV) changes in patients undergoing IMRT using daily kV-CT scans acquired before each treatment fraction on a LINAC machine.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted with 60 head and neck patients who completed their IMRT treatment between July 2019 to February 2022 at the Elekta™ Synergy linear accelerator unit, Apeksha Hospital, Maharagama, Sri Lanka. Patients treated with IMRT under kV-CT image guidance, with a minimum prescribed dose of 60 Gy in 30 fractions, and immobilized using a 5-point fixation thermoplastic shell were included in this study. Patients who did not complete their radiotherapy treatment were excluded. The details of the selected patients are shown in Table 1.

Table 1: The details of the selected patients and treatment protocols.

Age (years)	Between 20 to 80	
Gender	Male	49 (81.7%)
	Female	11 (18.3%)
Diagnosis	Oropharynx	36
	Larynx	5

	Oral cavity	6
	Nasopharynx	4
	Hypopharynx	3
	Salivary gland	6
Dose fractionation	70 Gy in 35 fractions	54
	60 Gy in 30 fractions	6
Neck irradiation	Unilateral	14
	Bilateral	46

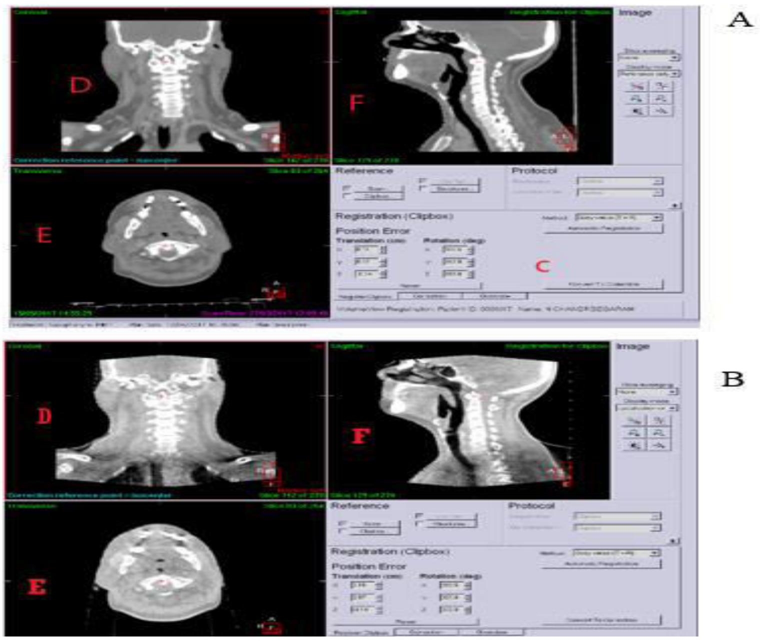


Figure 1: A-Planning CT image generated by treatment planning system. B-CBCT image obtained just prior to the delivery of treatment. C-Automatic registration. D-Coronal plane window. E-Axial plane window. F-Sagittal plane window.

CBCT is an important tool for verifying patient setup in relation to the position of the radiation beam. An isocentrically mounted Elekta iViewGT™ CBCT imaging system was used to acquire volumetric cross-sectional CBCT images. Typically, an X-ray radiation beam with an energy of 120 kVp is used for the acquisition of CBCT images. Visual comparisons between CBCT images and the planning CT images were performed by matching clearly visible soft tissue and bony landmarks in the area of interest. CBCT images acquired during the first fraction, mid fraction, and, last fraction of treatment were selected for this study to compare with planning CT images. All images captured by the Elekta iViewGT™ system are automatically stored for review purposes. These images can be reviewed offline using the MOSAIQ® oncology information system as shown in Figure 1.

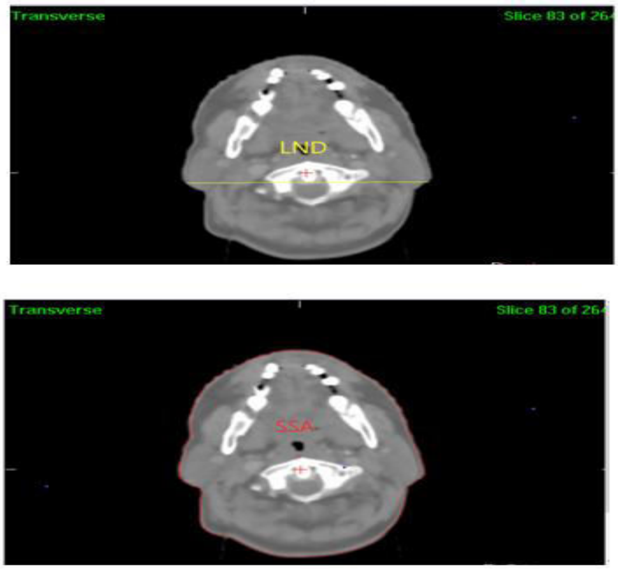
A total of 800 planning and CBCT cross-sectional images were processed using Digimizer™ 5.4 software (MedCalc Software Ltd) as shown in Figure 2. Relevant planning CT images (used as reference CT images) were compared with CBCT images from the first fraction of treatment, the mid fraction of treatment, and the last fraction of the treatment. To evaluate anatomical deviations during fractionated radiotherapy, axial plane cross-sectional planning

CT and CBCT slices at specific anatomical vertebral levels namely, the first cervical vertebra (C1) and the fifth cervical vertebra (C5) were selected for comparison of the surface slice area (SSA) and lateral neck diameter (LND) (Table 2). The following formula was used to calculate the percentage deviation of LND and SSA at the levels of C1 and C5.

$$percentage\ deviation(\%) = \frac{planning\ CT(SSA\ or\ LND) - CBCT(SSA\ or\ LND}{planning\ CT\ (SSA\ or\ LND)} \times 100\%$$

All data were analyzed using the software of Statistical Package for the social Sciences (SPSS) version 26.

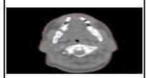
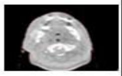
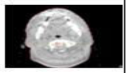
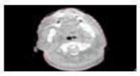
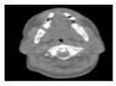
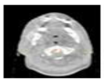
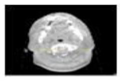
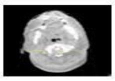
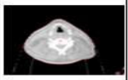
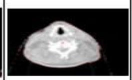
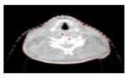
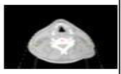
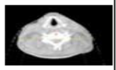
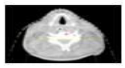
A



B

Figure 2: Analyzed images from DigimizerTM 5.4 software. A- LND measurement (distance measurement). B-SSA measurement (auto contour tool).

Table 2: Anatomical deviations explains SSA and LND at C1 and C5 levels.

	Planning CT	1st fraction of treatment	Mid fraction of Treatment	Last fraction of Treatment
C1 (SSA)				
C1 (LND)				
C5 (SSA)				
C5 (LND)				

RESULTS

Figure 3 shows the mean SSA percentage deviation at the C1 and C5 levels, while Figure 4 presents the mean LND percentage deviation at the same level. At the C1 level, the maximum and minimum anatomical deviation percentages of SSA between the planning CT and the first day of CBCT are 12.4% and 0.1%, respectively. For the mid-day of CBCT, the maximum and minimum deviations are 14.1% and 0.4%, respectively, and for the last day of CBCT, they are 17.5% and 0.1% respectively. Similarly, for LND at the C1 level, the maximum and minimum deviations between the planning CT and the first day of CBCT are 13.0% and 0%, respectively; for the mid-day of CBCT, they are 23.3% and 1%, respectively; and for the last day of CBCT, they are 23% and 0.1%, respectively.

At the C5 level, the maximum and minimum anatomical deviation percentages of SSA between the planning CT and the first day of CBCT are 21.2% and 0.1%, respectively. For the mid-day of CBCT, the maximum and minimum deviations are 28.4% and 0.1%, respectively, and for the last day of CBCT, they are 30.1% and 0.7%, respectively. For LND at the C5 level, the maximum and minimum deviations between the planning CT and the first day of CBCT are 15.7% and 0.2%, respectively; for the mid-day of CBCT, they are 20.2% and 0%, respectively; and for the last day of CBCT, they are 21.3% and 0%, respectively.

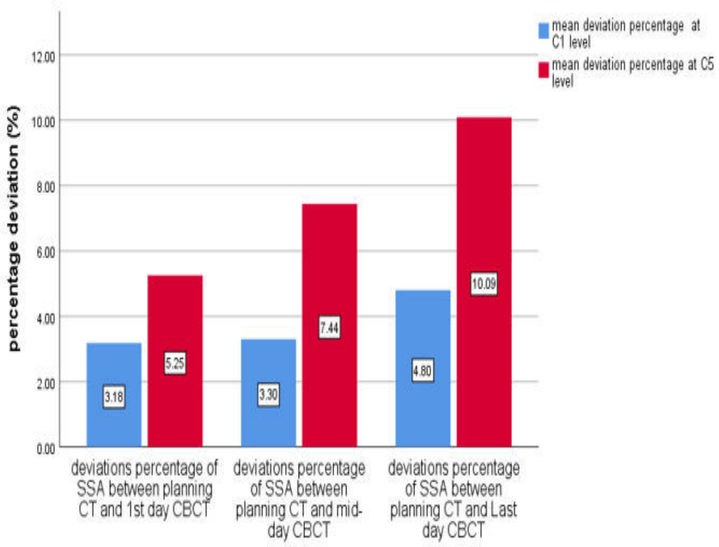


Figure 3: The mean SSA percentage anatomical deviations at C1 and C5 levels.

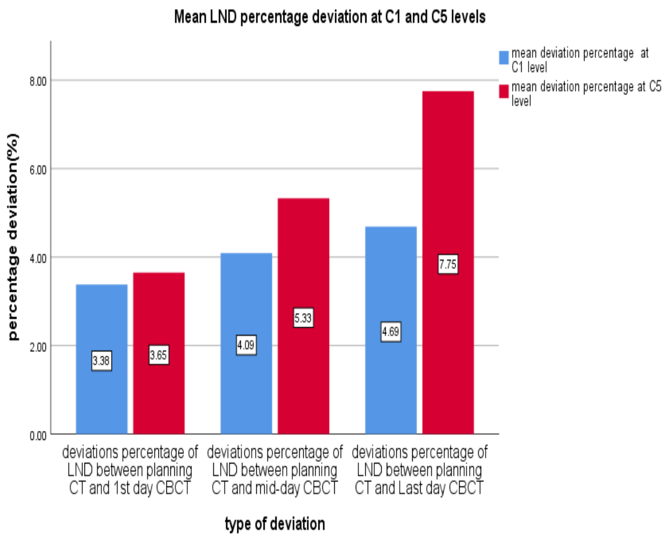


Figure 4: The mean LND percentage anatomical deviations at C1 and C5 levels.

A paired-sample t-test and related samples Wilcoxon signed rank test were performed to evaluate SSA and LND anatomical deviations between the planning CT and the first day, mid-day, and last day of CBCT. The results are presented in Table 3.

Table 3: The summary of comparison tests.

Anatomical Level		A significant difference was observed = ✓ A significant difference was not observed = ×		
		Time		
	Type of deviation	1st day	Mid- day	Last day
C1	LND	×	✓	✓
	SSA	×	×	✓
C5	LND	✓	✓	✓
	SSA	✓	✓	✓

DISCUSSION

The results of this study highlight the progressive anatomical changes that occur during IMRT for head and neck cancer, as evidenced by increasing deviations in SSA and LND at both C1 and C5 levels. These findings align with existing literature on the impact of treatment-related weight loss, tumor shrinkage, and soft tissue changes in this patient population.

The highest deviation for SSA at the C1 level was observed on the last day of CBCT, at 4.8% while the highest deviation for SSA at C5 level was 10.1% on the last day of CBCT. Similarly, the highest deviation for LND at the C1 level was 4.7% on the last day of CBCT, and the highest deviation for LND at the C5 level was 7.8% on the last day of CBCT. At the C1 level, SSA deviations ranged from a minimum of 0.1% to a maximum of 17.5%, while LND deviations reached up to 23% by the last fraction of treatment. These changes are likely attributed to soft tissue and muscle volume reductions in the upper cervical region. Similarly, the C5 level demonstrated even greater deviations, with SSA and LND reaching maxima of 30.1% and 21.3%, respectively. These more pronounced changes may reflect greater anatomical and volumetric alterations in the lower neck due to the cumulative effects of radiotherapy and concurrent weight loss.

According to this study, the findings indicate the necessity for re-planning as the results show significant deviations. However, evaluating changes in the mean value is not the sole factor contributing to the decision for re-planning. For greater accuracy in assessing significant changes, paired sample t-tests and related samples Wilcoxon signed rank tests were conducted separately for the LND and SSA datasets. At the C1 level shown in Table 3, significant differences were observed for LND on the mid-day and last day of CBCT, while significant changes in SSA were observed on the last day of CBCT.

A similar analysis was conducted for LND and SSA at the C5 level. According to the results obtained, significant changes were observed from the first day of CBCT for both LND and SSA data as shown in Table 3. Overall, deviations observed at the C5 level were greater than those at the C1 level.

The results suggest that the highest SSA and LND deviations at both C1 and C5 occurred between the mid-day and last-day treatment fractions compared to the planning CT. These deviations are attributed to shrinkage of the primary tumor and nodal volumes, edema resolution, weight loss, and other treatment-related factors. A previous study (Noble et al., 2019)[8] established re-planning criteria based on a maximum mean C1-SSA deviation percentage of 5.4%, a maximum C1-LND deviation percentage of 8.4%, and dose variations to the spinal cord. In the present study, dose variations could not be evaluated; hence, only anatomical deviations were considered.

Based on the analysis in this study, the significant differences observed between planning CT and CBCT imaging at various treatment fractions emphasize the importance of regular imaging and evaluation during IMRT. Adaptive radiotherapy (ART) has been proposed as a solution to address these anatomical variations. By updating treatment plans to reflect the patient's evolving anatomy. ART has the potential to improve dose accuracy, reduce toxicity to surrounding healthy tissues, and maintain therapeutic efficacy.

The findings reinforce the critical role of CBCT imaging in identifying and quantifying anatomical changes during treatment. Routine incorporation of mid-treatment imaging could serve as a valuable tool for early detection of significant deviations, enabling timely interventions and improved treatment outcomes.

CONCLUSION

This study demonstrates the progressive anatomical changes that occur during IMRT for head and neck cancer. Significant deviations in SSA and LND at C1 and C5 levels underscore the need for adaptive radiotherapy planning to accommodate these changes. Incorporating CBCT imaging throughout treatment allows for precise monitoring and facilitates timely modifications to treatment plans. Future studies should explore the integration of ART in clinical practice and its impact on treatment outcomes and patient quality of life.

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Clinical Implications of Beam Divergence and Field Matching in Multi-Field Radiotherapy: An Update

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Introduction

Modern radiotherapy depends on a simple but demanding clinical promise: deliver the prescribed dose to the target while minimizing unnecessary dose to surrounding normal tissues. In daily practice, this promise is shaped not only by advanced imaging, contouring, optimization algorithms, and dose-volume objectives, but also by basic geometric principles. One of the most important of these principles is beam divergence. Every external photon beam diverges from its source, and when multiple fields are used, the geometry of field edges, junctions, match lines, and collimator settings can strongly influence whether the target is fully covered or whether hot and cold spots are created at field borders [1] emphasized that failure to account for beam divergence can lead to inappropriate field design and compromised target coverage. This message remains highly relevant in the era of three-dimensional conformal radiotherapy, intensity-modulated radiation therapy (IMRT), volumetric-modulated arc therapy, and complex multi-isocenter or split-field approaches. Multi-field radiotherapy is essential in many anatomical sites, including breast and supraclavicular irradiation, head and neck cancer, large-volume IMRT, and craniospinal irradiation. These treatments often require field matching or field splitting because a single beam arrangement may not adequately cover long or complex target volumes while respecting organ-at-risk constraints. However, field matching introduces a delicate balance: a small overlap may increase dose at the junction, while a small gap may underdose part of the clinical target volume or planning target volume. Therefore, treatment planning must integrate geometric accuracy, dosimetric evaluation, image guidance, quality assurance, and careful physics review according to ICRU reporting requirements & TG 275 recommendation [8, 9].

Beam divergence and its clinical consequences

Beam divergence occurs because radiation fluence spreads outward as it travels from the source to the patient. Although the concept is fundamental, its clinical consequences may be underestimated during treatment planning. When a planner defines a field edge on the patient surface or at a given depth, the beam continues to diverge beyond that point. As a result, two adjacent beams that appear aligned on a simulation image may overlap or separate at depth depending on gantry angle, collimator angle, couch angle, source-to-surface distance, and field size [1] described this issue as a practical cause of target miss, particularly when field borders are placed near regions of microscopic disease or when multiple fields are matched without adequate attention to divergence. The problem becomes more clinically important when field borders lie within or close to target tissue. If a field junction produces a cold spot, the underdosed region may become a site of recurrence, especially in tumors with high microscopic extension risk. Conversely, a hot spot at a junction may increase the risk of acute toxicity, fibrosis, spinal cord injury, brachial plexopathy, dermatitis, or other late effects depending on the treated site. Thus, beam divergence is not simply a geometric inconvenience; it is a patient safety issue. A robust treatment plan should evaluate target coverage not only in a single axial slice or beam's-eye view, but throughout the full three-dimensional dose distribution, including field junctions and dose gradients [1, 8].

Field matching in multi-field treatment planning

Field matching is used when separate fields must meet at a planned junction. The goal is to obtain a clinically acceptable dose transition between fields while avoiding excessive overlap or separation. [2] presented an analytical approach to geometrical field matching and applied it to clinical situations such as craniospinal irradiation and breast irradiation with supraclavicular fields. Their work highlights a key principle: matching is not guesswork. It is a mathematically definable process involving beam angles, field dimensions, divergence, and patient geometry. Traditional field matching methods include half-beam blocking, asymmetric jaws, collimator rotation, couch rotation, skin-gap calculation, and mono-isocentric techniques. Each method attempts to control the location and orientation of beam edges so that adjacent fields meet predictably at depth. However, each method also has limitations. Skin-gap methods may be sensitive to patient thickness and setup reproducibility. Couch and collimator rotations may be technically demanding. Split-field approaches may create match-line uncertainty. Mono-isocentric techniques simplify some junction problems but require accurate mechanical alignment and jaw positioning. Therefore, the best technique is not universal; it depends on target length, anatomical site, machine capability, immobilization, image guidance, and departmental workflow [2, 4].

Target coverage: the first responsibility of planning

The primary purpose of radiotherapy is tumor control, and tumor control requires adequate target coverage. ICRU Report 83 provides a standardized framework for prescribing, recording, and reporting IMRT, emphasizing clear definitions of target volumes, dose-volume reporting, and plan evaluation [8]. In the context of beam divergence and field matching, target coverage must be assessed with special attention to the planning target volume near junctions. A plan that meets global dose-volume histogram goals may still have a clinically meaningful cold spot if the junction region is not carefully reviewed slice by slice. This issue is especially relevant in long targets or targets treated with split fields. In head and neck radiotherapy, for example, the target may extend from the primary tumor and upper neck to the lower neck and supraclavicular region. If the upper IMRT field is matched to a lower anterior neck field, the junction may lie near nodal regions at risk [4] reviewed the mono-isocentric split-field technique for conventional and IMRT head and neck treatments and noted that match-line homogeneity can be affected by mechanical and setup uncertainties. Similarly, [5] compared split-field and whole-field IMRT techniques in head and neck cancer and showed that both approaches can produce acceptable plans, but each has different advantages and trade-offs for target coverage and normal tissue dose.

Normal tissue sparing and junction-dose management

Normal tissue sparing is the second half of the radiotherapy equation. Multi-field arrangements are often chosen because they improve the ability to shape dose away from organs at risk. However, when fields are matched, the normal tissue near the junction may receive unintended high dose if field overlap occurs. The clinical significance depends on the site. In breast and supraclavicular radiotherapy, the junction between tangential breast fields and supraclavicular fields may influence dose to the lung, heart, brachial plexus, and skin. [3] dosimetry study and field matching for breast and supraclavicular fossa irradiation, reinforcing that careful matching is necessary to achieve acceptable dose distribution across the target and adjacent normal tissues. In head and neck treatment, normal tissue sparing involves multiple critical structures, including spinal cord, brainstem, parotid glands, larynx, oral cavity, mandible, and swallowing structures [5] found that whole-field IMRT may reduce uncertainty at the match line, while half-beam or split-field approaches may reduce laryngeal dose in selected cases. This illustrates a practical planning truth: eliminating a junction may improve geometric robustness, but it may also change the dose distribution to organs at risk. Therefore, treatment technique should not be selected only to simplify planning. It should be selected after comparing target coverage, junction robustness, organ-at-risk dose, treatment delivery efficiency, and patient-specific anatomy [5, 6].

Breast and supraclavicular radiotherapy

Breast radiotherapy with supraclavicular nodal treatment is a classic example of field matching. Tangential breast fields are often matched to an anterior supraclavicular field. The planner must consider divergence from the tangential fields and from the supraclavicular field so that the superior border of the tangents and the inferior border of the supraclavicular field do not create a significant gap or overlap. This junction is clinically important because it may cross regions of nodal drainage and nearby normal tissues [3]. Specifically, addressed dosimetry and field matching in this setting, showing the importance of matching technique in achieving clinically acceptable treatment. The practical lesson is clear: breast and supraclavicular planning should not be treated as a routine “set and forget” process. The field junction should be reviewed in three dimensions, and dose homogeneity should be evaluated across the match region. If deep inspiration breathes hold, field-in-field tangents, IMRT, or VMAT are used, the planner should still verify how the nodal and breast targets join dosimetrically. Modern planning tools can improve conformity, but they do not remove the need for geometric understanding [2, 3].

Large IMRT target volumes and fixed-jaw solutions

Large IMRT target volumes introduce another planning challenge. Some treatment planning systems split large fields, which can increase the number of multileaf collimator segments, monitor units, treatment time, and match-line dose uncertainty. [6] Split-field and fixed-jaw techniques for large head and neck IMRT target volumes, reported that target and organ-at-risk dose-volume coverage could be similar between techniques, but the fixed-jaw technique reduced issues associated with match lines and improved delivery efficiency. The clinical implication is important for departments treating extended head and neck volumes or other large targets. If two plans appear equivalent by standard DVH metrics, the planner and physicist should also examine deliverability, monitor units, segment complexity, treatment time, and junction robustness. A plan with slightly simpler geometry may be safer and more efficient if it maintains target coverage and normal tissue constraints. This is consistent with the broader philosophy of treatment planning: plan quality is not only about numerical optimization; it is also about reproducibility, quality assurance, and safe delivery [6].

Craniospinal irradiation and feathering

Craniospinal irradiation is one of the most demanding examples of multi-field radiotherapy because the target extends from the brain through the entire spinal canal. Traditional craniospinal techniques require matching cranial and spinal fields and, in many adult patients, matching two spinal fields. Because junction errors can produce high or low dose near the spinal cord, field matching and feathering are central to safe delivery. Feathering intentionally shifts the junction during treatment so that any junction-dose inhomogeneity is spread over a larger region rather than concentrated at a single anatomical level & integrated feathering for craniospinal irradiation as a method to improve patient safety and departmental efficiency [7]. Their work reflects a modern planning priority: technical solutions should not only improve dosimetry but also reduce workflow complexity and opportunities for error. In conventional feathering, multiple plans or shifts may be required, increasing workload for dosimetrists, physicists, physicians, and therapists. Integrated feathering can simplify this process by incorporating junction management into the planning structure, thereby improving consistency and reducing the burden of repeated setup or plan transitions [2, 7].

The role of physicist review and quality assurance

Beam divergence and field matching are vulnerable to small errors, physicist plan review is essential. AAPM TG-275 provides risk-informed recommendations for effective physics plan and chart review and emphasizes that review is a key safety barrier in radiation therapy [9]. For multi-field plans, the physicist review should include a specific check of field borders, match lines, jaw settings, collimator and couch angles, isocenter placement, dose calculation grid, heterogeneity correction, image guidance instructions, and consistency between the approved plan and treatment delivery parameters. A good review should ask practical questions. Does the field junction lie inside or near the target? Is the junction dose acceptable on axial, sagittal, and coronal views? Are hot and cold spots clinically acceptable? Are the jaws or MLCs used in a way that could create delivery uncertainty? Are couch or collimator rotations documented clearly? Is imaging guidance adequate to verify the anatomy near the junction? Are therapists given clear setup instructions? These checks are not administrative details; they are direct safeguards against target miss and normal tissue overdose [8, 9].

Practical recommendations for treatment planning teams

For clinical practice, the first recommendation is to respect geometry. Even in highly automated planning systems, planners should understand where beams diverge, where fields meet, and how dose behaves at depth then field junctions should be evaluated with both geometric and dosimetric tools. A visually neat beam arrangement is not enough; dose distribution across the match region must be reviewed, the team should compare alternative techniques when possible. For example, in head and neck cases, split-field and whole-field approaches may each be reasonable depending on target extent and organ-at-risk priorities. In large IMRT volumes, fixed-jaw techniques may reduce match-line and delivery complexity. In craniospinal irradiation, integrated feathering may improve safety and workflow efficiency [2, 5, 7] every department should standardize their field-matching protocols. Standardization does not mean every patient receives the same plan; it means that beam matching, junction review, documentation, and quality assurance follow a consistent process. Treatment planners, physicists, physicians, and therapists should communicate clearly about junction location and setup sensitivity. Many field-matching errors are not due to lack of knowledge but due to unclear communication or incomplete review. Finally, every department should treat match-line review as a high-risk planning step, especially in breast-supraclavicular, head and neck, and craniospinal cases [3, 9].

Modern Concept

Modern techniques like integrated feathering in a single IMRT/VMAT plan, coplanar field border (CFB) techniques and half-beam block optimizations have significantly minimized hot and cold spots at junctions compared to the convention manual shifting techniques. Advanced image-guided radiotherapy (IGRT) with daily CBCT or MRI-linac verification, as well as robust optimisation algorithms, further reduce setup uncertainties which increase divergence-related mismatches.

Future work work will involve using artificial intelligence for automated junction optimization, real time adaptive planning and prediction of penumbra and scatter effects in order to increase precision and efficiency in complex multi-field deliveries.[10]

Conclusion

Beam divergence is one of the oldest concepts in external beam radiotherapy; it remains one of the most clinically relevant. Multi-field radiotherapy allows complex target coverage and normal tissue sparing, but it also introduces field-matching challenges that can affect patient safety. The literature reviewed here shows that careful geometric planning, robust dosimetric evaluation, appropriate technique selection, and structured physics review are all necessary reminded the field that ignoring beam divergence can compromise target coverage. Later work on geometrical matching, breast and supraclavicular planning, head and neck split-field methods, large-volume IMRT, integrated feathering, ICRU reporting standards, and AAPM TG-275 review guidance extends that lesson into modern practice for the medical physics community, the message is practical and enduring: good treatment planning is not only about advanced technology. It is about understanding how radiation beams behave, anticipating where errors may occur, and designing plans that are accurate, deliverable, and safe. In every multi-field plan, target coverage and normal tissue sparing meet at the field junction. That junction deserves our full attention.

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Cancer genomics, biomarkers and precision radiation oncology: Radiobiology focused perspective for Medical Physicists

Prof. Arun Chougule
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Introduction: transition from physical dose to biological dose

Cancer incident is increasing so also the management and radiation oncology has evolved as the main modality of cancer treatment. Radiation oncology has traditionally focused on **physical dose prescription, target delineation, and geometric accuracy**. Further the biological foundations of radiotherapy have evolved through more than a century of experimental observations, clinical insights, and technological innovations. Early radiobiological understanding was shaped by the **Bergonié–Tribondeau law (1906)**, which proposed that cellular radiosensitivity is directly related to proliferative capacity, mitotic activity, and degree of differentiation. This principle provided the first biological explanation for differential tumour and normal tissue responses to ionizing radiation and established radiation as a rational modality for cancer treatment. Subsequent clinical experimentation by **Regaud and Coutard** in the early twentieth century demonstrated that **fractionated irradiation** could achieve durable tumour control while sparing late responding normal tissues. Their work introduced the concept that biological response is influenced not only by total dose but also by dose per fraction and overall treatment time, laying the groundwork for modern fractionation schedules. These observations preceded mechanistic understanding but accurately reflected underlying processes of cellular repair, repopulation, and tissue recovery.

The classical four R's of radiobiology - **Repair, Reassortment, Repopulation, and Reoxygenation** have provided the conceptual foundation for fractionated radiotherapy for several decades. While these principles successfully explain many aspects of tumour and normal tissue responses to ionizing radiation, they are increasingly insufficient to capture the biological complexity revealed by modern radiation techniques, molecular oncology, and systems biology. With the advent of high precision radiotherapy, hypofractionation, stereotactic body radiotherapy (SBRT), particle therapy, and biologically guided treatment strategies, a broader radiobiological framework is required. There is need to explore **radiobiology beyond the 4 R's**, emphasizing emerging biological processes that critically influence radiation response. Concepts of **intratumoral heterogeneity**, **cancer stem cell dynamics**, and **microenvironmental regulation**, particularly the roles of hypoxia gradients, immune cell infiltration, and stromal signalling need to be discussed. The limitations of clonogenic survival as the sole endpoint has led to the conceptual expansion of radiobiology to include the **5th, 6th, and 7th R**, reflecting a more comprehensive understanding of radiation response.

The **5th R: Radiosensitivity** emerged from clinical observations of marked interpatient and intratumoral variability in radiation response, even among histologically similar tumours. Advances in genomics and molecular profiling have demonstrated that intrinsic radiosensitivity is governed by DNA damage response capacity, cell cycle regulation, epigenetic states, and metabolic pathways. Recognition of radiosensitivity underscores the importance of biological heterogeneity and provides the **basis for biomarker** driven dose individualization and biologically guided tailor-made radiotherapy.

The **6th R: Reactivation of the Immune Response** has its genesis in the growing evidence that radiation is not merely a local cytotoxic modality but also a potent immune modulator. Radiation induced immunogenic cell death, antigen release, cytokine signalling, and modulation of the tumour microenvironment can stimulate systemic antitumour immunity, occasionally resulting in abscopal effects. This paradigm shift has profound clinical implications, particularly in the era of immunotherapy, where radiotherapy is increasingly used as an immune adjuvant to enhance treatment response.

The **7th R: Remodelling of the Tumour Microenvironment** reflects the recognition that radiation response is critically shaped by dynamic interactions between tumour cells, stromal components, vasculature, hypoxia, and immune infiltrates. Radiation induced vascular normalization, fibroblast activation, extracellular matrix remodelling, and changes in hypoxic niches influence both tumour control and normal tissue toxicity. This 7 th R emphasizes that radiation effects extend beyond tumour clonogen to the entire biological ecosystem of the tumour.

Together, the 5th, 6th, and 7th R's expand radiobiology from a cell centric to a **systems level discipline**, integrating molecular, immunological, and microenvironmental determinants of response. Understanding these principles is essential for the rational design of Hypofractionated regimens, adaptive strategies, and combination therapies. Moving beyond the classical 4 R's enables the transition toward **biology integrated, personalized precision radiotherapy**, with the potential to improve therapeutic ratio and ultimate clinical outcomes.

Recent insights into **DNA damage response signalling**, **epigenetic regulation**, and **metabolic reprogramming** highlight how radiation interacts with cellular pathways beyond simple DNA double strand break repair. The concept of **radiosensitivity as a dynamic and context dependent phenotype** is introduced, influenced by genomic instability, cell plasticity, and treatment induced selection pressures.

The article further addresses how these expanded radiobiological principles can influence **personalized radiotherapy**, including biomarker guided dose prescription, genomically guided, adaptive treatment strategies, and rational combinations with immunotherapy and targeted agents. Moving beyond the 4 R's enables a shift from purely physics driven optimization toward **biology integrated precision radiotherapy**. Over the years our knowledge and understanding regarding radiobiological basis of radiation response and molecular mechanisms of radiation damage which primarily causes DNA double strand breaks (DSBs), single strand breaks, base damage and chromosomal aberrations has shown that the biological outcome of radiotherapy depends on DNA repair capacity, cell cycle phase, oxygenation status and genomic instability. Therefor genomic alterations influence these mechanisms and radiotherapy outcome profoundly. These evidences force us to revisit the classical 4 Rs (Repair, Redistribution, Reoxygenation, Repopulation) with genomic context and expands this concept toward additional Rs: Radiosensitivity, Reactivation of immune response, Intrinsic radiosensitivity genes and microenvironmental regulation. This expanded framework supports biologically adaptive radiotherapy.

Further, cancer is fundamentally a genetic disease caused by accumulated alterations in the genome that disrupt normal cellular growth, differentiation, and apoptosis. Advances in molecular biology and genomics have significantly enhanced our understanding of cancer pathogenesis. The integration of cancer genomics with biomarker discovery has led to precision oncology, where treatment decisions are tailored according to molecular characteristics of tumours rather than only anatomical location. Biomarkers now play a crucial role in diagnosis, prognosis, therapy selection, and monitoring treatment response. Historically, cancer treatment strategies relied largely on western genomic datasets, which may not fully represent patients in this region. Therefore region specific genomic research is therefore essential for precision oncology.

Why cancer genomics matters for the region

- A large and genetically diverse population in this region
- Distinct cancer patterns (oral, cervical, gall bladder, breast etc.)
- Environmental and lifestyle risk factors unique to the region

  Therefore, a nationwide consortium mapping genomic alterations in cancers will help to understand cancer progression and device treatments accordingly.

  India has taken the lead in this region and Bharat Cancer Genome Atlas (BCGA) is developed by IIT Madras in January 2026 and created open access genomic data portals integrating DNA, RNA, protein data and clinical outcome linked datasets. The aim of the initiative is to bridge gaps in genomic data for Indian populations which will help identify biomarkers for early detection and personalized treatment, facilitate precision oncology infrastructure. The key contributors of the project are Tata Memorial Centre, AIIMS, IITs (Madras, Indore, Bombay etc.), Department of Biotechnology (DBT) initiatives and National Cancer Grid. This will boost translational oncology research.

Radiotherapy is not merely the delivery of radiation dose; it is the manipulation of biology across space and time. Embracing radiobiology beyond the classical 4 R's is essential for understanding treatment response in the modern era and for translating biological knowledge into clinically meaningful gains in tumour control while minimizing normal tissue toxicity. Increasing evidence shows that tumour control and normal tissue toxicity are strongly influenced by **tumour genomics, microenvironment, and molecular signalling pathways**. This paradigm shift is moving radiotherapy from:

"Uniform physical dose delivery" → "Biologically individualized dose optimization."

For medical physicists, this means expanding the framework of radiotherapy planning to include Radiogenomics, molecular biomarkers, systems radiobiology and AI driven biological modelling. Ultimately, the goal is **precision radiation oncology**, where radiation dose, fractionation, and combination therapies are tailored according to tumour biology.

Now we will try to understand the genomic determinants of tumour radiosensitivity and how DNA repair gene alterations, mutations in DNA repair genes significantly affect radiation response.

Gene	Biological Role	Radiobiological Implication
BRCA1/2	Homologous recombination	Increased radiosensitivity
ATM/ATR	DNA damage sensing	Altered repair kinetics
TP53	Cell cycle control	Apoptotic response variation
DNA-PKcs	Non-homologous end joining	Repair efficiency

BRCA1 and BRCA2 play central roles in homologous recombination-mediated DNA repair. Their deficiency leads to impaired repair of radiation-induced DNA double-strand breaks, resulting in increased radiosensitivity. This has profound implications for precision radiation oncology, including personalized dose prescription, targeted radio sensitization strategies, and improved therapeutic outcomes. Integration of genomic biomarkers like BRCA status into radiotherapy planning represents a major step toward biologically optimized cancer treatment.

ATM and ATR are master regulators of DNA damage sensing and repair following radiation exposure. Their dysfunction alters DNA repair kinetics, increases radiosensitivity, and influences both tumour control and normal tissue toxicity. Integration of ATM/ATR genomic information into radiation oncology represents a key step toward biologically optimized precision radiotherapy.

TP53 is a critical tumour suppressor gene that maintains genomic stability by regulating **cell cycle checkpoints, DNA repair, apoptosis, and cellular stress responses**. When functioning normally, p53 prevents the proliferation of damaged cells by inducing **cell cycle arrest** for repair or triggering **apoptosis** if the damage is irreparable. However, mutations in TP53 among the most common alterations in human cancers disrupt these protective mechanisms, leading to **genomic instability, tumour progression, and therapeutic resistance**. Understanding TP53 biology enhances individualized cancer management, supports targeted therapeutic development, and improves prognostic stratification, making it a cornerstone of modern precision oncology.

DNA-PKcs has emerging significance as a **predictive biomarker** for radiation sensitivity and treatment outcomes. Understanding DNA-PKcs-mediated NHEJ repair improves insight into radiation response variability and supports the development of individualized radiotherapy strategies, enhancing tumour control while minimizing toxicity in precision oncology.

Medical Physicists by understanding and incorporating these alterations can modify and justify dose escalation, altered fractionation and combining radiosensitizers in the treatment planning the fractionation schedules.

The **Radiosensitivity Index (RSI)** integrates gene expression data to quantify intrinsic radiosensitivity and the **Genomic Adjusted Radiation Dose (GARD)** translates genomic radiosensitivity into biologically effective dose prescriptions. The implications of GARD will help patient specific dose prescription, reduced overtreatment and thereby improved tumour control probability modelling. These tools bridge molecular biology and radiation physics.

In addition to radiosensitivity parameter, tumour microenvironment and radiobiology are also important for ultimate response to radiation and among them hypoxia is the major one. As hypoxic tumours exhibit radioresistance due to reduced oxygen fixation effect, altered metabolism and genomic adaptation. There are biomarkers to quantify hypoxia by understanding HIF-1α expression, CAIX protein levels and hypoxia gene signatures which will help to plan dose painting strategies, use of hypoxia modifying agents and adapting functional imaging integration. Further understanding of immune microenvironment is important as radiation induces immunogenic cell death, antigen release and cytokine modulation. The genomic biomarkers help identify patients likely to benefit from Immunoradiotherapy and combination checkpoint inhibitors and this is another area rapidly evolving radiobiological frontier. Radiogenomics and normal tissue toxicity studies genetic susceptibility to radiation toxicity such as fibrosis, pneumonitis, xerostomia and neurotoxicity and by understanding of these concepts will help clinical medical physicists to individualized dose constraints, personalized treatment planning and NTCP model refinement. The integration of anatomical and functional imaging such as PET-CT imaging, MRI biomarkers and genomic signatures enables spatially heterogeneous dose delivery based on tumour biology and implement **biological target volume (BTV) optimization.** However, there are some challenges such as validation of biomarkers, standardization of genomic assays, integrating biology into treatment planning system (TPS), biological uncertainty quantification, cost of genomic testing, data interpretation complexity. **Medical Physicists** can play a critical role in integrating these data streams and for this medical physicist must collaborate closely with biologists and clinicians. Therefore, emerging research areas for Medical Physicists are Radiogenomics treatment planning systems, AI driven biological optimization, microbiome radiation interaction studies, molecular imaging integration and personalized radiobiological modelling. These areas will define next-generation radiation oncology.

Conclusion

Cancer genomics and biomarker science are fundamentally reshaping radiotherapy from a physics driven discipline toward biologically informed precision radiation oncology. Understanding genomic determinants of radiosensitivity, normal tissue response, tumour microenvironment, and immune interactions allow:

- Personalized dose prescriptions
- Improved therapeutic ratio

- Reduced toxicity
- Enhanced treatment outcomes

Cancer genomics research in India has rapidly evolved through national initiatives such as the Indian Cancer Genome Atlas and Bharat Cancer Genome Atlas, aiming to decode population-specific cancer biology. These efforts are transforming precision oncology by enabling personalized diagnosis, targeted therapies, and improved radiation treatment strategies. Despite challenges in infrastructure and translation to clinical practice, India's growing genomic ecosystem is contributing significantly to global cancer research and holds strong potential for improving cancer outcomes, affordability, and accessibility in diverse populations. Medical physicists will play a central role in translating genomic knowledge into clinically actionable radiotherapy strategies, marking a new era where **biology and physics converge for precision cancer care**.

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Meet the expert

Title: Voice from the frontline of cancer care in South Asia: An Expert Perspective

Prof. Dr. Syed Md. Akram Hussain

Interview with
Prof. Dr. Syed Md. Akram Hussain,
Chairman, Dept of Clinical Oncology, Bangladesh Medical university
Senior Consultant, Square cancer Centre, Square Hospitals LTD

Interview taken by
Dr. Farzana Binta Rahman, FCPS Part II Trainee, Clinical Oncology, Bangladesh Medical University

Dr. Farzana Binta Rahman

Dr. Farzana: What was your inspiration for choosing clinical oncology and motivation to work in this field over 25 years?
Prof. Akram: This field appealed to me because it sits at the intersection of science, technology, and humanity as well. I was inspired by the thought of transforming lives by evidence-based medicine while contributing to progress of a rapidly evolving specialty. I wanted to empower every trainee, cure patients and strengthen the system for the nation, this motivation kept me working

Dr. Farzana: As we all know, you have established several cancer departments across the country, for example, Northeast Medical College, Khaja Younus Ali Medical College, BMU and also worked at NICRH, what was the biggest challenge?
Prof. Akram: Multiple challenges like lack of required expert manpower, limited resources with infrastructure and bureaucratic complexities. Perhaps the greatest challenge was what? transforming ambition into sustainable systems.

Dr. Farzana: Sir, what is your opinion about the relationship between clinical oncology and medical physics evolving in Bangladesh?
Prof. Akram: This is interestingly intertwined. Modern radiotherapy requires technological sophistication, and medical physicists are inseparable partners in ensuring precision, safety, and innovation

Dr. Farzana: What do you think about artificial intelligence in cancer care for low- and middle-income countries like us?
Prof. Akram:

Dr. Farzana: Sir, what advice would you suggest to young oncologists and medical physicists in South Asia?
Prof. Akram: AI has the power to become most useful innovations in the history of cancer care. As we face resource constraints, AI can offer diagnostic accuracy, optimize planning and expand expertise needed. But technology alone cannot be a solution. If we can augment human resources by AI, then we can accelerate the process in LMICS.

Dr. Farzana: What is your vision or goal for cancer care in South Asia over the next years ahead?
Prof. Akram: 1st, pursue knowledge ,2nd cultivate the practice of curiosity, 3rd build a team i.e., multidisciplinary collaboration, 4th contribute to research and finally mindful practice of empathy. Because technical expertise earns professional recognition but compassion, honesty, integrity and service define a true health care professional.

Dr. Farzana: Thank you, sir, for your time
Prof. Akram: May Allah bless you.

Meet the expert

Advancing Radiation Safety, Quality, and Medical Physics Education in South Asia

Dr. Syed Mansoor Naqvi

Interview with
Dr. Syed Mansoor Naqvi
Assistant Professor and Medical Physicist at Aga Khan University, Pakistan.

Interview taken by
Dr. Mary Joan,
Professor & RSO, Christian Medical College and Hospital, Ludhiana, India

Dr. Mary Joan

The South Asia Center for Medical Physics and Cancer Research (SCMPCR) continues its "Chat with Expert" series by highlighting distinguished professionals who have made remarkable contributions to medical physics, radiation protection, quality assurance, and education across South Asia. Through this initiative, the SCMPCR Newsletter seeks to preserve inspiring professional journeys, encourage collaboration, and provide guidance for the next generation of medical physicists.

In this edition, we are honoured to feature Dr. Syed Mansoor Naqvi, an accomplished medical physicist, educator, researcher, and radiation protection expert from Pakistan. Currently serving as Assistant Professor and Medical Physicist at Aga Khan University, Dr. Naqvi has over three decades of experience in teaching, radiation safety, quality assurance, diagnostic imaging, and nuclear medicine.

Dr. Naqvi has played a pioneering role in strengthening radiation protection practices and medical physics training in Pakistan. He established an Optically Stimulated Luminescence (OSL)-based in-house radiation dosimetry laboratory at Aga Khan University and introduced nationally significant training initiatives including “Radiation Protection for Healthcare Professionals” and “LASER Safety for Healthcare Professionals.”

Setup to check X-ray Beam Centring and Collimation

He is also the Founder President of the Pakistan Organization of Medical Physicists and has actively contributed to regional professional development through SCMPCR collaborations and educational activities.

With extensive involvement in quality management, radiation safety committees, academic mentoring, conference organization, and international collaborations, Dr. Naqvi represents the evolving role of the modern medical physicist; bridging clinical practice, education, research, leadership, and patient safety.

In this conversation with Dr. Mary Joan, Dr. Naqvi shares his professional journey, perspectives on medical physics development in South Asia, the importance of quality and radiation safety culture, the future of medical physics education, and his vision for strengthening regional collaboration through SCMPCR.

X-ray Beam Centring and Collimation check images

MJ: We are delighted to feature you in the SCMPCR Newsletter “Chat with Expert” series. Could you kindly share your early journey and what inspired you to pursue medical physics as a career?

SMN: Even though I was fascinated by physics, I was apprehensive about pursuing Medical Physics as a career, but my exposure to biophysics during my university years helped me lean towards this field. I also wanted to do something that directly helped people. I learnt that radiation could be harnessed for diagnosis and treatment of patients, and that physicists were the ones ensuring it was safe and effective. It was the perfect blend of science and service which aligned with my interests.

MJ: You have worked extensively in radiation safety, quality assurance, nuclear medicine, PET-CT, and diagnostic imaging. How has the role of medical physicists evolved over the past three decades?

SMN: It has changed a lot, back in the day, people thought of us mainly as the "machine checkers." Now, we're part of the clinical decision-making, teaching and research teams. We're involved in patient safety, research, and even policy making. In short, we've gone from being the quiet folk in the labs to being recognized as essential partners in patient care, while still being involved with our calculations and machines.

MJ: You established an Optically Stimulated Luminescence (OSL)-based radiation dosimetry laboratory at Aga Khan University. What motivated this initiative, and how has it contributed to radiation safety practices in Pakistan?

Landauer MicroStar OSL reader and Annealer

SMN: The motivation was simple, we needed a in-house reliable and modern way to monitor personnel radiation exposure. While comparing various options like TLDs or film-based dosimetry, OSL emerged as the most convenient solution amongst all. Today, it's helping not only our institute but also many hospitals and other radiation based entities across Pakistan.

MJ: As Founder President of the Pakistan Organization of Medical Physicists (POMP), what were the major challenges faced during the early development of the organization?

SMN: Building awareness, credibility, and unity were our major challenges. Convincing people that medical physics was a profession worth organizing around wasn't easy. Some thought we were just "technicians with fancy titles." but looking back, those struggles gave POMP its strong foundation and enabled us to build a name for our profession.

MJ: You have organized numerous radiation protection and laser safety training programs for healthcare professionals. Why do you think such educational initiatives are important in South Asia?

SMN: Knowledge is power, and in this case, it's also safety and protection. Many healthcare workers don't realize the risks until their training is completed and they gain some experience. These programs are like giving them a safety toolkit before they enter a more practical aspect of their career. Furthermore, they create a ripple effect, trained professionals spread awareness to their colleagues creating a culture of safety.

MJ: Quality assurance and patient safety remain central responsibilities of medical physicists. How can institutions strengthen a culture of quality and radiation safety in clinical practice?

SMN: It starts at the top. Leadership must show that safety isn't optional, it has immense value and not just only a goal. Institutions can strengthen the culture of quality and radiation safety by providing a safe working environment, promoting knowledge of radiation risks and controlling them, minimizing unsafe practices, supporting addressing of incident reports, and sharing responsibility among workers. Regular training, audits, and open discussions help too. I would also like to add that celebrating small wins keeps everyone motivated.

QA Tools for Xray Machines

MJ: You have been actively involved in accreditation activities, ISO quality systems, and Joint Commission-related initiatives. How do these experiences complement the work of medical physicists?

SMN: There was a time when Quality Management Systems (QMS) were considered only for services, businesses and industry but now its importance is realized more widely and even IAEA has issued QMS related guides and regulatory bodies are slowly striving to adopt them. They make sure we don't just *say* we're safe and consistent, we *prove* it. Accreditation forces us to document, standardize, and continuously improve. For physicists, it's like having a checklist that ensures our science translates into real-world patient safety. I would also like to mention that medical physicists can play a vital role in Quality Management Systems(QMS) as they are already trained in quality assurance and documentation. They can easily strive to develop their professional competence and growth in QMS.

MJ: What are the current opportunities and challenges for medical physicists working in South Asia?

SMN: There are many opportunities as new radiation therapy, imaging, nuclear medicine facilities and advanced technologies are emerging. The challenge is coping up with the need of trained professionals. We need more training programs and relevant applicable regulations to fulfill the human resource requirements.

MJ: Artificial intelligence, automation, and advanced imaging technologies are rapidly transforming healthcare. How should young medical physicists prepare themselves for these changes?

SMN: AI has progressively entered in every walk of life. I strongly recommend our young physicists to concentrate on the basics of data handling and numeric computational methods. This will make learning data sciences, and interpreting AI outputs more convenient. Stay curious, stay adaptable, and you'll thrive in today's world.

MJ: You have mentored many students and trainees over the years. What qualities do you believe are essential for young professionals entering medical physics?

SMN: Professionalism, competence and skills are not the only tools one needs to excel; curiosity, patience, kindness and a sense of humor also matter. You'll spend hours troubleshooting machines, so being able to have fun does help. Integrity is non-negotiable, and resilience will carry you through the tough days. And always remember, patient care is at the heart of everything we do.

MJ: Research and regional collaboration are increasingly important in advancing medical physics. How can SCMPCR further strengthen collaborative research and educational activities across South Asia?

SMN: By being the platform that connects us. Joint workshops, shared research projects, and exchange programs for professionals and students can make a huge difference. South Asian Association for Regional Cooperation (SAARC) can also be a forum to Imagine a student in Nepal learning from a lab in Pakistan, or a physicist in Sri Lanka collaborating with colleagues in Pakistan or Bangladesh or India, that's the kind of synergy we need.

MJ: The SCMPCR Newsletter has become an important platform for professional interaction and visibility in the region. How do you view the role of newsletters and scientific communication in strengthening the medical physics community?

SMN: Newsletters are convenient platforms to share our achievements and learn what others around us are doing. They keep us updated, connected, and inspired. These are generally counted as representative of a particular organization or community but their consistency starts to build impact and slowly motivate the contributors to share something more than news or a report, rather, their original scientific publications.

MJ: What future directions do you foresee for radiation protection and quality assurance programs in developing countries?

SMN: I see more digital tools, more affordable technologies, and stronger integration into national health systems. The future is about making safety accessible for all, being practical, not just theoretical.

MJ: In your opinion, what areas should SCMPCR focus on more actively in the coming years?

SMN: SCMPCR has already significantly contributed to medical physics education, training, and advocacy. Particularly in the field of radiation-therapy. I feel that diagnostic radiology, nuclear medicine and radiation protection require attention. Another area of concern is the use of LASER in medicine, as a matter-of-fact, policy making and regulations need to be developed for LASER usage just like radiation protection. This will not only improve the patient and healthcare providers' safety but will also open another professional opportunity.

MJ: Finally, what message or advice would you like to share with young medical physicists across South Asia regarding professional growth, ethics, and patient-centered care?

SMN: Avoid short-cuts. Medical physics is demanding, but it's also deeply rewarding. Stay humble, stay ethical, be professional, keep yourself updated and think big. And remember sometimes the best breakthroughs happen when you're having fun with your work.

MJ: Dr. Naqvi, thank you for sharing your remarkable professional journey, insightful perspectives, and invaluable advice with our readers. Your lifelong commitment to advancing radiation protection, quality assurance, medical physics education, and professional development has been truly inspiring. Your vision for strengthening regional collaboration, nurturing future generations of medical physicists, and fostering a culture of safety and excellence reflects the very mission of the South Asia Centre for Medical Physics and Cancer Research (SCMPCR). We sincerely appreciate your time and willingness to share your experiences with the SCMPCR community. On behalf of the SCMPCR Newsletter Editorial Team, I extend our heartfelt gratitude and wish you continued success in all your future endeavors. We look forward to your continued leadership and contributions toward advancing medical physics across South Asia and beyond.

Bangladesh Medical Physics Society Celebrates International Medical Physics Week 2026 with International Webinar Series

In celebration of **International Medical Physics Week (IMPW) 2026**, the **Bangladesh Medical Physics Society (BMPS)** successfully organized a four-day international webinar series from **20–23 April 2026**. The event brought together distinguished medical physics experts from **China, India, Australia, and Bangladesh**, highlighting recent developments in radiotherapy, professional development, quality assurance, and patient safety.

The webinar series was conducted virtually via **Zoom** and attracted participants from Bangladesh and abroad, including medical physicists, radiation oncologists, radiation therapists, academics, researchers, and students. The initiative reflected BMPS's continued commitment to promoting professional education and international collaboration in medical physics.

The scientific program featured four inspiring lectures:

- **20 April 2026: Prof. Xiance Jin** (First Affiliated Hospital of Wenzhou Medical University, China) delivered an insightful presentation on **"Self-growth of Clinical Medical Physicist and Certification,"** emphasizing professional development, competency building, and the importance of certification in advancing clinical practice.
- **21 April 2026: Dr. K. M. Rafic** (Apollo Speciality Hospitals, India) presented **"Online Adaptive Radiotherapy: Are We There Yet?"**, discussing current

technologies, clinical implementation, challenges, and the future prospects of online adaptive radiotherapy.

- **22 April 2026: Dr. Robin Hill** (University of Sydney, Australia) spoke on **"Self-managed Dosimetry Audits in Radiotherapy Departments,"** highlighting practical approaches for strengthening quality assurance programs and improving treatment safety through independent dosimetry audits.
- **23 April 2026: Dr. Md. Akhtaruzzaman** (Evercare Hospital Chattogram, Bangladesh) concluded the series with an engaging lecture titled **"Enhancing Patient Safety in Radiotherapy through Independent Dose Verification."** The presentation emphasized the growing role of independent dose verification systems in modern radiotherapy, showcasing how advanced verification technologies can improve treatment accuracy, strengthen quality assurance, and enhance patient safety.

Throughout the webinar series, participants actively engaged in discussions and interactive question-and-answer sessions, creating an excellent platform for knowledge exchange and professional networking. The lectures highlighted the rapid evolution of medical physics and reinforced the critical role of medical physicists in ensuring safe, accurate, and high-quality cancer care.

BMPS expresses its sincere appreciation to all distinguished speakers, participants, organizers, and volunteers for making the webinar series a great success. The society remains committed to organizing high-quality educational activities and strengthening international collaboration to advance the medical physics profession in Bangladesh and the Asia-Pacific region.

SRS Essentials: A Free International Lecture Series Advancing Stereotactic Radiosurgery Education Across Underserved Regions

In June 2026, SRS/SABR Essentials was delivered as a free three-part international online lecture series focused on linac based stereotactic radiosurgery. The course was conducted through Microsoft Teams and was designed for the wider radiation oncology team, including medical physicists, radiation oncologists, dosimetrists, radiation therapists, clinical scientists, and trainees. The series aimed to support advanced radiotherapy education across underserved regions by connecting practical clinical experience with international standards in SRS commissioning and quality assurance.

The lecture series was presented by Rahim Gohar, Medical Physics Specialist at GenesisCare, Queensland, Australia, and organized in collaboration with The Aga Khan Hospital, Dar Es Salaam, Tanzania, with K M Masud Rana serving as host and coordinator for Africa.

Lecture 1: Foundations of Stereotactic Radiosurgery introduced the clinical and radiobiological basis of SRS. It covered the historical development of radiosurgery, major clinical indications, the linear-quadratic model, BED/EQD2 concepts, and comparisons between Gamma Knife, CyberKnife, and linac-based SRS platforms. The session also highlighted staffing, equipment needs, small-field dosimetry, and commissioning requirements for a safe SRS program.

Lecture 2: Hitting the Mark focused on geometric accuracy, which is essential for safe SRS delivery. Topics included radiation isocenter accuracy, the Winston-Lutz test, gantry sag, image-guidance calibration, kV–MV alignment, and the dosimetric consequences of isocenter errors. This lecture emphasized how sub-millimeter precision directly affects treatment accuracy and patient safety.

Lecture 3: Navigating Precision Medicine: An SRS Journey presented a real-world experience of establishing a clinical SRS program. The lecture discussed machine acceptance, beam commissioning, ExacTrac Dynamic commissioning, small-field dosimetry, MapCHECK and EBT3 film validation, end-to-end testing, external audit, clinical workflow challenges, and lessons learned from two years of clinical SRS implementation.

Overall, SRS Essentials served as a valuable professional development initiative by making high-level SRS physics and clinical implementation knowledge freely accessible to colleagues across different regions. The series reinforced an important message: safe expansion of advanced radiotherapy requires not only modern technology, but also structured training, practical expertise, and international knowledge-sharing.

Dr. Atul Mishra Receives Second Prize Among Faculty of Medicine at Research Showcase–2025

The South Asia Centre for Medical Physics and Cancer Research (SCMPCR) is pleased to congratulate Dr. Atul Mishra, Associate Professor (Medical Physics), Department of Radiation Oncology, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, India, and Member, Education and Training Committee (ETC), Asia-Oceania Federation of Organizations for Medical Physics (AFOMP), on receiving the Second Prize among the Faculty of Medicine (Clinical Category) at Research Showcase–2025, organized by UPUMS on 4 December 2025.

Dr. Mishra received the award for his research entitled, "Evaluation of Tumor Control Probability and Normal Tissue Complication Probability in IMRT and VMAT: A Comparative Study for Assessing the Efficacy of Radiotherapy Plans in Tumors of the Thorax." The study demonstrates the clinical value of advanced radiotherapy planning techniques in improving tumor control while reducing radiation-induced complications in normal tissues, thereby contributing to safer and more effective cancer treatment.

This prestigious recognition highlights Dr. Mishra's continued contributions to medical physics, radiation oncology, and radiotherapy research. His achievement reflects a strong commitment to scientific excellence, innovation, and professional development, while further strengthening the visibility of the medical physics community in the Asia-Oceania region.

The South Asia Centre for Medical Physics and Cancer Research (SCMPCR) extends its heartfelt congratulations to Dr. Mishra and wishes him continued success in his future academic, clinical, and research endeavors.


BMPS
ACBMPS-2026
13th ANNUAL CONFERENCE OF BANGLADESH MEDICAL PHYSICS SOCIETY (BMPS)
"Safe Radiation, Stronger Nation"
4 DECEMBER 2026
Krishibid Institution Bangladesh
Dhaka, Bangladesh
CONFERENCE HIGHLIGHTS
Radiotherapy
Diagnostic Imaging
Nuclear Medicine
Radiation Protection
Cancer Biology
Medical Physics Education and Professional Development
SAVE THE DATE
Abstract Submission
15 SEPTEMBER 2026
Early Bird Registration Deadline
15 SEPTEMBER 2026
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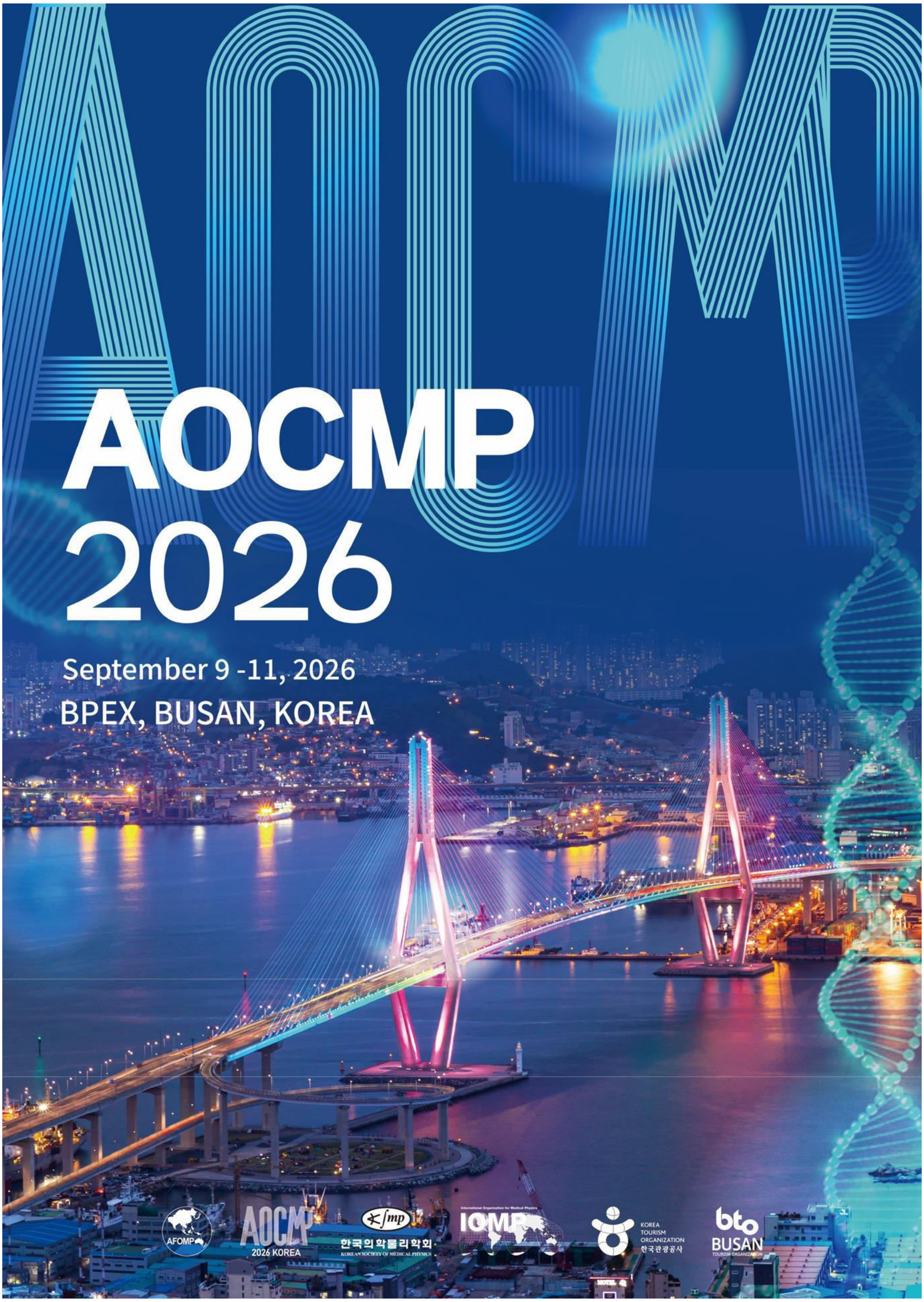
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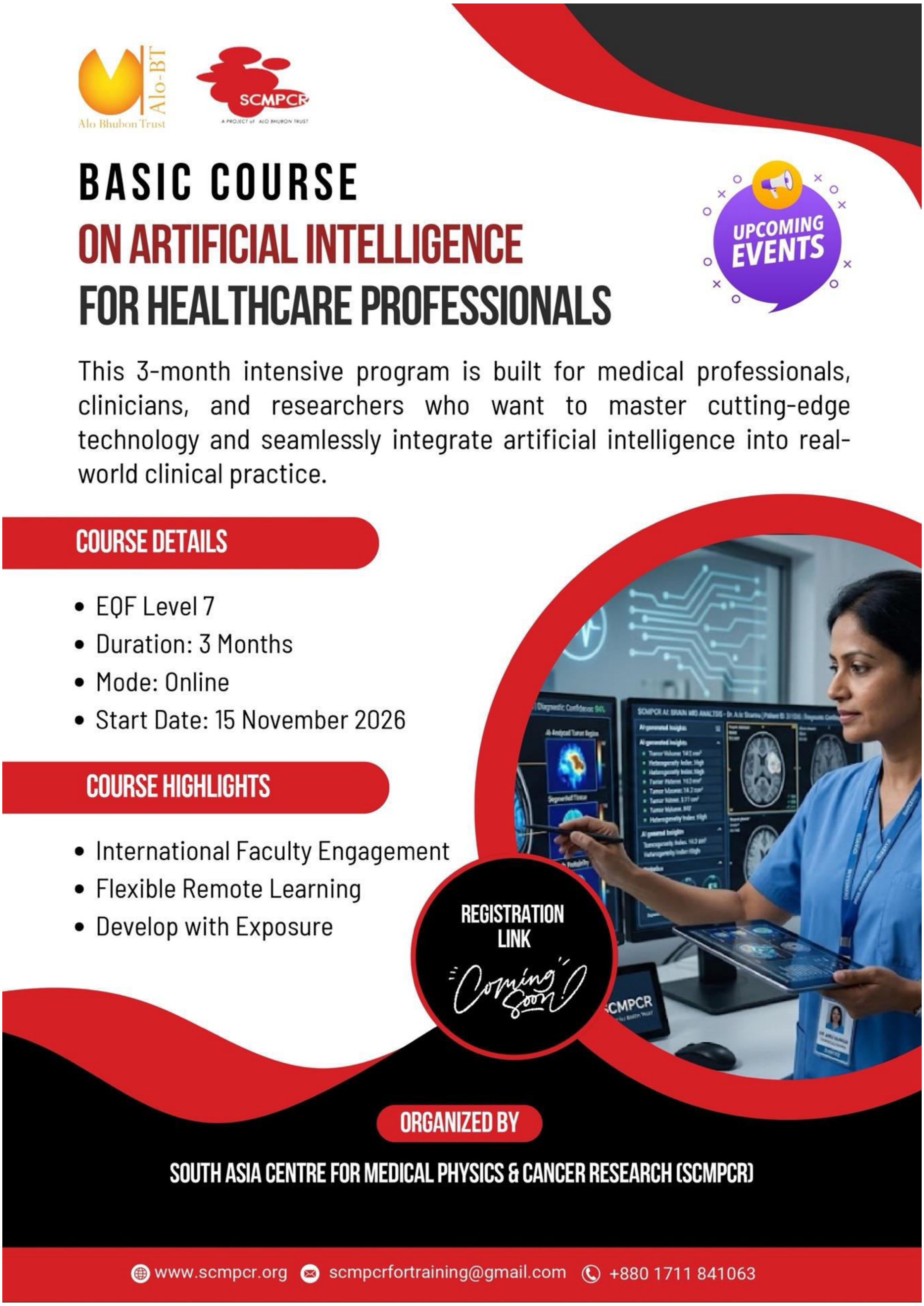
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South Asia Centre for Medical Physics and Cancer Research (SCMPCR)
E-learning Program (ELP-11)
Holistic Approach of Radiotherapy Practice for Medical Physicists, Radiation Oncologists and Technologists: From Simulation to Safe Delivery
Date: 01-21 Nov 2026
Accreditation
In Process
Panel of Speakers
Dr. Raju Srivastava
Senior Medical Physicist
Department of Radiation Therapy
University Hospital Ghent
Belgium
Dr. med. Robert Semrau
Radiation Oncologist
Specialized Doctor in Radiotherapy
Strahlentherapie Bonn-Rhein-SiegTroisdorf
Germany
Dr. Janine Simons
Radiation Oncologist
Erusmus University Medical Centre
Netherland
Dr. Manoj K Semwal
President, AMPI
Chief Advisor (Medical Physics & Radiation Safety),
Army Hospital (R&R), Delhi Cantt
Adjunct Faculty (Physics), IIT Ropar, India
Dr. Sehrish Abrar
Radiation Oncologist
Aga Khan University Hospital, Karachi
Pakistan
Dr. Martin Andrew Ebert
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School of Physics
University of Western Australia Crawley
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Date
01-21 Nov 2026
Venue
Online
Registration Link
Coming Soon
Registration Fees
1. South Asia
Students-20 USD
Professionals-25 USD
2. International (Beyond South Asia)
Students-20 USD
Professionals-30 USD
3. Group - 50$ (3 students)

SCMPCR Newsletter Submission Guidelines

The following guidelines are provided to ensure consistency, clarity, and smooth compilation of the Newsletter. All contributors are requested to follow these requirements strictly.

1. Overall Length

Maximum total pages of the newsletter: 30 pages

2. Types of Submissions & Page Limits

A. SCMPCR Report

- Maximum length: 3 pages
- Maximum number of photographs: 4
- Photos must be submitted separately (not embedded in the document), each with a clear caption.

B. General Articles

- Total allocation: 3–4 pages
- May include maximum two general articles depending on length.
- Photos, tables, graphs must be sent as separate files with proper captions.
- Must follow APA reference style

C. Scientific Articles

- Maximum: 5000 words per article
- May include maximum two scientific articles depending on length.
- Photos, tables, graphs must be sent as separate files with proper captions.
- Must follow APA reference style

D. News & Events

- Maximum length: 1 page
- Maximum photos: 1 photo with caption (to be submitted separately)
- Should focus on recent, relevant activities or announcements

E. Awards & Honors

- Maximum length: 1⁄2 page
- Must include a photo of the awardee(s) submitted separately
- Include award title, date, venue, and a concise description (50–100 words)

3. Formatting Requirements

Text

- Font: Times New Roman
- Size: 11 pt
- Line spacing: Single
- Submit in Word format (.doc or .docx)
- Do not apply any special formatting, columns, or layout—the designer will format accordingly.

Tables, Figures & Photos

- Must be submitted separately as image files (JPEG/PNG/TIFF preferred)
- Do not embed inside Word files
- Each table/figure/photo must have:

  a. Caption
  b. Numbering (e.g., Figure 1, Table 1)

4. Referencing

- All references must follow APA Style (7th Edition).
- Ensure accuracy and completeness before submission.

5. Authorship and Submission Ethics

- Write-up must not be generated by AI.
- AI may only be used for language editing, proofreading, or grammar correction.
- Authors are responsible for ensuring:

  a. Originality of the content
  b. Accuracy of data and references
  c. Proper permission for any photos used

6. Submission Checklist

- Before submitting, ensure:
- Word file in 11 pt Times New Roman
- No embedded photos or tables
- All images/tables sent separately with captions
- Word count and page limits followed
- APA references checked
- AI-generated content not used for writing the article
- Author name, designation, affiliation, and email provided


SOUTH ASIA CENTRE FOR MEDICAL PHYSICS AND CANCER RESEARCH
(A Project of Alo Bhubon Trust)
SCMPCR
SUBMISSION DEADLINE FOR NEXT ISSUE : NOV 30,2026
The main objectives of SCMPCR
To orgimise awareness, prevention, and screening program for cancer disease.
To provide adequate training to all personnel associated with cancer treatment.
To establish the clinical residency training program for medical physicists.
To develop the infrastructure of e-learning and library.
To establishment welfare home for poor cancer patients.
To build a self-help groups for cancer patients
To establish a team who will assist in the management and quality control (QC) procedure for the diagnostic radiology equipment in the districts levels.
SCMPCR was established on 3rd July 2018 and is comprised of a group of philanthropic personnel with representatives from different regions of South Asia to work on different projects. SCMPCR is an autonomous body under All Bhubon Trust (Alo-BT) and is accountable to its board of trustees/governors. It is a non-profit public partnership which will seek support from other sources. It shall work conjointly with various national and internationals organisations. The major activities of SCMPCR are: to produce skilled manpower, enhance health education and establish a welfare home for cancer patients.
MISSION
TO Achieve UNDP SDG-goal 3 & 4
OUR VISION
TO
PROVIDE QUALITY SERVICES IN CANCER TREATMENT THROUGH TRAINING, EDUCATION INCLUDING E- LEARNING IN RADIOTHERAPY AND IMAGING DISCIPLINES.
GOALS OF SCMPCR
Major activities of SCMPCR are to produce skilled manpower, enhance health education and establish a welfare home for cancer patients.
UNDP SDG-goal 3 (Good Health & Well-being)
Awareness program for the mass people for different communicable and non-communicable diseases, especially for cancer patients.
UNDP SDG-goal 4 (Quality Education)
Arranging and conducting training programs to develop skilled manpower. It realizes the need to educate specially, women regarding the screening and prevention of cancer treatment under UNDP SDG-goal 4.
SCMPCR
PROJECT of ALO BHUBON TRUST (Alo-BT)
FIND US
OUR MOTTO
QUALITY EDUCATION AND HEALTH SCIENCE FOR PATIENT BENEFIT