International Conference on Medical Physics in Radiation Oncology & Imaging (ICMPROI-2011)
11-13 March 2011
PHA Building, Gonoshasthaya Kendra, Nayarhat, Savar, Dhaka-1344, Bangladesh

Conference Proceedings

Organized by
The Department of Medical Physics & Biomedical Engineering (MPBME)
Gono Bishwabidyalay (University) &
The Bangladesh Medical Physics Society (BMPS)

In cooperation with
The Bangladesh Society of Radiation Oncologists (BSRO)
Indication based success in the treatment of...

**BREAST CANCER** & **COLON CANCER**

**Paclitaxel**
- **Active Ingredient**: Paclitaxel
- **Dosage Form**:
  - Paclitaxel 50mg /5ml, Inj.
  - Paclitaxel 100mg /16.7ml, Inj.

**Oxaliplatin**
- **Active Ingredient**: Oxaliplatin
- **Dosage Form**:
  - Oxaliplatin 50mg/10ml, Inj.
  - Oxaliplatin 100mg/20ml, Inj.

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List of Products available in Bangladesh

**Doxorubicin**
- **Product Name**: Oxaliplatin
  - **Generic Name**: Oxaliplatin
  - **Strengths**: 50mg

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**SBTL**

Product Name               | Generic Name | Strengths |
---------------------------|--------------|-----------|
Doxorubicin                | Doxorubicin  | 10mg      |
Doxorubicin                | Doxorubicin  | 50mg      |
Etoposide                  | Etoposide    | 100mg     |
5-FU                       | 5-FU         | 500mg     |
Methotrexate               | Methotrexate | 50mg      |
Vincristine PCH            | Vincristine  | 1mg       |
Vincristine PCH            | Vincristine  | 2mg       |
Azathioprine PCH           | Azathioprine | 50mg      |

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The inaugural ceremony of the first International Conference on Medical Physics in Radiation Oncology and Imaging (ICMPROI-2011) jointly organized by the Department of Medical Physics & Biomedical Engineering (MPBME), Gono Bishwabidyalay, Savar and the Bangladesh Medical Physics Society (BMPS) in cooperation with the Bangladesh Society of Radiation Oncologists (BSRO), will be held on Friday, 11 March 2011 at 10:00 am at the PHA Building, Gonoshasthaya Kendra, Mirzanagar, Savar, Dhaka, Bangladesh.

Prof. A.F.M. Ruhal Haque, MP
Honorable Minister of Health & Family Welfare
Govt. of the People’s Republic of Bangladesh
has kindly consented to be the Chief Guest.

Architect Yeafesh Osman
Honorable State Minister, Ministry of Science and Information & Communication Technology
Govt. of the People’s Republic of Bangladesh, will be the special Guest
And

Dr. Farid Uddin Ahmed, Chairman, Bangladesh Atomic Energy Commission & Emeritus Professor, Prof. A B M F Karim, Chairman, Oncology Club will be present as the Guests of Honor.

You are cordially invited to attend the inaugural ceremony.

Prof. Golam Abu Zakaria
Organizing Chairperson (ICMPROI-2011)

Dr. Hasin Anupama Azhari
Organizing Secretary (ICMPROI-2011)
PROGRAMME

Venue: PHA Building, Gonoshasthaya Kendra, Mirzanagar, Savar, Dhaka-1344, Bangladesh

Friday, 11 March 2011

08:30 : Registration of the Participants

10:00 : Welcome address by Organizing Secretary and President of BMPS: Dr. Hasin Anupama Azhari

10:05 : Welcome by Patron: Prof. Mesbahuddin Ahmad

10:10 : Address by the President of BSRO: Prof. Hafizur Rahman Ansary

10:15 : Key Note Speaker: Prof. Golam Abu Zakaria
       Organizing Chairperson
       Topic: Medical Physics and Medical Physics Education in Bangladesh

10:30 : Address by the foreign guest: Prof. Guenther H. Hartmann

10:35 : Address by Guest of Honor: Prof. A B M F Karim,
       Chairman, Oncology Club

10:40 : Address by Guest of Honor: Dr. Farid Uddin Ahmed
       Chairman, Bangladesh Atomic Energy Commission

10:45 : Address by Special Guest: Architect Yeafesh Osman
       Honorable State Minister, Ministry of Science and Information
       & Communication Technology

10:55 : Address by Chief Guest: Prof. A.F.M. Ruhal Haque, MP
       Honorable Minister of Health & Family Welfare

11:10 : Vote of thanks: Dr. G. M. Faruque, Secretary BSRO

11:15 : Refreshment
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Preface

Very recently, the International Atomic Energy Agency (IAEA) – committed to its self-consciousness “Atoms for Peace” – has organized a scientific forum in Vienna addressing the important topic: Cancer in Developing Countries: Facing the Challenge. The forum was promoted as a particular response to the situation of increasing cancer diseases. According to recent estimates of the International Agency for Research on Cancer and the World Health Organization, approximately ten million new cancer cases are being detected per year worldwide, with slightly more than half of the cases occurring in developing countries. By the year 2015 this number is expected to increase to about 15 million cases, of which two thirds will occur in developing countries. The IAEA has even coined the term of a silent crisis in a document describing this situation. Mohamed El Baradei, former IAEA Director General said: “A silent crisis in cancer treatment persists in developing countries and is intensifying every year. In addition, in low – and middle-income countries, cancer overwhelmingly affects the poor. This has huge implications for human suffering, health systems, health budgets and the drive to reduce poverty.”

If current knowledge were put into practice, at least one third of cancer cases could be prevented, another third could be detected early, treated and cured; and suffering could be alleviated through palliative care for patients with advanced cancers. Among different treatment modalities, radiotherapy could take over a significant role in the treatment of cancer, i.e. at least 50 to 60 per cent of cancer victims could benefit from radiotherapy.

Most of the developing countries do not have enough radiotherapy machines or sufficient numbers of specialized doctors and other health care professionals. However, whereas lack of equipment is a problem which can be principally solved by a prudent investment policy, the task to overcome the problem of missing health professionals require persistent and sustained efforts. Radiotherapy treatment requires highly-trained personnel in a variety of interrelated disciplines. Indeed, the most important component of any radiotherapy programme is qualified personnel. Investment in equipment without concomitant investment in training is dangerous. Furthermore, it is important that training not only include practical details of individual procedures, but also how to design treatment approaches that are comprehensive, replicable, of high quality and safe.

These statements particularly apply to the field of medical physics. It follows that education and training of medical physicists competent to work in a radiotherapy department is an important challenge in Bangladesh. First activities of education started in 1994 at the Physics Department of the Bangladesh University of Engineering and Technology. In the year 2000, a decision was made at Gono Bishwabidyalay (University) in Savar, Dhaka to found a new department for Medical Physics and Biomedical Engineering (MPBME) in order to offer a qualified education by a M. Sc in that subject. Between 2002 and 2006, a complementary collaboration program between Gono Bishwabidyalay and Heidelberg University was implemented. It was granted by the German Exchange Service. Education and the training of fellows was the primary objective of this collaboration. Up to now, a significant number of young medical physicists have passed the examinations and they are currently growing more and more into Bangladesh’s system of radiotherapy and imaging facilities. In addition to the M. Sc, the department has opened a B. Sc in 2005.
Bangladesh Medical Physics Society (BMPS) promotes continuously the advancement in status and standard of practice of medical physics profession, education and training related activities.

This conference – the first international conference of Medical Physics in Radiotherapy and Imaging in Bangladesh (ICMPROI-2011) – is in particular aiming at serving to mutual information within the Asian region on the current status of medical physics in Bangladesh and even more at assisting to establish better networking between medical physicists, within the country and also across the country borders with other country neighbors in the region. We would like to thank the organizers, contributors and all well wishers of this conference for having made all these efforts to bring together many specialized doctors, medical physicists and other health professionals working in the field of radiotherapy and imaging.

Prof. Dr. Mesbahuddin Ahmad
Patron, ICMPROI-2011 and VC, GB

Prof. Dr. Golam Abu Zakaria
Chairperson, ICMPROI-2011

Prof. Dr. Hafizur Rahman Ansary
Co-Chairperson, ICMPROI-2011 and President, BSRO

Dr. Hasin Anupama Azhari
Secretary, ICMPROI-2011 and President, BMPS
Head, MPBME, GB

Prof. Dr. Guenther Hans Hartmann
Convenor, Scientific Committee, ICMPROI-2011
Welcome Message

Welcome to the first International Conference on Medical Physics in Radiation Oncology and Imaging (ICMPROI-2011) in Bangladesh. This three days conference will be held at the conference hall in PHA Building of the Gonoshasthaya Kendra (People’s Health Center) in Nayarhat, Savar, Dhaka-1344 from 11-13 March 2011. The scientific program of the conference covers a wide range of issues related to Dosimetry, External Beam Therapy and Brachytherapy, Treatment Planning, Nuclear Medicine, Quality Assurance, Radiobiology, Radio-Oncology, Radiation Safety, Biomedical Engineering, Advanced Techniques in Radiotherapy and Education on Medical Physics.

The subject Medical Physics is new in Bangladesh. We have received many abstracts; out of these 94 abstracts have been accepted for the conference. The number of participants will be more than 200 including 36 experts from 10 foreign countries (China, Great Britain, Germany, India, Indonesia, Japan, Lebanon, Nepal, Nigeria, and Pakistan). We are very happy to have such a resonance from home and aboard.

I hope this first international conference will give us an impetus to develop Medical Physics and Biomedical Engineering in Bangladesh. It will also facilitate research activities and bring to the notice of the policy makers in the government, commercial and donor community to understand the need of the Medical Physics in the development of the nation.

My best thanks go to the contributors, abstract reviewers, organizing committee, vendors and all other peoples who make this conference a success.

We have arranged a Bangladesh Night Program with Bangladeshi food and cultural show and a tour that includes visits to a modern cancer hospital in a remote area and sightseeing near the great river Jamuna (Bramaputra).

I welcome all the participants specially the foreign guests to visit the beautiful places of Bangladesh and enjoy the Bangladeshi hospitality.

Professor Dr. Golam Abu Zakaria
Chairperson, ICMPROI-2011
## Scientific Program for ICMPROI – 2011
### 11-13 March 2011

#### Friday, 11 March 2011

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<td>Inauguration</td>
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<td>Inaugural Tea</td>
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<td>PS – 01 Radiation therapy of head and neck tumours in Germany – from history to the present day</td>
<td>M Muniruzzaman (JU, Dhaka, BD)</td>
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<td>PS – 02 Dosimetry – Past and Future</td>
<td>G. H. Hartmann (Heidelberg, Germany)</td>
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<td>PS – 03 Imaging In Radiotherapy</td>
<td>A. K. Rath (Bhubaneswar, India)</td>
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<td>13:00 – 14:30</td>
<td>Lunch Break</td>
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<td>14:30 – 16:00</td>
<td>Session 1</td>
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<td>IV – 01 Recent Advancement in CT imaging</td>
<td>Chair</td>
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<td></td>
<td>IV – 02 The potential of Brachytherapy in precision Radiotherapy -current and future developments and applications</td>
<td>Amena Begum (DU, Dhaka, BD)</td>
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<td>Co-Chair</td>
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<td>Kirsten Hierholz (Darmstadt, Germany)</td>
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<tr>
<td>15:10 – 15:30</td>
<td>IV – 03</td>
<td>Past, Present and Future: Radiobiological Modelling in Radiotherapy</td>
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<td>15:30 – 15:50</td>
<td>IV – 04</td>
<td>Update in Cardiac Imaging: A Personal View</td>
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<td>15:50 – 16:00</td>
<td>OP – 01</td>
<td>Determination of Physical and Biological Criteria for External Beam Radiotherapy and Brachytherapy: Plan Ranking</td>
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<td>16:00 – 17:40</td>
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<td><strong>Session II</strong></td>
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<td><strong>Scientific Presentation on New Equipments and Drugs</strong></td>
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<td>16:00 – 16:20</td>
<td>VP – 01</td>
<td>Varian Medical System</td>
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<td>16:20 – 16:40</td>
<td>VP – 02</td>
<td>Elekta Medical System: Volumetric Modulated Arc Therapy- Treatment Planning and Delivery</td>
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<td>VP – 04</td>
<td>Precisis AG: Radiosurgery with the SmartKnife- cheap, effective and precise: The SmartKnife system as an economic solutions for high precision radiation therapy</td>
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<td>17:20 – 17:40</td>
<td>VP – 05</td>
<td>IBt Bebig : Technical and physical parameters of the new HDR system using the miniaturized co60 source ; plan comparison and results</td>
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<td>07:00 – 08:00</td>
<td>Registration and Breakfast</td>
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<td>08:00 – 10:30</td>
<td>Session III</td>
<td>Medical Physics In Radiotherapy</td>
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<td>08:00 – 08:20</td>
<td>IV – 05</td>
<td>Dosimetric &amp; QA Challenges In The Era of New Radiotherapy Technologies</td>
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<tr>
<td>08:20 – 08:40</td>
<td>IV – 06</td>
<td>Commissioning, QA and HDR Brachytherapy Treatments of Cervical Cancers: Using the First Co-60 BEBIG Multisource Unit in Bangladesh</td>
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<td>08:40 – 08:50</td>
<td>OP – 02</td>
<td>Combating Cancer with Radiotherapy in view of dosimetric aspects of Radiation Physics.</td>
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<td>08:50 – 09:00</td>
<td>OP – 03</td>
<td>Radiation Therapy Physics-Past, Present and Future</td>
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<td>09:00 – 09:10</td>
<td>OP – 04</td>
<td>Dose Investigation Accuracy in Mega Voltage Blocked Beam γ-Radiation (60Co) for Radiotherapy Treatment Procedure</td>
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<td>09:10 – 09:20</td>
<td>OP – 05</td>
<td>Determination of Virtual Source to Skin Distance for electron beams as a clinical solution for extended SSD treatment</td>
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<td>09:20 – 09:30</td>
<td>OP – 06</td>
<td>Verification of Photon Beam Data Calculated by Eclipse Treatment Planning System Based on Pencil Beam Model</td>
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<td>09:30 – 09:40</td>
<td>OP – 07</td>
<td>Comparison of 3DCRT with IMRT techniques for radiotherapy of prostate cancer</td>
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<td>09:40 – 09:50</td>
<td>OP – 08</td>
<td>Calibration of HDR IR-192 Source by using various types of Brachytherapy Calibration Protocols</td>
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<td>09:50 – 10:00</td>
<td>OP 09</td>
<td>Comparison between Physical and Enhanced Dynamic Wedges of Varian Linear Accelerator</td>
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<td>10:00 – 10:10</td>
<td>OP 10</td>
<td>Importance of immobilization devices for modern radiotherapy</td>
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<td>10:30 – 11:00</td>
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<td>Tea Break</td>
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</table>
| 11:00 – 12:40 | Session IV | Imaging in Radiotherapy & in Biomedical Engineering          | Chair
Syed Mizanur Rahman (BSRI, Dhaka, BD)  
Co-Chair
Uwe Oelfke (Heidelberg, Germany)  
| 11:00 – 11:20 | IV 07| A Proposed Interleaved Echo Planar Imaging Technique for High Resolution fMRI | Shahida Rafique (DU, Dhaka, BD)             |
| 11:20 – 11:40 | IV 08| The Use of Image-J and MS-Excel to Analyze CT Performance            | Katsumi Tsujioka (Toyoake-city, Japan)        |
| 11:40 – 12:00 | IV 09| The scope of FDG-PET-CT versus diagnostic CT as a diagnostic modality in case of oncology patients (Hodgkin Lymphoma) in Bangladesh. | A. K. M. Moinul Hossain (Lad Aid Hospital, Dhaka, BD)  
<p>| 12:00 – 12:20 | IV 10| Fundamental studies on the production of the 124I radionuclide for diagnosis and therapy | M. S. Uddin (Jülich, Germany)                |
| 12:20 – 12:30 | OP 13| Dual Isotope SPECT-CT Imaging of Parathyroid Adenoma: Methodology and Clinical Experience | Alp Notghi  (Birmingham, UK)              |
| 12:30 – 12:40 | OP 14| Assessment of malnutrition using dual energy X-ray absorptiometry     | A. K. M. Khadim (NU, Gazipur, BD)           |
| 12:40 – 13:15 |      | Visit to GB &amp; GPL                                                    |                                               |</p>
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<td>13:15 – 14:00</td>
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<td>Lunch Break</td>
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<td>14:00 – 16:00</td>
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<td><strong>Radiation Protection &amp; Nuclear Medicine</strong></td>
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|            |         | *Chair*  
Farid Uddin Ahmed (BAEC, Dhaka, BD)  
*Co-Chair*  
Alp Notghi (Birmingham, UK) |
<p>| 14:00 – 14:20 | IV – 11 | Status of Radon Measurement Program in Bangladesh                    | M. A. Malek (BAEC, Dhaka, BD)                       |
| 14:20 – 14:40 | IV – 12 | National Diagnostic Dose Reference Levels (DRLs) for Computed Tomography Examinations | Johan Noor (Malang, Indonesia)                      |
| 14:40 – 15:00 | IV – 13 | Analysis of Radiation Protection Parameters and Occupational and public Safety in Radiological Facilities in Dhaka City | Mofazzal Haider (BAEC, Dhaka, BD)                   |
| 15:00 – 15:10 | OP – 15 | Justification of Instantaneous Dose Rate (IDR) basis design limit for secondary radiation shielding calculation and obtain a formula for workload calculation applicable for all treatment modalities | M. Anwarul Islam (SHL, Dhaka, BD)                  |
| 15:20 – 15:30 | OP – 17 | Shielding Calculation: Choice of High Dose Rate (HDR) Source (Co-60 &amp; Ir-192) | K. M. Masud Rana (GB, Dhaka, BD)                    |
| 15:30 – 15:40 | OP – 18 | NMR characterization of metabolites in prostate adenocarcinoma        | Bimol Kumar Sarkar (Vellore, India)                 |</p>
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<td>16:00 – 16:20</td>
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<td>16:20 – 18:20</td>
<td>Session VI</td>
<td>Radiation Oncology</td>
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<td>16:20 – 16:40</td>
<td>IV – 14</td>
<td>Experience of 3 Dimensional Conformal Radiation Therapy (3DCRT) in Brain Tumor at Square Hospital Ltd, Dhaka</td>
<td>Qamruzzaman Choudhury (SHL, Dhaka, BD)</td>
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<tr>
<td>16:40 – 17:00</td>
<td>IV – 15</td>
<td>Efficacy of Intensity Modulated Radiotherapy and Three dimensional conformal Radiotherapy in malignant brain tumors</td>
<td>K. P. R. Pramod (Bangalore, India)</td>
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<td>17:00 – 17:20</td>
<td>IV – 16</td>
<td>IGRT: The different types of treatment verifications</td>
<td>Christine Voith (Darmstadt, Germany)</td>
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<td>17:40 – 17:50</td>
<td>OP – 21</td>
<td>History of IMRT</td>
<td>Qazi Mostaq Hossain (DMC, Dhaka, BD)</td>
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<td>17:50 – 18:00</td>
<td>OP – 22</td>
<td>Evidence Based Treatment In Radiation Oncology</td>
<td>Aliya Shahnaz (DMCH, Dhaka, BD)</td>
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<tr>
<td>18:00 – 18:10</td>
<td>OP – 23</td>
<td>An observational study of radiation alone versus radiation with chemotherapy boost for advanced squamous cell carcinoma of head and neck</td>
<td>Mukitul Huda (DMCH, Dhaka, BD)</td>
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<td>16:20 – 17:00</td>
<td>IV – 18</td>
<td>Synthesis and characterization of advanced Calcium Hydroxyapatite for preparing bone-fixing screws</td>
<td>Abhijit Chanda (Kolkata, India)</td>
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<td>16:40 – 17:00</td>
<td>IV – 19</td>
<td>Comparisons of the effects of Radiation sterilized Biological membrane (Amnion) and Silver Sulphadiazine in the management of burn wounds in Children.</td>
<td>A. K. Mostaque (GK, Dhaka, BD)</td>
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<td>17:00 – 17:10</td>
<td>OP – 25</td>
<td>The Effects of Electromagnetic Fields on Human Health</td>
<td>Ibrahim Duhaini (Beirut, Lebanon)</td>
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<td>17:10 – 17:20</td>
<td>OP – 26</td>
<td>Activity concentrations of selected natural radionuclides in some commercialized bottled drinking-waters in Nigeria and consequent radiation doses to consumers</td>
<td>O. S. Ajayi (Ondo State, Nigeria)</td>
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<td>17:50 – 18:00</td>
<td>OP – 30</td>
<td>Preterm Delivery: Role of Zinc and Copper</td>
<td>Masuda Sultana (DCH, Dhaka, BD)</td>
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<td>18:00- 18:10</td>
<td>OP – 31</td>
<td>Effects of Electromagnetic Fields: Electromagnetic Hypersensitivity (A case Study)</td>
<td>Sabab Zaman (Banglalink GSM, Dhaka, BD)</td>
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<tr>
<td>18:10 – 18:20</td>
<td>OP – 32</td>
<td>Low cost, noiseless and patient safety ECG amplifier and filter</td>
<td>Afzalur Rab (DU, Dhaka, BD)</td>
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<tr>
<td>18:20 – 18:30</td>
<td>OP – 33</td>
<td>On chip si-microring resonator for bio-medical applications at µm wavelength”</td>
<td>Rajib Ahmed (DU, Dhaka, BD)</td>
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**Bangladesh Night**

**19:00 – 20:00**

**Cultural Program**

**20:00 – 21:30**

**Special Dinner**

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### Sunday, 13 March 2011

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<td>08:00 – 10:20</td>
<td>Session VIII</td>
<td>Advanced Techniques in Radiotherapy</td>
<td>Chair&lt;br&gt;H. R. Ansary (Apollo Hospital, Dhaka, BD)&lt;br&gt;Co-Chair&lt;br&gt;Arun Chougule (Jaipur, India)</td>
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<td>08:00 – 08:20</td>
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<td>New Trends in Medical Physics: Radiotherapy and Imaging for Cancer Treatment</td>
<td>G.A. Zakaria (Bangladesh/Germany)</td>
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<td>Uwe Oelfke (Heidelberg, Germany)</td>
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<td>Kirsten Heirholtz (Darmstadt, Germany)</td>
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<td>G. H. Hartmann (Heidelberg, Germany)</td>
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<td><strong>Co-Chair</strong></td>
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<td>K. J. Maria Das (Lucknow, India)</td>
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Invited Papers

PS – 01

Radiation Therapy of Head and Neck Tumors in Germany – from History to the Present Day

Kober B.
Klinikum Darmstadt GmbH, Institute of Radiotherapy and Radiooncology, Darmstadt, Germany

Often head and neck tumors and their lymph node metastasis respectively can not be removed completely by operation surgery. For that reason using radio therapy for these kinds of tumors already started in the beginning of the 20th century.

The aim of this presentation is to show the history of treating head and neck cancer-especially in Germany-from that time till nowadays. The development of different radiation techniques (like external therapy and brachytherapy) will be reported as well as the use of combined radio-chemotherapy. Modern radiotherapy techniques like intensity modulated radio therapy IMRT (step and shoot as well as sliding windows technique) and especially intensity modulated rotational therapy like Rapid Arc or VMAT will be compared to conventionally used techniques as opposing fields and half field techniques.

PS – 02

Dosimetry – Past and Future

Hartmann G. H.
German Cancer Research Center, Department of Medical Physics in Radiation Oncology, Heidelberg, Germany

Clinical application of radiation started very shortly after the discovery of x-rays in 1895 and the phenomenon of radioactivity in 1896. The first treatment of a skin tumor was performed in 1899. The term "dose of radiation" was coined already very early similar to the idea of a dose of medicine. Several phenomena were used to quantify a dose of radiation. However, very soon it becomes obvious that a scientific and consistent method is required for the measurement of dose of radiation in such a way that the observed radiation effects can be uniquely related to that quantity (in more or less linear relationship).

More than hundred years later, the field of dosimetry is well established although there is still a continuous improvement in the methods employed. This talk briefly describes the evolution of dosimetry, its present state and possible further developments for applications in radioprotection and radiotherapy. The development and role of dosimetry protocols is discussed as well as remaining measuring problems when the highest possible accuracy is aimed at. Finally, different methods are presented when dose and dose distributions are calculated based on different physical models.
Imaging in Radiotherapy

Rath A. K.
Hemalata Hospitals and Research Centre, Nalco square, Bhubaneswar, Orissa, India

Imaging science has undergone tremendous changes in the last decade, thanks to the development of both hardware and software in the field of computers in medicine. Radiotherapy as a whole has also simultaneously witnessed a quantum change primarily due to the developments that have happened in the field of imaging. The role of Computed Tomography (CT) has changed from a supportive diagnostic tool to a primary treatment planning tool. Magnetic Resonance Imaging (MRI), used as add on diagnostic tool in oncology services has now become a primary tool for tumor localization and treatment planning. Positron Emission Tomography, (PET) just recently available only in selected centers of excellence is fast emerging as a primary modality of monitoring disease progression and metastasis’s detection including treatment assessment. Further, availability of real-time and online imaging devices on radiotherapy equipment have crated a new discipline of Image Guided Radio Therapy (IGRT) which has brought reverse integration of imaging and therapy to its pinnacle. The practice of Oncology from its rudimentary conventional film based extrapolation of tumor volume to Image Guided Radiotherapy with capability of tracking tumor deformation, online and real time positioning and guiding radiation delivery is a great leap forward in the management of the dreaded disease of cancer.

The next significant advance in cancer therapy will occur with the paradigm shift from a population-based to a personalized patient-based prescription. In radiation therapy this paradigm shift will require, not only adjustment of the total radiation dose prescribed, but also a shift from the current standard of uniform dose prescription to a non-uniform dose prescription, which will be tailored to the spatial distribution of biological properties in the tumor. Incorporation of comprehensive patient- and tumor-specific information will enable design of more effective therapies. Furthermore, monitoring of the treatment response through the treatment will provide grounds for treatment adaptation if necessary. Rapid developments of imaging, particularly adoption of molecular imaging offer unprecedented opportunities for achieving these goals.

Recent Advancement in CT Imaging

Naqvi S. M.
Dept. of Radiology, Aga Khan University, Karachi, Pakistan

This review paper is describing the principles and evolution of multi-slice CT (MSCT), including conceptual differences associated with slice definition, helical pitch, and helical scan technique. Radiation dose issues pertinent to MSCT are also discussed. Most recent developments in the technology and their applications in imaging are included along with the arising problems with the evolution.
The Potential of Brachytherapy in Precision Radiotherapy - Current and Future Developments and Applications

Hensley F. W.
University Hospital Heidelberg, Dept. of Radiation Oncology, Im Neuenheimer Feld 400, 69120 Heidelberg, Germany

The steep dose gradients in Brachytherapy can be used to provide conformal tumour coverage with low doses to surrounding healthy tissues. In many cases the unique properties of Brachytherapy may allow the production of dose distributions which may well compete with the most advanced techniques in radiotherapy, including intensity modulated and image guided radiotherapy, and even particle therapy. By placing the radiation sources into the target, Brachytherapy may be able to provide quicker solutions to the issues of motion adapted radiotherapy to moving tumour sites. The presentation will show possible applications and developments with which Brachytherapy can contribute to dose escalation and improvement of radiotherapy. Not for all but for many cases, Brachytherapy can help treating larger numbers of patients with precision radiotherapy at costs much lower than the advanced external beam technologies.

Past, present and future: Radiobiological Modeling in Radiotherapy

Chougule A.
Faculty of Paramedical Sciences, Incharge Telemedicine, S.M.S. Medical College & Hospitals, Jaipur, India

All the tumors are not treated with same time dose fractionation schedule and all radiotherapists do not treat similar tumors with schedules followed by others. Therefore many fractionation schedules are followed by radiotherapists in different institute or within the same institute. Many fractionation schedules encounter gaps, planned or unplanned and many tumors are treated by altered fractionation schedules, combination of brachytherapy and teletherapy is choice of treatment in few malignancies. Since treatment schedules are numerous and different from each other it is rather difficult to intercompare them unless they can be reduced to preferably a single number. To correlate the biological effectiveness of different time, dose factors, many empirical models such as NSD, CRE, TDF and TSD were put forth and were used despite of their many drawbacks. The need for reliable dose effect relationship in fractionated radiotherapy has increased significantly in recent years with the advent of a variety of innovative fractionation techniques such as hyper fractionation, high dose rate fractionated remote after loading, single fraction intraoperative radiotherapy, stereo tactic radio surgery (SRS), intensity modulated radiotherapy (IMRT), intended inhomogeneous dose distribution in PTV, biological isodose planning and many other forms of dynamic fractionation. The most commonly used radiobiological model for quantitative prediction of time – dose dependence is linear quadratic [LQ] model and has gained popularity because it is a mechanistically based model, with tumor control and normal tissue complications attributed specifically to cell killing. The rationale of LQ formalism is with mechanistic understanding and therefore less likely to catastrophically fail as had occasionally happened with empirically based models.
In this communication evolution of empirical time-dose fractionation models and the recent radiobiological models will be discussed in detail along with their advantages, drawbacks and applicability to various situations.

IV – 04

**Update in Cardiac Imaging: A Personal View**

**Notghi A.**

City Hospital, Birmingham, UK.

In recent years there have been several important developments in nuclear cardiology in the hardware, software and radiopharmaceuticals. I believe these developments will enable to keep nuclear medicine in the forefront of cardiac imaging despite new developments in competing imaging modalities. This is a personal view on the new developments in nuclear medicine cardiac imaging. I will also discuss the effects of the new National Institute of Clinical Excellence (NICE) guidelines on myocardial perfusion imaging in the UK.

**Radiopharmaceutical developments:**

Although available myocardial perfusion imaging agents (thallium and technetium based radiopharmaceuticals MIBI and tetrofosmin) will be widely used for the foreseeable future, there are several new agents developing and available for cardiac imaging. PET perfusion agents such as rubidium 82 utilises PET scanners with relatively fast through put and also enables absolute blood flow measurement. Faster imaging using gamma cameras may see resurgence of agents with short myocardial redistribution such as Tc$^{99m}$-tobuxorxime. Labelled fatty acids (Tc$^{99m}$-BMIPP) with ischaemic memory are promising agents for imaging acute chest pain presenting to A&E in the hospitals. Sympathetic innervation assessment using I$^{123}$-MIBG has great promise for stratification and selection of patients with heart failure for cardiac device treatments.

**Hardware developments:**

Gamma cameras specifically designed for cardiac imaging has been available for a while. These are usually smaller cameras based on known standard gamma camera technology which are cheaper and more suitable for cardiac imaging with patient comfort. However during the last few year there has been major developments in cardiac cameras some drastically different from anger gamma camera technology. These cameras include those with moving multiple pinhole collimators, new collimator designs focusing on heart and the new CZT solid state cameras with no moving parts. This has increased the sensitivity of the gamma cameras up to 10 times, with improved resolution approaching that of PET scanners. Combination of these cameras with multi-slice CT has enabled one-stop fast diagnostic patient imaging pathways.

**Software development:**

Cardiac software development has been steady over the last few decades. Some of the development has been in acquisition and processing of cardiac images (such as resolution recovery software), and some in reporting (cardiac reporting packages). There is also improved software for SPECT multi-gated blood pool studies which enables calculation of both left and right ventricular functional parameters.
**Future of nuclear cardiology:**
There are exciting and fast developments in the other imaging modalities such as CT and MRI which have profound effect on how cardiac disease is investigated. The place of nuclear cardiac imaging is being redefined with these developments. The new NICE UK guideline for management of patients presenting with recently onset chest pain, introduced in April 2010 is an attempt to re-define the place of different imaging modalities in one group of patients. Implementing the new developments can ensure the continuing major role of nuclear medicine in cardiac imaging. Functional imaging will continue to have a major role in the management of cardiac patients.

**IV – 05**

**Dosimetric & QA Challenges in the Era of New Radiotherapy Technologies**

Negi P. S.

Delhi State Cancer Institute, Delhi & RGCI & RC, Delhi

All IMRT / IGRT technologies based on Segmental / Dynamic MLCs especially, Helical Tomotherapy, Robotic radiotherapy and IMAT techniques no doubt need challenging machine and patient specific dosimetry and QA procedures accounting the complexity of non-moving and moving target volumes and OARs generated out of associated imaging techniques for clinical implementation (ICRU-83, 2010). The recent unfiltered Beam IMAT/ Non-IMAT techniques have thrown another challenging task for medical physicists (Negi et al, 2009 & 2010).

Radiological physics centre reported that of the 250 irradiations of a head and neck phantom as part of an IMRT credentialing process, 71 (28%) failed to meet the accuracy criteria of even 7% for dose in a low gradient region and/or 4mm distance to agreement in a high gradient (Ezzell et al, US Data IMRT Failures, 2009). Sensitized by this evidence AAPM Task Group 119, 2009 has produced quantitative confidence limits and action levels as baseline expectations values for IMRT commissioning.

Radiation dosimetry of small field of filtered and unfiltered beam of new technologies for IMRT & IGRT for beam modelling in TPS is challenge of different kind (Alfonso et al, 2008 & Negi et al, 2008 & 2010). Inaccurate model leads to inaccurate MU prediction and inaccurate positioning of leaves resulting in hot or cold spots in IMRT delivery resulting in unexpected clinical output. Measurement and modelling of dose in the non-equilibrium region of shallow micrometer/millimeter depths in the skin and below immobilization shell and incorporation of treatment couch attenuation in calculation algorithms is still a dosimetric challenge. Quantification of dose in the region of rebuild-up/interface zone of mucosa in head/neck and thoracic region are also a problem due to electronic disequilibrium demanding solution.

QA of clinical trials involves challenging tasks for medical physicists like performing various benchmark tests, understanding each protocol, performing protocol QA and submitting required data especially for credentialing.
Commissioning, QA and HDR Brachytherapy Treatments of Cervical Cancers: Using the First Co-60 BEBIG Multisource Unit in Bangladesh

Malik S. R.
Delta Medical College and Hospital, Dhaka-1216, Bangladesh

High Dose Brachytherapy (HDR) is an important modality of cancer therapy where dose is delivered at short distances locally to the tumor with rapid dose fall-off in the surrounding normal tissue. The Co-60 remote after-loading unit was the first of its kind in Dhaka. Acceptance and Quality assurance are imperative to justify functionality and dependability in delivering a treatment. All methods referring to Quality Assurance (QA), the commissioning of the Co-60 unit and finally to the delivery of high dose have been investigated and systematically analyzed. All results that have been obtained by measurements have been documented before treating a patient. Studies and safety requirements of this HDR remote after-loader are carried out as laid down in the AAPM Task Group Reports (viz. 43, updated 43, 59 and 60).

The determination of absorbed dose in Gy to a point P at a certain distance from the source of known source strength in terms of Reference Air Kerma Rate, RAKR, is following the equations as given in the AAPM Task Report. The source strength measurement can be performed using a calibrated well type ionization chamber (as provided by a company such as PTW) or a free in air measurement as recommended by an IAEA protocol. Well type chambers require a calibration by a primary standard dose laboratory such as the German PTB. In our case an uncertainty of 2.5% is quoted by PTB (2009) for the RAKR measurement.

QA and Commissioning required measurements and Emergency Tests to verify the functional limits of parameters for acceptance of the HDR afterloading unit. Some acceptable limits are:

- Deviation between specified and measured source strength: ± 3%
- Positional Accuracy and Uniformity: ± 1 mm
- Temporal Accuracy (i.e. timer error & linearity and end error): ± 1% or 30 sec
- Treatment Planning System (Digitizer & Localization Software): ± 3% or 1 mm
- Distance from line to first dwell position and all other positions: 5 mm and 10 mm (± 1 mm)

Following the acceptance of the Co-60 Multisource HDR Unit, Delta Hospital has completed about 31 Cylinder and 38 Tandem & Ovoid (Fletcher Suit & Manchester applicators) treatments since December, 2010. CT scans are done before planning at HDR-plus where a good reproducibility (± 2%) has been documented in repeating the plan for the same set up and patient.

Implications of these studies are described in detail in this paper, where equipments and guidelines of measurement parameters are enunciated. Treatment plans, as per protocol, are evaluated viz. Contouring structures from CT Images, Prescription Points for dose delivery, Optimization, Isodose Evaluation, DVH, Dwell Times and 3-D Dose reconstructed images, etc. followed by a final verification after delivering the treatment at the console. Average Bladder dose remained within 38-53% while the rectum dose evaluated to be <27% of the prescription dose (Rx).

Finally, it was found that the modality of treatment (T&O or CYL) is different in different age groups from December 10 to Mid February11 using BEBIG60 Co Multisource with the Fletcher Unit & Cylinder (Total Tx=64).
A Proposed Interleaved Echo Planar Imaging Technique for High Resolution fMRI

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An interleaved Echo Planar Imaging (EPI) fMRI technique has been proposed here for obtaining spatially high resolution activation map overlaid on EPI image to reduce image acquisition time. First of all, the 2D and 3D anatomical high resolution and 3D + Time series (4D) low resolution functional images have been reconstructed and normalized. Slice timing correction for avoiding disorder and motion correction for small head motion during the scan has been provided using the post-processing image registration algorithm. The extent of translational and rotational head movements in fMRI data that can be corrected has also been determined and observed that 1-2 mm of translational and 2-40 (deg) of rotational head movement correction can be achieved. The effect of hemodynamic response (HDR) on the neural activation has been observed and the relevant activation map has been found for correlation coefficient, $r > 0.20$. In order to obtain a highly reliable and noise-free activation map, spatial smoothing has been done using a Gaussian filter with different kernel width and 4 mm filter was found to be best with acceptable SNR. Frequency selective temporal filtering of fMRI data has been done to avoid cardiac, respiration and Cerebral Spinal Fluid (CSF) pulsation, which shows that 0.10Hz upper cut-off frequency filtering is the most effective one. Finally high resolution functional and anatomical reference image have been obtained at 3.0T using the interleaved EPI technique. This fMRI analysis offers possibilities for improved neurological research and clinical neurosurgical applications.

The Use of Image-J and MS-Excel to Analyze CT Performance

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In QA program for CT it is important that the performance of the CT equipment is well analyzed. However, many people may think that the performance evaluation of the CT needs a high professional background and deep familiarity with CTs. However, there are tools available for performance evaluation which are easy to apply and yet not generally known. In this paper, we explain a specific performance evaluation method using “Image-J” and “MS-Excel”.

The Scope of FDG-PET-CT Versus Diagnostic CT as a Diagnostic Modality in Case of Oncology Patients (Hodgkin Lymphoma) in Bangladesh.

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**Purpose:** The scope of FDG-PET-CT and diagnostic CT (dCT) may be performed for staging, event-free survival, and to test agreement of sites involved in cancer patients like Hodgkin lymphoma (HL).
with further focus on early and late therapy response assessment between clinical and FDG-PET-CT-image–based results to predict overall patient outcome.

**Materials and Methods:** We would like to enroll all our enlisted patients of HL at the LABAID specialized hospital, Dhaka starting from this current year for at least next three consecutive years provided PET-CT becomes available at our hospital. We would like to perform our study retrospectively comparing FDG-PET-CT and diagnostic CT for staging, event free survival and assessing therapy response.

**Results:** This is hypothetical and should be considered as a future possible study with high potentiality.

**Conclusion:** We believe FDG-PET-CT and dCT both might be necessary for staging HL. However, based on our future analysis, we might be able to state that FDG-PET-CT is useful for assessing therapy response and overall outcome in HL.

**Fundamental Studies on the Production of the $^{124}$I Radionuclide for Diagnosis and Therapy**

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The radionuclide $^{124}$I ($T_{1/2} = 4.18$ d; $E_{\beta^+} = 2.13$ MeV; $I_{\beta^+} = 22 \%$) is one of the most important non-standard positron emitters with possible utilization in nuclear medicine for theragnostics. Presently, the $^{124}$Te(p,n)$^{124}$I reaction on highly enriched $^{124}$Te is the method of choice. However, the $\alpha$-particle induced reaction on $^{123}$Sb also appeared interesting. Excitation functions of ($\alpha$,xn) reactions on 98.28% enriched $^{123}$Sb and on $^{nat}$Sb were measured from 9 to 40 MeV. The data could be described well in terms of statistical and precompound models using the code TALYS. The discrepancies in the literature data for the formation of $^{125}$I and $^{126}$I were solved. The nuclear reaction $^{123}$Sb($\alpha$,3n)$^{124}$I on an enriched target appears to be interesting for the production of $^{124}$I over the energy range $E_\alpha = 42 \rightarrow 32$ MeV; its yield being 11.7 MBq/μA h. This value is comparable to that obtained by the $^{124}$Te(p,n)$^{124}$I reaction. The levels of the radionuclidic impurities $^{125}$I and $^{126}$I amount to 1.8 % and 0.6 %, respectively. The use of $^{nat}$Sb as target material for $^{124}$I production is unsuitable due to the high level of $^{123}$I impurity.

After completing the nuclear data base, development work related to a small scale production of $^{124}$I for practical application was started. This included medium current irradiation of a thick $^{nat}$Sb target, clean radiochemical separation and quality control of the radioiodine produced. The basic parameters of the radiochemical separation have been worked out. Radioiodine can be separated well by column chromatography. Besides column chromatography, the solvent extraction technique was also studied for the separation of iodine from Te and Sb. The radionuclides $^{123}$Te ($T_{1/2} = 119.7$ d) and $^{124}$Sb ($T_{1/2} = 60.3$ d) were used as radiotracers, which were produced well by the $^{122}$Te(n,γ)$^{123}$Te and $^{123}$Sb(n,γ)$^{124}$Sb reactions, respectively, in the research reactor TRIGA Mark II in Dhaka. The results should help in devising a suitable separation method of radioiodine for medical application.
Status of Radon Measurement Program in Bangladesh

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Radon is being extensively measured all over the world due to its hazardous health effects as well as for different geological applications. In this regard, some studies have been conducted by different research groups in Bangladesh. However, these studies are scattered and need to be combined/listed somewhere for future studies of radon in Bangladesh. In this article, all the studies concerning radon measurements have been reviewed. The main emphasis is on different methods used in the measurement of radon. In Cox’s Bazar district town, a research group found high radon concentration levels inside the old residential houses in comparison to that found in the newly brick made houses. The radon concentration levels in other locations are comparatively low. In the mineral separation pilot plant at Cox’s Bazar, max. concentration was 2103 Bq/m³ at the processed mineral stock areas. The concentration at raw sand stock area and other locations was in the range of 116 – 2042 Bq/m³. The same research group found the radon concentration ranged from 386 Bq/m³ to 1012 Bq/m³ in Magurchara gas explosion area. In the Sylhet and Hobiganj district town, the radon concentrations were ranged from 61 Bq/m³ to 1258 Bq/m³ and from 14±3 Bq/m³ to 524±23 Bq/m³ respectively. Another research group found the average radon concentration in some dwellings in Rajshahi and Chuadanga 32.4 Bq/m³ and 27.3 Bq/m³ respectively.

National Diagnostic Dose Reference Levels (DRLs) for Computed Tomography Examinations

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Radiation dose from computed tomography (CT) scanners is currently of concern due to the increase of its use for diagnostic purposes since their first inception in the 70s due to advances in their scanning speed, image processing and image quality. The introduction of multi-detector CT (MDCT) and its advanced techniques (e.g. helical, fluoroscopic, and multi-slice) fulfill the demand for better image quality and faster image acquisition. However, it exposes patients to many fold higher doses compared to those for general x-ray radiography. This trend makes CT machines the major source of unwanted dose to the population from medical x-ray procedures. Because of the potential for high radiation doses in CT, there has been an increasing interest in measurement of doses from routine CT examinations. Many researchers from many countries have been trying to establish national dose reference levels (DRLs) for their respective countries to comply with the recommendation from the International Commission for Radiological Protection (ICRP). Although there is no strict regulation from international bodies, such as the International Atomic Energy Agency (IAEA) and the ICRP, to force the application of the recommended dose levels, it is important to conduct periodic quality assurance and regional dose surveys to set up regional reference levels for the benefit of the patients. This paper will discuss the work on the establishment of the dose reference levels.
Analysis of Radiation Protection Parameters and Occupational and Public Safety in Radiological Facilities in Dhaka City

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In diagnostic radiology, the X-ray machines are still playing vital role for diagnosis even though the latest techniques including ultra sonography, magnetic resonance imaging (MRI) are available these days. The types of X-ray imaging include chest examinations, dental radiography, computed tomography (CT), mammography, bone densitometry, angiographic and interventional procedures etc. However, the misuse and uncontrolled use of X-ray may cause harms to the occupational workers, patients and the public at large. The detriments may be deterministic and stochastic. The proper application of radiation protection methods in the radiological facilities and adequate knowledge about risks and benefits from the use of ionizing radiation, such as X-ray, is crucial for ensuring safety to the radiation workers, patients and the member of public. Therefore, it is required to assess the radiation protection aspects of radiological facilities, like diagnostic X-ray facilities, in Dhaka City, Bangladesh. This study will provide necessary data, such as, the shielding status of doors, walls, control panel barriers and the dose levels at locations of interest of an X-ray room. The Regulatory Information Checklist (RIC) and appropriate dose rate meter have been used to collect the desired data. As many as 50 diagnostic X-ray facilities of Dhaka City have been chosen randomly to perform the study. In most of the cases of shielded control panels, the radiation dose levels are found within the regulatory limit of 10 µSv/h (as per NSRC rules ’97). But, in unshielded control panels the dose levels are generally found very high, in some cases even 5 - 10 times higher than the regulatory limit depending on the shielding condition, tube orientation and the machine specifications etc. The results of this study are utilized to determine and analyze the occupational and public exposure in the radiological facilities of Dhaka City.

Experience of 3 Dimensional Conformal Radiation Therapy (3DCRT) in Brain Tumor at Square Hospital Ltd, Dhaka

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Purpose:
To determine the feasibility, safety and efficacy of 3 dimensional conformal radiation therapy (3DCRT), in patients with primary brain tumor.

Materials and Methods:
During February 2010 to February 2011, 411 patients attended Square Oncology & Radiotherapy Centre for Radiotherapy treatment. Fifty two (36 men, 16 women) patients with brain tumor received radiation therapy at our centre for effective treatment. Out of which 25 (48.07%) patients clinically, radiologically and cytologically proved as primary brain tumor. The age ranges were between 17 to 72 years. Cytological pattern revealed: 17 (68%) Glioblastoma Multiforme, 3 (12%) Grade-II Astrocytoma, 1
(4%) Ependymoma, 2 (8%) Craniopharyngioma, 1 (4%) Non-Hodgkins Lymphoma, 1 (4%) Pituitary Adenoma. All the patients underwent surgical decompression with 20 cases of near total removal and 5 cases of partial excision. Pre and post surgical evaluation with MRI or CT scan were usually done. All the patients have been simulated with GE light speed CT simulator. 3DCRT with multiple fields have been applied to each patient for effective tumor control with a range of standard radiation doses (45 to 54Gy). Pre- and post-RT tumor dimensions were measured and tumor volumes were calculated. Response evaluation also was performed using WHO criteria.

**Results:**
25 patients with primary brain tumor were treated. The predominant histological type from primary brain tumor was GBM WHO grade-IV. Only one patient from primary brain lesion documented recurrence at the primary site, and median disease free survival was 4.1 months.

**Conclusions:**
Radiation therapy is a safe, less toxic and effective treatment in majority of the primary brain tumor, producing fair amount of disease free survival.

**IV – 15**

**Efficacy of Intensity Modulated Radiotherapy and Three Dimensional Conformal Radiotherapy in Malignant Brain Tumors**

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**Purpose:** To determine whether Intensity Modulated Radiotherapy (IMRT) improves target coverage, target homogeneity, target conformity, critical tissue sparing without increasing the total integral dose to the non target brain tissue to the three dimensional conformal radiotherapy in Supratentorial Astrocytic series WHO grade III-IV primary malignant brain tumor.

**Methods and Materials:**
Twenty patients of malignant glioma treated with 3DCRT were selected for a comparative dosimetric evaluation with IMRT. Target volumes, organ at risk (OAR), dose volume constrains were used for planning. Cumulative dose volume histogram of target volumes and organ at risk (OAR), normal brain tissue integral dose, target coverage, target homogeneity, target conformity, and normal tissue sparing with 3DCRT and IMRT planning were compared. Statistical analysis was performed to determine the differences and significance.

**Results:** In all 20 patients examined, there was no significant difference in target coverage between IMRT and 3DCRT plans with slightly superiority in 3DCRT plan in the range of 95-100% of prescribed dose. IMRT improved target conformity, dose reduction to normal tissues including brain stem (D_{mean} by 17%, D_{max} by 12%), optic chiasm (D_{mean} by 33%, D_{max} by 22%), right optic nerve (D_{mean} by 54 %, D_{max} by 46%), left optic nerve (D_{mean} by 42%, D_{max} by 38%), right eye (D_{mean} by 37%, D_{max} by 29%), left eye (D_{mean} by 33 %, D_{max} by 35%), p< 0.001. This was achieved without increasing total non target brain tissue integral dose. Overall integral dose to brain tissue was reduced by approximately 8%, p < 0.001 with IMRT compared with 3DCRT.
**Conclusions:** These results indicate that IMRT treatment for high grade glioma allows for improved target conformity, better critical tissue sparing without increasing the integral dose to normal brain tissue.

IV – 16

**IGRT: The Different Types of Treatment Verifications**

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Accurate tumor localization and verification are central to modern radiotherapy practice. Intensity-modulated radiotherapy enhances the ability to produce steep dose gradients in the boundaries between a tumor and nearby critical structures. This means that any variation in organ volume or position and patient setup during treatment may alter the actual dose delivered to both the target and surrounding normal tissue to an even greater extent than similar changes occurring during conformal radiotherapy. Therefore, precision in patient setup and control before the treatment is important in this new era of radiotherapy.

This presentation will give an overview about On-line imaging like MV-imaging, KV-imaging and cone-beam-computed-tomography (CBCT). The technique of CBCT will be explained. Examples of different types of treatment verifications will be shown in various tumor sites. Advantages and disadvantages will be demonstrated.

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**Comparative Study of Simulator Fluoroscopy Versus Surface Marking Based Radiotherapy Planning in Carcinoma Oesophagus.**

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A study was done from January 2009 to December 2009 among the Oesophageal Cancer patients who were planned based on Simulator Fluoroscopy and surface marking. A total number of 20 patients were included in the study. Ten patients were planned with Simulator Fluoroscopy (Arm A, SAD technique) and 10 patients were planned with surface marking (Arm B, SSD technique). All the patients had squamous cell carcinoma in the middle third of oesophagus without having evidence of locoregional or distant metastasis (Stage I &II). The mean age of the patients was about 52 years and male female ratio was 2.4:1. In Arm A, SAD technique with one anterior and two posterior oblique fields were given. The proposed dose was 56 Gray in 28 fractions with 84 exposures. The calculation was done with dosimetric parameters like tissue maximum ratios.

In Arm B, SSD with anterior and posterior fields were given. The proposed dose was 44 Gray in 22 fractions with 44 exposures. The calculation was done at midpoint with percentage depth dose. It was found from the study that the treatment response was better in Arm A with low morbidity than with Arm B. The response and morbidity were evaluated with some indicators like tumor size and toxicities such as pain, dysphagia and vomiting. The tumor size was evaluated by follow up endoscopic findings and routine laboratory tests.
Synthesis and Characterization of Advanced Calcium Hydroxyapatite for Preparing Bone-fixing Screws

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Replacement of bone with synthetic materials like Calcium Hydroxyapatite (HAp) has gained popularity in recent past. However as far as the mechanical strength and structural integrity is concerned, it has some serious limitations and hence it is yet to be proposed for preparation of bone fixing screws. Number of research groups across the world is trying various dopants and different synthesis routes for the enhancement of mechanical and biological properties of HAp. Processing techniques like slip casting and Microwave sintering are being proposed in recent past by us for enhancement of properties. Composite preparation with carbon nano-tube (MWCNT) is also being tried. In this study, we have made an attempt to synthesize doped bioactive hydroxyapatite (HAp) ceramic powder using a simple Chemical method and studied its physical, mechanical and biological properties. Different quantities of magnesium, titanium, zinc were incorporated as dopants into HAp at the time of chemical synthesis so as to increase strength and promote better biological performance. The synthesized powder samples were analyzed for their phases and granular size using standard characterization techniques like X-ray diffraction technique, Fourier Transform Infrared Spectroscopy. The synthesized powders were compacted and then sintered at 1250ºC for 1hr in air. Vickers hardness testing was performed to determine the hardness of the sintered structures. Fracture toughness of sintered samples was calculated from indentation cracks using Inverted Optical Microscope with Image Analysis software. Microstructural analysis has been done using SEM. Detailed nano-indentation tests were done to find out nano-hardness, stiffness and plasticity parameter. The results indicate that with the introduction of dopants, mechanical properties were enhanced in number of cases. There was substantial improvement in mechanical strength and even after prolonged exposure to simulated body fluid there was hardly any sign of mechanical degradation. The change in mechanical properties can be attributed to structural changes in unit cell level due to incorporation of dopants. Biological performance of the materials were tested using both in-vitro and in-vivo mode. Clear signs of apatite formation were observed in most of the cases within one or two weeks. Animal studies are being conducted on rabbits following standard protocol to study the osteo-integration behavior and in-situ mechanical performance of the material in long range of time domain. Design of screws is also being done so as to ensure fracture-free prolonged service life.

Comparisons of the Effects of Radiation Sterilized Biological Membrane (Amnion) and Silver Sulphadiazine in the Management of Burn Wounds in Children.

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This prospective study was conducted on 102 children with 2nd degree thermal burn to assess qualitative differences between topical silver sulphadiazine and oven-dried radiation sterilized human amnion as wound dressing. The patients were divided into silver sulphadiazine and amniotic membrane
group by random sampling technique. The variables compared (1) number of days stay in hospital, (2) number of applications and time needed to epithelialize, (3) comfort and pain of the patients, (4) mobility during treatment, (5) comfort of the doctor during application, and (6) acceptability of the modules by the patients or attending guardians. Included children’s age ranging from 1 day to 12 years admitted in the burn unit within 72 hours of occurrence.

Fifty-one burned children enrolled in each group. Mean of hospital stay is significantly lower in amniotic membrane group (p<0.003). Number of dressing changes in amniotic membrane group was significantly lower (p<0.001). Mean time taken for epithelial coverage of 2nd degree burns is significantly lower in amniotic membrane than in sulfadiazine group (p<0.001). Application was painless in amniotic membrane than sulfadiazine group (p<0.001). State of pain in between application also shows significant difference (p<0.001). Application of amniotic membrane was significantly more comfortable to the attending doctor (p<0.001) with highly significant mobility of the patients during treatment (p<0.001) and acceptable to the patients or parents (p<0.001).

This study indicated that amniotic membrane might reduce the hospital-stay and the number of dressing drastically; epithelialization of the wound occurs within minimum possible time, is painless, odorless and safe. The procedure is easy and comfortable to the doctor. It is well accepted. Most of the patients remain mobile and active during treatment.

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New Trends in Medical Physics: Radiotherapy and Imaging for Cancer Treatment

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In the year 1948, A.K. Solomon made a basic statement in “Physics Today” on the relation between Physics and Cancer: “The connection between physics and cancer is peculiarly intimate – as intimate as cause and effect. For radiation, a valuable agent in the treatment of cancer, can itself cause cancer. This curious interrelationship exits largely because no one knows what causes growth, whether it is normal or abnormal. The primary problem in cancer is not an exploration of such isolated problems as the connection between radiation and cancer. It is the much larger and much more stimulating problem of understanding the fundamentals of growth.” This presentation is following some of these ideas.

Concept of using radiation against cancer: The probability to control the growth of cancer by radiation largely follows the integral Gaussian function of dose. The same function applies also to the probability for the undesired normal tissue complications, however normally at a higher mean dose. From these observations the basic concept of radiotherapy is derived: The principal capability of increasing growth control of any cancer with dose is always associated with the unavoidable increasing normal tissue
reactions. In other words, success of radiotherapy is primarily governed by tolerance doses of the surrounding healthy tissue and organs at risk. Accordingly, many physical-technical developments in radiotherapy facilities are aiming at a concentration of dose to the tumor volume and at the same time at a reduction of dose in the surrounding health tissue. Examples are the development of 60Co irradiation units in the 50ties and medical linear accelerators (Linac) in the following decades, application of neutrons, protons and even heavier ions. At the same time, the irradiation methods have been continuously improved from conventional multi-beam techniques to tumor shape conformal methods such as “radiosurgery”, “intensity modulated radiotherapy” (IMRT) or brachytherapy (BT).

Other correlated important developments: Concentration of dose to tumor requires a precise information on the shape and the anatomical geometry of the tumor within the body. Techniques providing such information in a visible form are summarized by the term “Imaging”. Of course, x-rays have played a dominant role almost from their time of discovery in 1895. The use of x-rays has now been developed to tomographic imaging with CT, other imaging modalities like ultrasound (US), magnetic resonance imaging (MRI) or positron emitting tomography (PET) appeared in the last decades. By combined use, the required information on the clinical target volume for radiotherapy has tremendously been improved.

In addition to therapy-related efforts undertaken by physicists, some physicists (or related scientists) have also devoted their work to a better understanding of cellular growth. Examples are Erwin Schrödinger, Max Delbrueck or the discoverers of the “doppel-helix”, Rosalind Franklin, J. Watson and B. Crick.

IV – 21

Challenges in Hadron Therapy Treatment Planning

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The theoretically promising depth dose characteristic of the Bragg peak, observed for charged particle beams, makes proton and heavy-ion beams a most attractive treatment modality in radiation oncology. However, although the rather complex issues of charged particle dose delivery are solved, a number of inherent uncertainties seem to prevent a full exploitation of the projected advantages of this innovative therapy form.

First, daily setup uncertainties of the radiation target and the effects arising from organ motion, both well known from radiation therapy with high energy photons, reveal a severe degrading effect on optimized dose distributions. Moreover, particle therapy specific uncertainties, like erroneous estimates of the particle range within the patient or the relative biological effectiveness of heavy-ion beams, further dilute the correlation between planned and delivered dose distributions.

One strategy to overcome these problems in modern hadron-therapy is the development of robust inverse planning methods. We will discuss a couple of approaches, how any of these known risks in particle therapy can be directly considered at the stage of treatment planning. The basic idea of the devised strategies is to exploit the degeneracy of the inverse problem defined by the treatment optimization and select only plans of high quality that are insensitive to the anticipated dose delivery errors.

Starting with an introduction to inverse treatment planning for particle therapy, we will demonstrate the influence of the considered uncertainties on optimized dose patterns, before the concepts of robust
optimization will be discussed in terms of clinical examples. Moreover, aspects related to the biological optimization of heavy-ion therapy will be addressed.

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Quality Assurance in Case of IMRT or RapidArc-an Overview Over Various Methods

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Introduction: The implementation of complex treatment methods like intensity modulated radiotherapy (IMRT) or rotational intensity modulated radiotherapy (RapidArc) places great demands on the linear accelerator, the record- and verify system and the treatment planning system. At the same time the necessity is increasing to check the transfer of these complex treatments to the patient. So verification of treatment plans should be possible with high accuracy and a low deal of work and time.

Pre-condition, application, advantages and disadvantages of several methods for patient related and machine related quality assurance will be demonstrated.

Material and Methods: From September 2003 till October 2009 selected patients have been treated with IMRT. Especially head and neck tumors, prostate and abdominal tumors have been treated in this way. During that period the following methods have been used for verification of treatment plans: (a) X-ray-film dosimetry, (b) 2D-Array seven29 (PTW, Freiburg) in combination with software VeriSoft, (c) VARIAN portal dosimetry by means of using the Portal Imager aS500 and aS1000 for generating integrated images. Since November 2009 patients can also be treated with RapidArc. Because of the short treatment time also rectal and anal tumors in prone treatment position can now be treated with this high sophisticated treatment method. Whole brain treatments with simultaneously boosting of solitary metastases are now also possible. For verification of RapidArc treatment plans the following methods have been used: (a) 2D-array seven29 with Octavius phantom and Verisoft software for evaluation, (b) Integrated images generated with a Portal Imager (aS1000) in combination with the evaluation software Epiqa (EPIDos s.r.o). The process used for evaluation of patient related verification is the Gamma Index Method, which shows in a simple, graphical way the goodness of the agreement between treatment plan and treatment delivery. The parameters used for accepting a treatment plan have been: More than 95% of all points should have a Gamma Value <1. Gamma Values <1 are defined with less than 3mm deviation in geometry and less than 3% deviation in dose. The principle of Gamma Index method will be shortly explained and for all quality assurance methods examples of evaluation and comparisons will be shown. It will also be shown what kind of quality assurance measurements will be necessary prior to start with IMRT or RapidArc in clinical routine. Some of the above-mentioned methods are also used for machine related quality assurance. Here some examples and results will be shown.

Conclusion: Since starting IMRT in 2003 there have been calculated 651 IMRT treatment plans. In comparison for one year experience with RapidArc treatments 784 treatment plans have been calculated, because delivering a RapidArc plan is much faster than delivering an IMRT plan. As patient related quality assurance means a great deal of work and time, the presentation will end with some experiences and recommendations about the frequency of treatment plan evaluation and machine related quality assurance.
Performance Evaluation and Clinical Implementation of 4DCT for Stereotactic Body Radiotherapy: AIIMS Experience

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The purpose of the study was to evaluate the performance of 4DCT-Simulator and also to determine the accuracy of four-dimensional computed tomography (4DCT) imaging technique for stereotactic body radiotherapy. The 85cm Philips Big-Bore brilliance 16-slice 4DCT-simulator was installed in our department recently. The 4DCT-Simulator consists of CT scanner, moving laser marking and positioning system, AcQSim virtual simulation system and bellow belt respiratory monitoring system. Combined all together is known as 4D-CT Simulator. The performance evaluation of CT-simulator was done using 7 different phantoms such as for table top calibration, laser calibration, electron density, Catphan-500, AAPM/ACR and CTDI head and body phantom for electromechanical, image quality and CT dose measurements. Procedures followed the recommendations of AAPM-TG-66 report. The image quality parameters (slice thickness accuracy, high-contrast resolution, low-contrast resolution, uniformity and noise, CT number accuracy and linearity and CTDI values) were found to be within the acceptable limits. The clinical implementation of 4DCT and its accuracy was evaluated using QUASAR programmable respiratory motion phantom. The moving phantom has two different shapes of spherical and square targets and two organs-at-risk (OARs) located near and farther from targets. Also lung patients were analysed using ADAC Pinnacle 8.0 treatment planning system for stereotactic body radiotherapy. The accuracy of 4DCT was determined in terms of volume analysis, shape, geometric and positional accuracy analysis. Phase-binning accuracy for the various ranges of motion parameters for maximum intensity projection (MIP), average intensity projection (AvgIP) and 10 separate phases of 4DCT with reference to the free-breathing conditions data sets was determined. The assessment of volume, positional and the range of motion appeared to be more accurate in MIP position than other phase data sets. Hence we have adopted the MIP images for target volume delineation for lung SBRT at our institute.

Dose Verification in Modern IMRT

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The verification of dose delivered in a modern IMRT like VMAT, RapidArc and Tomotherapy came into the focus within an article by the “New York Times” in 2010 about uncertainties, risks and unknown outcome of radiotherapy treatment.

Thereby it seems to be compulsive to review dose verification methods and to offer an overview of available technologies and evaluation methods.

One of the major parts in the IMRT process is a reproducible and precise quality assurance management programme. Essential fractions of such a quality assurance programme in IMRT are procedures for plan and dose verification. The treatment with IMRT is a highly complex process in which the dose varies.
widely throughout the treatment volume when measured through a phantom plan to verify the actual treatment. The importance of dose verification could be expressed by the fact that an uncertainty of about 5% in dose delivery is required to treat certain types of cancers effectively and to reduce complications (s. ICRU 24/42).

A review among the 3D-conformal and modern IMRT techniques, therein the experimental methods for IMRT verification, will be presented. Required tools used for the verification process like suitable phantoms, point dose measurements using ionisation chambers or different X-ray films are shown. A detailed view on diode-based area and volume detectors for 3D- and 4D-dose verification will be given as well as a special view on portal dosimetry and recent development in entrance and exit dosimetry. Important properties like spatial resolution as well as occurring uncertainties will be discussed in detail. Also different methods of in-vivo dosimetry will be addressed, additionally the QA of the corresponding dose calculation. The discussion of the different methods in dose verification will touch the existing recommendations and national and international protocols for IMRT (e.g. AAPM or IAEA) and their characteristics in terms of dose verification. Further recommendations in dose verification will be provided for the most common cases in modern IMRT.

IV – 25

**IMRT – Commissioning, Quality Assurance and Patient Specific Dose Verification**

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**Purpose:**
Implementation of Intensity Modulation Radiotherapy (IMRT) commissioning and Quality Assurance (QA) with dynamic multileaf collimator (dMLC) using the sliding-window technique.

**Material & Methods:**
Linear accelerator with 120-leaf Millennium MLC is used with 6 and 18 MV photon beams. The basic commissioning and quality assurance of linear accelerator was carried with mechanical and electrical tests. The leaf position accuracy and leaf position repeatability check were performed for static MLC positions. To check the stability of the dMLC and the reproducibility of the gap between leaves, two tests were carried out: the picket fence test and garden fence test. Quality assurance test patterns provided by Varian customer acceptance procedure were also performed. The radiation test was performed to check position accuracy of MLCs in the collimator system. The tests are collimator spoke shot, gantry spoke shot and coincidence of light and X-field for MLC field size. The dMLC dosimetric checks like output stability, average leaf transmission and dosimetric leaf separation were also investigated. Pretreatment verification for IMRT is performed. In order to check the consistency of the stability and the precision of the dMLC, it is necessary to carryout regular weekly and monthly checks.

**Results & Discussion:**
The mechanical checks like collimator rotation isocentre, gantry rotation isocentre, crosshair alignment, light field alignment, static MLC position and Radiation tests are within 1 mm of the manufacturer’s specified value. The output stability for dMLC routine QA was consistent. The output with gravitational effect for various gantry angles was within 0.9%. The measured average leaf transmission for 6 MV was 1.6% and 1.8% for 18 MV beam. The dosimetric leaf separation for 6 MV is 2.2 mm and 18 MV is 2.3 mm. The dynalog files analysis for Garden fence, leaf gap width and step wedge test patterns carried out
weekly were in good agreement. The variations of calculated absolute dose for all treatment fields with the ion chamber measurement, for the patients, were within the acceptable criterion. The relative dose for each measured field agree well with the calculated field (95% gamma pixel match with 3% delta dose and 3 mm DTA), except for large dose gradient fields.

**Conclusion:**
Commissioning and quality assurance of dMLC for IMRT application requires considerable time and effort. Many dosimetric characteristics need to be assessed carefully failing which the delivered dose will be significantly different from the planned dose. In addition to the issues discussed above we feel that individual MU check is necessary before the treatment is delivered.

IV – 26

**Role of Robotic Radiosurgery (Cyberknife) in cancer management**

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**Abstract:** Short course radiation therapy (RT) is the one of the most talked about subject in recent years and also a fascinating research zone. Hypofractionated radiation therapy (Hypo RT) is an old concept, but only in recent years with tremendous improvement in radiation therapy delivery technologies there is a significant visible surge in its applicability in clinical practice. Modern RT technology is capable of delivering high dose to the target while sparing majority of the adjacent critical structures. Hence, it is possible to deliver short course of treatment regimen with higher dose per fraction without increasing in toxicity. Apart from the intracranial lesions, there are emerging evidences about short course treatment schedule in ‘extracranial’ sites such as in lung, prostate, breast, pancreas and also in various ‘oligometastasis’. Shorter treatment regimens with Cyberknife are comfortable to both patients and caregivers. These regimens are more acceptable to the patient, have higher completion rate and have a definite positive influence in quality of life. However, hypofractionated treatment planning is demanding, highly skill dependent and needs strict quality assurance. Appropriate training of the treating physicians, physicists as well as radiation technologists is critical to have desired treatment outcome. Cyberknife is a high precision RT delivery system. It has a linear accelerator attached with a robot and is capable of treatment from various coplanar and non-coplanar field arrangements. Cyberknife has sub-millimeter accuracy and unmatched dose distribution. The advanced technology behind Cyberknife uses image guidance technology and computer-controlled robotics to deliver and extremely precise dose of radiation to targets, avoiding the surrounding healthy tissue, and adjusting for patient and tumor movement during treatment. Patient benefits from the Cyberknife are significant, majority of the complications associated with conventional cancer therapies are minimized or eliminated with Cyberknife usage. Cyberknife is outpatient treatment, no anesthesia required, duration of treatment (usually less than 5 days) and recovery period is short and it is possible to treat multiple tumors at different locations at the same session. Common indications of Cyberknife are cranial benign and malignant tumours, gall bladder and pancreatic cancer, prostate cancer, recurrent head and neck cancer. This recent revolution in radiation therapy has immense potential to treat with high dose short course regimens and improve loco-regional control without increasing toxicities.
Medical Physics Status in the Middle East Countries

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Middle East Federation of Medical Physics (MEFOMP) has passed in different stages. During the ISEP-2007 conference held in Bahrain in November 2007, a meeting was arranged among representative physicists from the region and was decided to move ahead with the establishment of IOMP Middle East chapter. This follows more discussion among local physics societies in ME to further collect support and encouragement for such initiative. During the 16th International Conference on Medical Physics 2008 that was held in Dubai in April 2008, there was a meeting for all the medical physics societies in the Middle East and the delegates signed a “Motion of Intent” which stated that all the delegates approve to form the Middle East Federation of Medical Physics (MEFOMP) which is part of the International Organization of Medical Physics IOMP and Ibrahim Duhaini was appointed the Secretary General of this federation by the President of IOMP professor Barry Allen. The following countries have signed up for the chapter: Bahrain, Iran, Iraq, Jordan, KSA, Lebanon, Oman, Qatar, Syria, and UAE.

Medical Physics Service in B. P. Koirala Memorial Cancer Hospital (BPKMCH), Bharatpur, Nepal

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Radiation oncology medical physics pertains to therapeutic application of ionizing radiation. The equipment associated with their production, use, measurement and clinical dose evaluation, quality and handling of images and radiation protection associated with it. The aim of this presentation is to discuss the scenario of medical physics practice in radiation oncology department of BPKMCH. The radiation oncology department of BPKMCH is the nucleus of therapeutic radiology in Nepal. It is equipped with full range of megavoltage machines like one tele-cobalt and two Varian linear accelerators (one with low single 6 MV photon beams and other with dual energies 6 and 20 MV photon beams as well as with a number of electron beams ranging from 6 to 22 Mev). These machines are with multileaf collimators and portal vision. There is a Ximatron simulator with Ximavision varies network system and Eclipse 3D planning system. There is a high dose rate (HDR) Varisource remote afterloader with Iridium 10 Curie’s source wire along with BrachyVision treatment planning system. We are in process to upgrade low energy Linac with Intensity modulated radiotherapy. The commonest cancers are head and neck, uterine cervix followed by lung. Cervical cancer is treated based on BPKMCH protocol with external beam and HDR brachytherapy.

About 170 patients receive palliative and curative external beam radiotherapy and 4-6 brachytherapy daily. There are 8 radiation oncologists, 4 medical physicists and 13 radiotherapy technicians and technologists working in the department. An accurate measurement of dose delivered to the tumor in external beam therapy is one of the primary responsibilities of medical physicists. In this paper
improvements in dose measurements based on IAEA TRS 398 protocols, Quality Assurance (QA), radiation safety and physics specific brachytherapy will be presented.

We get $N_w$ absorbed dose in water calibration factors for chambers and Dose 1 electrometer from SSDL/BARC Mumbai, India and perform constancy and stability check with check sources. Routine beam energy constancy and quality index checks are performed in a water phantom. The daily QA, QA, IAEA TLD postal quality audit for teletherapy beam results and eclipse plan verification are satisfactory. Exposure level of personnel is within safe limit. BPKMCH has potential to lead medical physics in Nepal by starting training courses or residency. Nepalese Association of medical physicists (NAMP) was formally registered in 2009 to promote the profession.
ORAL PAPERS

OP – 01

Determination of Physical and Biological Criteria for External Beam Radiotherapy and Brachytherapy: Plan Ranking

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Advances in imaging and radiotherapy technology have the potential to improve the outcome of radiotherapy, but at the same time, they have also increased the complexity of radiotherapy treatment planning aiming at improving the dose conformity to the target and reducing the dose to the normal structures surrounding the target for external beam radiotherapy (EBRT) as well as for brachytherapy (BT). Most radiotherapy departments have separate treatment planning systems for EBRT and BT. Up to now, commercially available planning systems with a fully integrated option for combined planning are still lacking.

In this study a combined plan is evaluated for a case of nasopharyngeal carcinoma with physical (ICRU conformity, dose homogeneity, dose gradient) and biological criteria (tumor control probability, TCP and normal tissue complication probability, NTCP) with a new suggestion of evaluating physical parameters for combined one at the Zhejiang Cancer Hospital, Hangzhou, China using two different treatment planning systems: 1) Pinnacle3, ADAC (version 7.6) for EBRT and 2) PLATO, Nucletron (version 3.4) for BT. Pinnacle appear to be less convenient compared to PLATO, it offers the possibility to combine BT and EBRT planning results and to perform a biological plan evaluation. In this study BT planning is done in Plato and in computer with a software program Fortran version 90, voxelized 3D dose information is generated according to TG 43 protocol. Associated BT treatment data like source parameter, dwelling position and dwelling time, source coordinate data with matrix, dose data and CT image are retrieved from the Nucletron Plato planning system. All these are transferred to Pinnacle TPS with USB port. For the same case BT and EBRT CT images are at first fused with (Sytegra) fusion method. BT and EBRT doses are converted into equivalent dose in 2 Gy/F and inputted in Pinnacle. Pinnacle can display the EBRT / BT combined dose distribution, DVH as well as biological treatment planning. The radiobiological models included in the Pinnacle are NTCP model (Lyman-Kutcher) and the Poisson TCP model of Källman.

The coverage index, conformity index, dose homogeneity index, dose gradient index are 0.871, 1.75, 0.638, 0.7683 respectively. The Biological parameter TCP, NTCP, Probability of success is 0.998, 0.887, and 0.1127 respectively. Combining advanced delivery techniques with the selection of patient specific, biologically conformal prescription doses is the next frontier in Radiotherapy. In future new treatment planning tools that incorporate biological objectives into the treatment planning process are needed.
Combating Cancer with Radiotherapy in View of Dosimetric Aspects of Radiation Physics.

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This study is conducted with the purpose to excel control check points for confidence building in maintaining constancy & consistancy in radiotherapy dose delivery. Radiotherapy has been shifting from conventional to conformal dose delivery era for the management of human tumors. One needs to match the challenges of clinical influx, throughput, requirement on technologies with the existing expertise availability, working better & working faster to achieve an optimum.

Adequate Tumor Control, which is possible through dose delivery to target to +- 5% accuracy (ICRU Report No. 24, 50, 60, 38) and Radio-Therapeutic Regimens limitations for dose tolerance level of normal human organ are two important factors in maximising therapeutic potentials. Dosimetric measures are important things to deal with at every step of Radiotherapy framework from beginning to end. To deliver accurate dose to desired accurate targets, recognition of discrepancies involved in each step of overall process of radiotherapy starting from the image acquisition to execution of last fraction of dose delivery is essential. To reduce the likelihood of unwanted dose delivery requires incorporation of Standard dosimetry protocols and development of safety culture encompassing both personal attitudes & organizational policies. Increased complexity in advanced radiotherapy technology is inevitably associated with larger possible uncertainties. Enhanced capabilities & functionalities incorporated in Radiotherapy process in combination with less number of physics support group for radiation therapy, present a challenge to maintain the accuracy of radiotherapy without restoring to extensive efforts in quality assurance. In analyzing comprehensive dosimetry aspects of radiotherapy, there has been always need to develop hospital based case to case patient specific quality assurance policy. It generally needs to be less onerous, less resource intensive and more comprehensive.

Experiences with Radiotherapy facility at RCC (Regional Cancer Center), Nagpur having basic conventional as well as conformal radiotherapy is used as the basis for the study. RCC, Nagpur is a tertiary cancer center and one of 29 RCC under Ministry of Health & Family Welfare, Govt. of India. To meet the challenges of Radiotherapy, an in-house based excel control check point system is designed on the basis of clear understanding about the picture, principles & the values involved in Radiotherapy process.

Our experiences in Radiotherapy dose delivery in combating cancer and an in-house based excel control check point system for confidence building in maintaining constancy in radiotherapy dose delivery shall be discussed. As each radiotherapy facility use to have different combination & ranges of armaments for radiotherapy dosimetric verification, the process and end goals always remains same. Hence an extrapolation of this excels check point system for the different set up is possible, but needs to be tested.
Radiation Therapy Physics-Past, Present and Future
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Alexander Freud firstly reported the disappearance of a hairy mole following treatment with X-rays in 1897. Again Becquerel in 1898 reported skin erythema when he inadvertently left a radium container in his vest pocket. From these early beginnings, radiation therapy for controlling tumor has developed to a great extent. Therapy begins with Orthovoltage X-ray units, and then Radium age started. Extensive study and clinical application were done with Radium. Due to some practical radiation safety problem Radium was discarded. Age of Caesium and Cobalt artificial radioactive sources started both in the field of Teletherapy and Brachytherapy. Miniature Iridium Brachytherapy sources were fabricated and hence HDR Brachytherapy era started with very sophisticated multichannel delivery machines along with advanced planning software facilities. Megavoltage Linear Accelerator with dynamic MLC and excellent image guidance and very sophisticated software to deliver targeted dose to the tumor sparing normal tissue is the present era of radiation therapy. Scientists in the field of radiation biology have been doing excellent research work in understanding biological effects of radiation in cancer as well as normal tissue. Extensive research work was done in developing proton and other heavy charged particle therapy which is very useful to deliver highest dose to the cancer tissue and very low dose to the normal tissue. Well understanding of radiation biology with particulate radiation, development of both hardware and software in particle therapy machine and the model based algorithms and direct Monte Carlo based dose calculation algorithms for treatment planning are becoming more and more radiation therapy protocols of the future.

Investigation of Dose Accuracy in Mega Voltage Blocked Beam γ-Radiation (^{60}Co) for Radiotherapy Treatment Procedure
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In the present study inverted-Y and double Cornea Shielding blocks have been taken up. Beams are blocked with above-mentioned lead shielding blocks for field size of 25×25cm² and 5×5cm² respectively. Doses were measured experimentally as well as calculated by the Clarkson's method which are compared and variations of 4.43%, 4.38%, 5.42%, 7.34%, 7.22% and 7.20% were observed at dose investigation points 1, 2, 3, 4, 5, 6 for inverted-Y block of field size 25×25 cm². For Cornea block the dose variation between measured and calculated values were found to be 0.25%, 0.97% and 1.02% at dose investigation points 1, 2, 3 of field size 5×5 cm². In this study dose were calculated by an empirical relation using correction factors and it was found to be exactly equal to the experimental value. Both in double Cornea and Inverted-Y shielding the averaged value of uncertainty in dose measurement at the points of dose investigation between calculated dose values of Clarkson’s method and Empirical relation were found to be ±0.37% and ±3.095%, respectively, which is statistically satisfactory. Because according to the International Commission on Radiation Units and Measurements (ICRU) the dose delivered to the target volume should be at least within ±5%. In this study doses were measured in solid
phantom at 0.5 cm depth with a 0.6 ccm Farmer type ionization chamber coupled with PTW UNIDOS dosimeter. Measured doses were compared with the calculated doses with the following empirical relation:

\[ D_{W,E_{\text{corrected(Exp.)}}} = (OFD) \times C_{j}^{i} \times CF_{i} \times K_{sp} \]

where \( C_{j,k}^{i} \) and \( CF_{i} \) are two correction factors.

Fig 1 (a,b): Dose investigation points both in Clarkson’s method and Empirical relation for Inverted-Y and double Cornea shielding block

Fig.2 (a,b): Comparison among the doses in blocked beam, open beam, Clarkson’s method and empirical relation in Inverted-Y and double Cornea shielding block respectively
OP – 05

**Determination of Virtual Source to Skin Distance for Electron Beams as a Clinical Solution for Extended SSD Treatment**

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Electron beams produced in a Linac head seem to come not from a physical source, but from a point source known as virtual source. Since the physical characteristics of electron beams are affected by scattering and energy losses occurring along the beam path, knowledge of this virtual source is required. Therefore, it has become common practice for calculation purposes to treat electron beams using the virtual source. Determination of the position of the virtual source is based on the following procedure: The diverging broad beam of electrons originating from the actual effective extended source is simulated by a beam of electrons coming from a virtual point source in such a way that when placed in vacuum would produce exactly the same distribution of the electron fluence in position and angle as the actual beam. Many situations exist in radiotherapy, clinical electron beam dosimetry and treatment planning where knowledge of the virtual point source position is required. The virtual source to skin distance (VSSD) was determined for a Varian Clinac-2300CD linear accelerator as a function of the electron beam energies and electron beam size using the inverse slope method. As a result it was found that the VSSD is varying with the energy as well as with the electron cone size.

OP – 06

**Verification of Photon Beam Data Calculated by Eclipse Treatment Planning System Based on Pencil Beam Model**

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Presently in Bangladesh, the radiotherapy treatment is at its transitional period from the conventional to the 3-D conformal radiotherapy method. To deliver the 3-D conformal radiotherapy with Linear Accelerator (Linac), a sophisticated Treatment Planning System (TPS) is used to improve the accuracy of dose calculations in radiotherapy treatment planning. Before starting any clinical treatment with Linac, the validation of TPS is mandatory, that includes acquisition and verification of all data necessary in order to use the system clinically. The aim of this work is to verify the validity of photon beam data as calculated by the Eclipse Treatment Planning System (version 5.7.1) by comparing it with measured photon beam data. Both Eclipse reference guide and the IAEA Technical Report Series (TRS)-430 have been followed for the verification. All the data such as: the Machine data, Percentage Depth Dose (PDD) data, Beam Profiles, Output Factor (OF), Collimator Factors (SC), Peak Scatter Correction Factors (PSCF) and Wedge Factors (WF) for photon beams of the Clinac2100C Linac (Varian Medical Systems) have been determined according to Eclipse instruction manual and then transferred into the TPS. Later on, some representative tests were done in water
phantom and the obtained data were compared with the calculated one. The comparison of measurement and calculation of profiles both for open and wedge fields shows in the middle-field region a deviation of less than 1%. However, on field boundaries, a greater deviation (maximal 4%) is present. The difference between measured and calculated PDD and OF both for open and wedge fields is negligible (<0.5%). In conclusion, dose calculation using treatment planning system based on the pencil beam model is accurate enough for clinical use except when calculating dose at depths above maximum dose for small field size. Accurate dosimetry should be done to overcome this problem.

OP – 07

Comparison of 3DCRT with IMRT Techniques for Radiotherapy of Prostate Cancer

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Purpose: To compare two strategies of 3DCRT with IMRT for radiotherapy of prostate cancer quantifying the degree of conformity and investigating the dose profiles of primary tumors, electively treated organ and OARs.

Materials and Methods: Four (4) Patients were selected and immobilized in supine position. CT scans were performed at 5 mm slice thickness using GE light speed CT scanner. For each patient, target volume for primary lesions (76 Gy) and electively treated regions (54 Gy) were predefined. The beam number and directions of 3DCRT plans were manually adjusted to avoid at OARs and beam weights were selected in order to maximize primary tumors dose homogeneity. The beam arrangements of IMRT plans were nine equispaced non-opposed coplanar beams. The same dose volume constraints were used for all IMRT plannings during inverse optimization. All the 3DCRT and IMRT plans were planned using ECLIPSE (version 8.6) treatment planning system of VARIAN Medical System. The degree of conformity parameters (TC, CI, CN and HI), isodose distributions and DVHs were generated for each treatment plan. The 100% is perfect TC coverage, if the 95% isodose covers all of the clinical and pathologic target volume, treatment is considered to comply with the protocol. A CI is equal to 1 corresponds to ideal conformation. The CN ranges from 0 to 1, where 1 is the optimal conformity and value close to 0 indicates a less conformal the plan. Smaller values of HI correspond to more homogeneity and 0 corresponds to absolute homogeneity.

Results: The mean TC, CI, CN and HI values for 3DCRT and IMRT were 99.10, 97.16 (TC), 0.54, 0.90 (CI), 0.53, 0.87 (CN) and 0.069, 0.065 (HI), respectively. For 3DCRT plans, TC were higher and high isodose line covered more normal tissues. The CI and CN values were close to 1 indicating that IMRT plans were more conformal than 3DCRT plans. The IMRT plans were better than those of 3DCRT plans in terms of sparing OARs. The dose distributions of both techniques were comparable homogeneous as seen in the HI values which were close to zero.

Conclusion: IMRT is superior to 3DCRT in dose delivery and critical structure sparing for the treatment of prostate cancer. The primary tumor can get higher equivalent dose by IMRT techniques.
Calibration of HDR IR-192 Source by Using Various Types of Brachytherapy Calibration Protocol

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With the increasing use of HDR Ir-192 Remote Afterloading Equipment in the country, the need for reliable source calibration procedures before clinical use also increases. For this reason a study on calibration methods of the Brachytherapy Source is very important. Sources can be calibrated with three techniques (1) free in air, (2) well type ionization chamber, and (3) solid phantom (Krieger Phantom). Well type and Free in air measurement techniques are recommended by the IAEA (International Atomic Energy Agency) and the Solid phantom technique is recommended by German Society of Medical Physics (DGMP). In this paper we have calibrated the HDR Ir-192 source by using all three techniques. For Free in air measurement and Solid phantom techniques we have used Microselectron HDR machine, Microselectron V2 Iridium192 HDR source, Serial Number (S/N) D36B1582, Farmer type Ionization chamber 0.6cm$^3$ type PTW M30002, S/N-0209 and PTW 0.3cm$^3$ rigid chamber type PTW M23332, Serial Number 067 and a Unidos Electrometer. For Well type ionization chamber technique we have used Gamma Med Plus HDR machine, IR-192 source type IR-192 GAMMAMED PLUS 0.9MM, S/N-NLF-01D24B-088, a Well Type Ionization Chamber – HDR 1000PILUS, S/N-A03447 (Standard Imaging) and an Electrometer, type CD2x2000B, S/N-JO33354 (standard Imaging). The recommended quantity for specification of the gamma source is the Reference air kerma rate (RAKR) according to ICRU 38 and 58. The measured source activities (in mGy/m$^2$/h) were compared with the vendor supplied measurement of source activity. The air kerma was measured in free in air at several distances (10-30 cm) from the source. The room scatter correction factor was determined by a method based on the inverse square law. Various other correction factors were applied on measured air kerma values at multiple distances and mean value was taken to determine the Reference air kerma rate of the source. The deviation between measured and quoted source strength by manufacturers was found 0.46% for solid phantom technique, 0.469% for Well type ionization chamber technique and 2.78% for free in air technique, within a tolerance limit (±3%). The analysis of this last result shows that increasing the distance in air probably produces reduced signal, high leakage current of the ionization chamber, and also high divergence of incident photons due to non-collimated geometry causes more deviation in measurement from the vendor’s source strength. On the other hand Krieger phantom and Well type ionization chamber technique offer a suitable insert for the ionization chamber and for the source and thus a more reliable measurement setup.

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Comparison Between Physical and Enhanced Dynamic Wedges of Varian Linear Accelerator

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Purpose: Both Enhanced Dynamic Wedge (EDW) and Physical Wedge (PW) of modern linear accelerators are required for treatment planning and dose delivery to patients. In this study, wedge beam characteristic of Physical and Enhanced Dynamic Wedge were calculated and verified by measurement.

Materials and Methods: All measurements were performed with a linear accelerator (Clinac 2100C, DHX-2300CD Varian Medical Systems) at 6 MV & 15 MV X-ray beams. Wedge factors and profiles for PW and EDW were measured by a PTW cylindrical ionization chamber and a Scanditronix-Wellhoefer LDA-99 linear array detector in a water phantom respectively. Measured profiles were compared with calculated profiles from the Eclipse Treatment Planning System (TPS) for PW and EDW. Measured Wedge factors for PW and EDW were also compared.

Results: The comparison of measurement and calculation of PW shows in the middle-field region a deviation of less than 1%. However, on field boundaries, a greater deviation (maximal 4%) is present, which is largely independent on the wedge angle. For EDW, the deviation between measurement and calculation in the middle-field are in general slightly larger than for PW (maximal 2%). The comparison of calculated to measured beam profile between PW and EDW shows in the middle-field region a deviation of less than 1%. However, on field boundaries, a greater deviation (maximal 5%) is present, both for 6MV and 15MV photon energy. Additionally, on field boundaries a higher deviation is present which increases with the wedge angle. By using PW, the maximum variation in normalized wedge factor NWF with field sizes is 4.5% for thick wedge (60°) and decreases with decreasing wedge angle. Whereas for EDW, the maximum variation is from 20% to 40% from thinner to thicker wedge.

Conclusions: In this study it was found that, the deviation between measurement and calculation for both PW and EDW has no relevant effect in the clinical practice. However, one should be noted that the irradiation of patients with fields using EDW could lead to errors due to non-constant movement of the collimators. Therefore it must be examined at frequent intervals.

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Importance of Immobilization Devices for Modern Radiotherapy

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In the process of radiation therapy treatment planning, patient treatment and patient positioning is one of the most important and basic factors that need to be given great importance. In deciding the optimal patient position, there are four main considerations:

1. The target volume to be treated.
2. The organ of risk to be spared.
3. The envisaged treatment portal arrangement.
4. The patient’s general condition and comfort.

The planning target volume (PTV) depends on the precision of tools such as:
- Immobilization devices
- Lasers

Immobilization devices have two fundamental roles:
- To immobilize the patient during treatment.
- To provide a reliable mean of reproducibility of the patient position.

The simplest immobilization means used for external radiotherapy are:
- Masking tape.
- Velcro belts or elastic bands.

The basic immobilization device used in radiotherapy is the head rest which help in positioning, comfort and immobilization of the patient in conventional radiotherapy.

Variety of immobilization devices available are:
- Plastic mask or cast, thermoplastic cast or orfit.
- Thoracic or pelvic cast.
- Vacuum based devices (reusable).
- Chemical based foam pillow or alfa cradle.

Special immobilization techniques such as Stereotactic Radiosurgery require such a high precision that conventional immobilization techniques are in adequate.

- Conventional radio therapy.
- Stere tactic Radio surgery ( SRS)
- Fractional Radio surgery ( FRS)
- IMRT, 3D-CRT, IGRT (Image Guided Radio therapy)

Imobilization devices are also used for diagnostic imaging (CT, MRI, DSA)

**OP – 11**

**Acceptance Testing and Commissioning for Photon Beams of a Linear Accelerator**

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Radiotherapy is one of the three treatment modalities to treat cancer. Linac is the machine which can deliver conformal radiotherapy. Before the treatment is delivered the machine has to go through acceptance tests and commissioning after installation. International protocols like AAPM, ICRU, IEC, TRS-398, BJR Supplement 25 have been used for the acceptance testing and commissioning. These are the tests which optimize and calibrate the machine to deliver the
treatment accurately. I have performed my work at the Delta Medical Center for Photon beams. Linear Accelerator provides both Electron and Photon Energies. Photon beam plays the vital role for the deep seated tumors and delivers the maximum dose at a certain depth depending on the energy. Most of the patients require Photon energy treatment. In the acceptance testing the Linac undergoes safety checks, where it ensures the radiation safety for both patients and the hospital staffs. Mechanical checks are carried out to check if all the sensors and motional parts like gantry, collimator and couch of the machine are working and moving precisely and dosimetry checks allow us to find if the machine is delivering the exact dose required at the exact point for the exact duration and to see if the dose delivery is balanced and maintains its consistency. Commissioning allow us to optimize and calibrate the Linac to deliver accurate treatment to a patient. It provides some tests like PDD, beam profiles, output factors, TMR, TPR, absolute dosimetry and other measurements which must be carried out to make the machine optimized to deliver a particular treatment plan to the particular patient. All the test results were compared to the machine specifications and the PDD data have been compared to the BJR Supplement 25 which showed almost exact match with each other.

**OP – 12**

**Acceptance Testing and Commissioning for Electron Beams of a Linear Accelerator**

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Cancer patients are increasing tremendously in the whole world and to fight this disease there are three modalities among which radiotherapy offers high success rate if diagnosed in time and with more affordability. In our country the cancer patients are now given conformal radiotherapy, which gave the quality of treatment a new definition. Linear Accelerator (Linac) does the job very efficiently. After a linac is installed at a hospital it has to go through acceptance testing and commissioning. These are the processes to make the machine capable of delivering correct, precise and desired treatment. I worked in Delta Medical Center Ltd. They have installed a new Varian CLINAC 2100C DMX machine, which offers two photon energies and four electron energies. The machine is able to deliver 3D CRT. In my work I have tried to cover the things about acceptance testing and commissioning for electron beams of a linac. Electron beams have great use for the superficial tumors. In acceptance testing safety check, mechanical check and dosimetry checks were performed. For commissioning percentage depth doses, beam profiles, output factors, absolute dosimetry and Monitor Unit calculations were carried out. For both the acceptance testing and commissioning all the tests were carried out as recommended by the IAEA, ICRU, IEC, AAPM protocols. Protocols like TRS-398, BJR Supplement 25 have been used. All the test results were within the tolerance level and passed the acceptance tests efficiently. As the hospital was in a rush to start delivering the treatment, only the necessary tests for the commissioning were performed to start delivering the treatment, the remaining tests will be carried out later by the hospital physicists. Although having some problems the whole process of installing the new linac and carrying out the acceptance testing
and commissioning was a great success.

**OP – 13**

**Dual Isotope SPECT-CT Imaging of Parathyroid Adenoma: Methodology and Clinical Experience**

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Nuclear medicine imaging has been used for localization of parathyroid adenomas for many decades using several radiopharmaceuticals and methods. Methods include subtraction images using various combinations of thallium, Tc\(^{99m}\)-MIBI, Tc\(^{99m}\)-tetrofosmin with either Tc\(^{99m}\)-pertechnetate or I\(^{123}\) subtraction for parathyroid visualisation, and more recently Tc99m-MIBI wash out technique. The success rate has been variable ranging from 30% to over 80% identification of the parathyroid, this variation may be partly due to patient referral, conceivably as the clinical diagnosis is made earlier, the localisation of smaller adenomas could be more difficult. In our institution the preferred method of imaging has been Tc\(^{99m}\)-MIBI/I\(^{123}\) subtraction method. For planar imaging 20 MBq intravenous I\(^{123}\) is injected in the morning. The patient is brought back 4 hours later (to allow for good iodine uptake by the thyroid tissue) and positioned supine under the camera. After insertion of an intravenous cannula the patient is instructed and positioned securely to avoid any movement during and in between the imaging. First image is acquired 4 hours after I\(^{123}\), before Tc\(^{99m}\)-MIBI injection is given, this includes a thyroid image using I\(^{123}\) energy window and a scatter image using Tc\(^{99m}\) energy window. Then Tc99m-MIBI is injected intravenously via the IV cannula. Two dual acquisition images (Tc\(^{99m}\) + I\(^{123}\) windows) are then obtained one at 5 and another at 10 minutes after Tc\(^{99m}\)-MIBI injection. It is crucial that there is no patient movement in between the images in particular if I\(^{123}\) scatter image into Tc\(^{99m}\) window is utilised in image processing. Subtracted 5 and ten images are used to locate parathyroid adenoma.

We introduced subtracted dual isotope SPECT imaging with CT co-registration for localisation of parathyroid adenoma in 2009. 20 MBq of I\(^{123}\) is injected. Four hours later 400 MBq of Tc\(^{99m}\)-MIBI is injected and dual energy planar and tomographic images are acquired using a GE Infinia Hawkeye-4 gamma camera using asymmetric narrow energy windows (151-175keV for I\(^{123}\) & 129.5-147keV for Tc\(^{99m}\)) with CT localisation. Tomographic images were reconstructed with and without cross-talk correction using iterative reconstruction; Butterworth filter (Power 12, CF 0.5cycles/cm). The reconstructed I\(^{123}\) thyroid images were normalized to MIBI images using values from thyroid regions of interest before subtraction. Standard subtraction Tc\(^{99m}\)/I\(^{123}\) method was used for planar images. So far we have imaged over 50 patients using both planar and SPECT-CT Dual Isotope Subtraction for Imaging Parathyroid Adenomas and planar imaging. We compared the planar imaging with SPECT-CT in this group of patients. With planar imaging alone, only in 38% of patients the parathyroid adenomas could be clearly identified and localised. SPECT-CT also clearly identified all these adenomas. In further 25% of patients, parathyroid adenomas were suspected but could not be confidently localised on planar images; however SPECT-CT clearly identified parathyroid adenomas in all these patients. There were further 19% of patients where parathyroid adenoma could be clearly
localised only with SPECT-CT when planar images were negative and non diagnostic. In the remaining 18% of patients parathyroid adenomas could not be confidently identified by either technique. In these patients the difficulty was compounded by presence of multi-nodular goitre.

<table>
<thead>
<tr>
<th>Adenoma Identification</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planar: Clearly identified</td>
<td>38%</td>
</tr>
<tr>
<td>Planar: Suspicious but not diagnostic</td>
<td>25%</td>
</tr>
<tr>
<td>Planar: Not Diagnostic</td>
<td>37%</td>
</tr>
<tr>
<td>SPECT: Clearly identified</td>
<td>82%</td>
</tr>
<tr>
<td>SPECT: Not Diagnostic</td>
<td>18%</td>
</tr>
</tbody>
</table>

In our institution dual isotope subtraction SPECT-CT is the preferred method for parathyroid adenoma imaging. This method identified more adenomas and with more confidence than planar imaging. In addition the surgeons find additional information from CT helpful in localising and planning minimally invasive surgery and are now specifically request SPECT-CT before parathyroid surgery.

**OP – 14**

**Assessment of Malnutrition Using Dual Energy X-ray Absorptiometry**

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Dual energy X-ray absorptiometry (DEXA) can estimate three body compartments consisting of fat mass, lean body mass, and bone mass. The mean Z-score has the advantage of describing the nutritional status of the entire population directly without resorting to a subset of individuals below a set cut-off. Using the mean Z-score as an index of severity for health and nutrition we have conducted a study for the measurement of malnutrition status of the unprivileged children of the Foridpur. A mixed sample of 251 unprivileged children was used for the analysis. All participants had weight and height data. These children were separated into two age groups (7 to 9 years and 10 to 12 years) and all of their body compositions were determined by DEXA. There were no significant differences in anthropometric variables between those with and without skinfold or DEXA data. Our present study shows that 42.25% of the unprivileged children suffer from malnutrition and found to be stunted (Reduced growth rate). 7.59% female children were found to be stunted at the age group of 7 to 9 years. As for 9 to 12 year age group the percentage increases for female population and it becomes 15.15%. The male population showed higher number of stunted children at 7 to 9 years of age group but the percentage reduces at the age group of 10 to 12.
Justification of Instantaneous Dose Rate (IDR) basis design limits for radiation shielding calculation and determination of a formula for workload calculation applicable for all treatment modalities

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The modalities of radiation therapy are changing rapidly with 3D conformal radiotherapy (3DCRT) to intensity modulated radiotherapy (IMRT) and also rotational IMRT. The secondary radiation shielding is a major concern for IMRT treatment delivery. We have made an approach to apply the concept of Instantaneous Dose Rate (IDR) using data on the workload. The IDR is the quotient of the dose and irradiation time for a given time pattern of dose delivery. Workload basis calculation formulas are available in IAEA safety report series (SRS-47). We analyzed 3DCRT and IMRT treatment data from our center to calculate the average workload per day at isocenter for both cases. The workload (W) is different for 6MV, 10 MV energies and also for IMRT. We estimated the maximum possible workload for different modalities of treatment with 8 hour per working day. The estimated workload for IMRT treatment is 1800 Gy/week and 740 Gy/week for 3DCRT and the relationship between the workload for 6MV and 10MV is $W_{6MV} = \sqrt{2} W_{10MV}$. with the base of energy used. We obtained the following formula for workload calculation:

$$W_T = 18 T_{3d} + 26 T_{imrt} \text{ Gy/day}$$

where $T_{3d}$ is the time in hour reserved for 3DCRT treatment per working day and $T_{imrt}$ is the time in hour reserved for IMRT treatment per working day. The treatment field size is an important factor for shielding calculation. We analyzed 756 fields for 3DCRT and 334 fields for IMRT treatment data to calculate the average field sizes. The calculated average field size by jaw for 3DCRT is $13.81 \times 15.55 \text{ cm}^2$ and for IMRT is $19.81 \times 14.83 \text{ cm}^2$. The maximum $40 \times 40 \text{ cm}^2$ field size is considered to calculate the shielding with IAEA SRS-47. We have done a survey to determine the average treatment time for 3DCRT and IMRT. The average treatment times for 3DCRT and IMRT cases are 9.64 min and 16.92 min respectively. We analyzed more than 400 patient’s data treated last year. The 297 MU used per average per fraction of treatment for 3DCRT and 2D cases and 1285 MU used for IMRT cases including patient specific QA. We calculated the maximum possible total BEAM ON time per 8 hour working day individually for 3DCRT and IMRT and hence we were able to calculate the design limit of instantaneous dose rate IDR for outside of the secondary barrier. The proposed design limit for IDR is following an IAEA recommendation with 1 mSv/year for public and 20 mSv/year for occupational workers. The data are shown on the following table below:

<table>
<thead>
<tr>
<th>Treatment Modalities</th>
<th>Calculated IDR (in $\mu$Sv/h)</th>
<th>Permissible (in $\mu$Sv/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public Area</td>
<td>Occupational Area</td>
</tr>
<tr>
<td>3DCRT center</td>
<td>IDR&lt;10</td>
<td>ID&lt;194</td>
</tr>
<tr>
<td>IMRT center</td>
<td>IDR&lt;4</td>
<td>ID&lt;80</td>
</tr>
</tbody>
</table>

In our observation, the IDR for design limit depends on the machine dose rate, treatment modalities, total working hours per day and the total working day per year. In conclusion, our
studies reveal that most of the radiotherapy departments in our country are unnecessarily over designed.

OP – 16

A View of the Status of Radiation Protection, Quality Control and Patient Entrance Dose in Diagnostic X-ray Radiology in Nepal

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Nepal has a long history of medical radiology (1923). Unfortunately, till now, there are no radiation protection laws and infrastructures, as well as no radiation regulatory board, to control the use of ionizing radiations in the various fields. The aim of this study was an assessment of the radiation protection in X-ray diagnostic departments, including patient skin entrance dose levels during X-ray diagnostic imaging at different hospitals in Kathmandu valley. The patient doses were done using thermo-luminescent dosimeters TLDs from “Nuclear Service” Bologna. This is the first attempt in Nepal to make spot measurements of the skin entrance dose received during conventional examination in X-ray by using TLD. Due to lack of laws and regulations, in Nepal, radiation survey and quality control is neither compulsion nor mandatory only some institutions have some systems voluntarily.

The following activities were carried out to assess the status of radiation protection barriers and general conditions in different radiological centers; Questionnaire for radiation workers were used; radiation dose levels were measured and an inventory of availability of radiation equipment made. This study was done to create awareness on radiation, to make the radiation workers aware on possible radiation health hazard and to understand their view on radiation protection and also to initiate steps towards establishment of Nepalese code of radiological practice. The dose levels were measured by Roentgen Gamma Ray Dosimeter (RGD27091) and FAG-FH40/F1.

Altogether 12 hospitals including 22 X-ray and 4 CT rooms were monitored, and 107 radiation workers entertained the questionnaire. Most of the general X-ray and CT working areas are safe but some area needs more protection. In Fluoroscopy, some exceed the dose limit noted by ICRP. Only one of the surveyed hospitals has a personnel monitoring system. 70% of the radiation workers are aware of radiation hazard and would like TLD for personnel monitoring, and are aware of the importance of radiation regulatory board and radiation act. There is no quality control program in all surveyed hospitals. There is a maintenance contract with the company, but it is doubtful (most unlikely) whether such contract includes regular quality control (QC) measurements. A QC program should be performed on the X-ray equipment regularly, following international protocols. TLD results show that at some centers patients receive higher dose. Hence there must be regular quality control parallel to maintenance program for the X-ray equipment at regular intervals.
Shielding Calculation: Choice of High Dose Rate (HDR) Source (Co-60 & Ir-192)


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Brachytherapy is one of the cancer treatment management besides external beam radiotherapy (EBRT). At present Brachytherapy treatment is moving from Low Dose rate (LDR) to high Dose Rate (HDR) due to its radiation protection advantage. HDR Brachytherapy is a highly versatile system for enhancing cure and achieving palliation in many common cancers of developing countries. But at present it is a burning question of any hospital in our country regarding installation of HDR Remote Afterloading unit which source either Co-60 or Ir-192 will purchase. For this purpose before establishment of Brachytherapy HDR unit one should have in mind to know the shielding aspects, physical aspects, technical aspects, and economical aspects for this 2 source. To find out a logical answer which source either Co-60 or Ir-192 are clinically and economically more viable, this work has been done. As a result of an expected increases in the construction of Brachytherapy facilities HDR Brachytherapy should be carried out in specially designed shielded treatment rooms where as LDR treatment performed in a ward area. Three materials concrete, lead, steel, and have been used for shielding purpose. Shielding thickness for both HDR units is for primary barriers walls (East, West, North, & South) have been calculated. The protocols used for this work is National Council Radiation & Measurements (NCRP), International Atomic Energy Agency (IAEA), International Commission on Radiological Protection (ICRP) and Basic Safety Standard (BSS) and Safety Series-47. For HDR Ir-192 unit the calculated value of the shielding walls thickness using concrete materials is as follows, East 35.8cm, North 53.2cm, West 55.6cm, South 24.3cm, Maze 34cm. Using Steel materials East 10.1cm, North 15.1cm, West 15.7cm, South 6.7cm, Maze 9cm. Using Lead materials East 3.8cm, North 5.6cm, West 5.9cm, South 2.6cm, Maze 3cm. For Co-60 unit the calculated value of the shielding walls thickness using concrete materials is as follows, East 51.4cm, North 76.3cm, West 79.8cm, South 34.8cm, Maze 43cm. Using Steel materials East 16.7cm, North 24.9cm, West 26.0cm, South 11.3cm, Maze 14cm. Using Lead materials East 9.7cm, North 14.4cm, West 15.0cm, South 6.5cm, Maze 8cm. In all calculation have been done using all area outside 4 walls is fully (T=1) occupied. In spite of shielding barriers thickness Ir-192 unit is less then Co-60 unit but considering other factors like cost effectiveness, source replacement, half life, Treatment time, Co-60 HDR Brachytherapy unit is more viable & perfect in context to Bangladesh.

NMR Characterization of Metabolites in Prostate Adenocarcinoma

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The understanding of metabolite alterations is very important to trace the neoplast progression in tumors. To monitor the metabolite variation in such pathology, gene and protein expression have been extensively profiled. Despite the complicacy of the investigation of the expression, Nuclear Magnetic Resonance spectroscopy could be the resourceful tool for assigning and quantifying the metabolite changes occurring in the abnormal tissues. Variation in metabolite concentration can be attributed to the biochemical status of organisms. Researchers are being attracted to NMR-based metabolomics using serum samples for the diagnosis and prognosis of disease. Due to presence of hydrogen and phosphorus in the major biological compound, $^1$H and $^{31}$P magnetic resonance spectroscopy is useful to explore the metabolic signatures of squamous cell carcinoma in differentiating from benign tumors and normal tissues. During assigning the metabolites in NMR spectra, it has been found that the choline/creatine ratio is higher in squamous cell carcinoma in comparison to normal tissue. Phospholipid metabolism in the cell membrane is characterized by choline and its derivatives as markers of cellular proliferation. For the detection of metabolites, 2D NMR has been used to indicate the elevated level of alanine, glutathione, histamine, isoleucine, and leucine in tumor tissue in comparison to normal tissue. In this work we present a review on the specific application of NMR to characterize the metabolites differentiating benign prostate, clinically localized prostate cancer, and metastatic disease. Emphasis is placed on the applicability of NMR modality to investigate the changes of metabolites like creatine, choline compounds (choline, glycerophosphocholine, phosphorylcholine), polyamines (predominantly spermine), lactate, alanine and citrate which act as potential biomarkers in the assessment of prostate cancer. The ratio between different metabolites is much more indicative rather than the individual metabolite for the prediction of prostate cancer.

OP – 19

Management of Spent Ion Exchange Resin by Solidification Method and Risk Factor Estimation

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The aim of the study is to manage the radioactive waste product spent ion exchange resins which are generated as low level solid radioactive waste in water purifying system during the operation of TRIGA Mark-II research reactor at Atomic Energy Research Establishment (AERE), Savar, Dhaka for the safety of the environment.

A laboratory based experiment has been conducted for solidification test of spent ion-exchange resin in sand-cement matrix. Ordinary Portland cement and normal sand (1.25 g/ccm) matrix was used in this study. The study was conducted with the variation of sand-cement matrix ratio and also the reverse process. Overall study was designed with two standard process (i) uniformly mixed method (ii) column method. The attenuation coefficient was also estimated for solidification of total amount of spent ion-exchange resin by column method. Radionuclide
leaching study from spent ion-exchange resin has been investigated using de-ionized water with different molar acidic and alkaline water for a period of 1-30 days.

All the spent ion exchange resin samples were collected from the Central Radioactive Waste Processing & Storage Facility (CWPSF), AERE, Savar. Four radionuclides, e.g., $^{137}$Cs, $^{54}$Mn, $^{65}$Zn, $^{60}$Co have been identified in spent ion-exchange resin and the total activity of these radionuclides was estimated on the basis of experimental data as obtained with the HPGe detector. The inhalation dose for the different body parts (bladder, bone surface, brain, breast, stomach, kidneys, liver, bone marrow, lungs, skin and thyroid) of the worker were estimated according to the ICRP 68 with the help of computer tools (RAD TOOL BOX Software).

The average inhalation dose in different body parts were 1.64 µSv, 93.25 µSv, 15.86 µSv, 819.49 µSv and maximum in bladder, liver, lungs respectively for $^{137}$Cs, $^{54}$Mn, $^{65}$Zn, $^{60}$Co. The removal (%) of radionuclides in uniformly mixed method is less than the column method and the removal (%) increasing with the variation of cement. In the leaching study, the leaching rate of $^{137}$Cs, $^{54}$Mn, $^{65}$Zn, $^{60}$Co was negligible for one day to thirty days experiment.

It is seen that in the solidification, that the column method is more effective than the uniformly mixed method and variation of cement is more effective than the sand. These experimental and theoretical results demonstrated that the solidification method is an effective method to manage the contaminated spent ion exchange resin produced in the research reactor.

**OP – 20**

**Optimal Design of Radiotherapy Room for 10 MV to 18 MV Photon Energy Beam by Using IAEA Protocol**

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3) Dept. of Med. Radiation Physics, Gummersbach Hospital, Academic Teaching Hospital of the Univ. of Cologne, Germany

Radiotherapy room design should be cost effective and universal for an energy range and vendors. The design modalities are the important part of the shielding design to protect the non allowable radiation hazard. We have considered ordinary concrete for shielding design with a density of 2.36 g/cm³ for 10 MV to 18 MV energies. A neutron protected door was designed with hydrogenous material for 18 MV. The proposed design will be appropriated for all vendors’ machine for 10 MV to 18 MV photon energies and all ranges of electron energies. The calculation of room dimensions are considered by the machine dimensions with other related parameters of Varian, Elekta and Siemens. The rule of radiation protection, recommendations and requirements by Bangladesh Atomic Energy Commission (BAEC) and Nuclear Safety and Radiation Control Division (NSRCD) also considered for this design. The shielded barrier thicknesses are calculated followed by IAEA method and protocol.
History of IMRT

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In 1990 few physicists were working on IMRT. In the mid-1990s the main techniques had been established but all deliveries were to phantoms not patients, and in university hospitals. The subject had not become interdisciplinary. By the late 1990s all the major manufacturing companies were offering embryonic IMRT planning and delivery systems and now one might observe “everyone wants IMRT”. The rise of interest in IMRT has been astronomical. It has become truly interdisciplinary requiring the merged skills of oncologists, radiographers, engineers, physicists and technologists. It promises a major change of approach to clinical practice and education, training, practical experience and implementation of IMRT should become non-negotiable features of the future of radiotherapy. The language of IMRT In the early days we spoke and wrote about ‘beam modulation’, ‘variable fluences’, and a variety of other phrases mean the same thing. No official body standardized the language and the acronym “IMRT” has entered our language (about 1996) without anyone being able to recall its first use. Ned Sternick’s book was the first to have the words IMRT in its title. Pre-history of IMRT The mathematician George Birkhoff showed in 1940 that any drawing could be made up of lines of varying pencil thickness so long as negative pencils were allowed. If we read “X-rays” for “pencils” and “dose distribution” for “picture” the analogy with IMRT is clear. Sadly there are no negative X-rays or uncomplicated tumour control would be 100% guaranteed. In the 1950s Shinji Takahashi was using beams shaped by a primitive multileaf collimator (MLC) with rotation to achieve CRT. The Royal Free Hospital developed the tracking cobalt unit and MGH Boston tracked the jaws of a linac to shape fields. Proimos developed “gravity blocking”, a form of binary on-off IMRT, in which the target was always in the beam’s-eye-view and synchronous shielding of organs at risk (ORs) was a feature.

There is very little dissention from the view that IMRT began in 1982 with the seminal publication from Anders Brahme and colleagues in the Karolinska Institute in Stockholm. This paper showed that for a very special 2D inverse problem with complete circular symmetry it was possible to generate an annulus of uniform dose around a completely blocked central circle by rotating a modulated beam profile. This first paper on IMRT showed how to begin with a desired dose distribution and arrive at a specification of the required fluence modulation to create it. Today we refer to this process as inverse-planning. The next milestone in inverse planning in 1988 was also by Brahme in which was explained the notion of creating fluence profiles from dose distributions by first inspecting the dose distribution in dose space, then deconvolving the point-spread dose kernel from this to create the density of fluences required. The next step was to backproject the density of fluence back into fluence space to create the fluence profiles. Then, from the profiles so generated, the deliverable dose distributions could be formed by a process of projecting the fluence back into dose space. Also, the process could generate negative fluences and so required some form of truncation to zero or the addition of constant terms in fluence space. The work was a landmark because it established the idea of this kind of planning viewed as a form of inverse computed tomography, a term which actually was used for a while but later abandoned. It is important to make a few observations on the “position” in 1988. (i) There was no equipment capable of delivering a modulated beam (other
than a compensator). Computer controlled multileaf collimators were only just beginning to be available and it would be 6 more years before the “translation equations” linking modulated fluence to field patterns would be known. Even then it would be another 3 years before commercial equipment would be available. (ii) There was just this one inverse planning technique. (iii) There were no commercial inverse-planning algorithms or equipment. (iv) The subject was generally regarded as the research interest of physicists. The next steps in inverse planning in the late 1980s/early 1990s. At the end of the 1980s there were just a handful of physicists working on inverse planning for IMRT. At the Royal Marsden Hospital in London, Webb had developed IMRT inverse planning by simulated annealing by 1989. At Memorial Sloan Kettering Cancer Center in New York, Mageras and Mohan has made similar independent developments. At DKFZ, Heidelberg, Bortfeld working with Schlegel, was developing an analytic gradient descent technique that mimicked the inverse of computed tomography. These techniques generated 2D dose distributions from 1D modulated fields. In the early 1990s techniques were extended to generate 3D dose distributions from 2D modulated fields.

OP – 22

Evidence Based Treatment in Radiation Oncology
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The field of radiation oncology is continuously changing to provide best possible treatment to the malignant patients. For the management of cancer patients application of newly developed radiation techniques or treatment strategy to a particular type of malignancy is needed. It requires vigorous testing and verification before it can be called standard. Though much progress has been made in clinical research and that medical decision making based on the result of scientific studies has increasingly prevailed, simply citing or using some research is insufficient for effective clinical decision making. For evaluating and understanding scientific evidence requires proficient skill and knowledge of evidence based medicine. The conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patient is called evidence based medicine. So, now, application of principle of evidence based medicine in radiation oncology is necessary and what is called evidence based medicine in radiation oncology is a very important issue. In this article methods of application of evidence based medicine in radiation oncology will be discussed. A discussion on merits and demerits and current recommendations of evidence based treatment in radiation oncology will be included. In conclusion in the modern era, knowledge should be concrete to improve the quality of cancer care through the utilization of best available scientific evidence in patient’s value and physician’s expertise that is - the evidence based radiation oncology.
An observational study of radiation alone versus radiation with chemotherapy boost for advanced squamous cell carcinoma of head and neck

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Background: Head and neck cancer is the most common cancer in Bangladesh. Low socio-economic status, poor oral hygiene, poorly fitting denture, smoking all contribute for the development of head-neck cancer. Majority people live in the rural areas and attain doctor or hospital with advance disease due to lack of awareness.

Rationale of the study: Though radiation therapy has a good response to control loco-regional extension of the disease, it has less effect on metastatic deposits. To increase local treatment response and overall survival, in addition to radiotherapy, chemotherapy has an important role to promote tumour regression and inhibition of micrometastasis.

Aim and objective: To observe the treatment response with chemotherapy boost in the last five days of treatment by radiation versus radiotherapy alone at primary site and metastatic neck nodes of head-neck cancers and, to observe toxicities between the two arms.

Result: A total of 128 patients with advanced head-neck cancer (stage III and IV disease) were enrolled in two arms according to patient selection criteria. Arm A treated with radiotherapy 56 Gy in 28 fraction and concurrent chemotherapy Inj. Cisplatin 10 mg/m\(^2\)/day and Inj. 5 Flurouracil 400 10 mg/m\(^2\)/day in last five days three hours after radiotherapy as chemo-boost and Arm B treated with radiotherapy 60 to 66 Gy. Complete response was observed in 74.2% and 56.2% at primary site and 62% and 40.6% at neck node in arm A and arm B respectively which were statistically significant. Significant mucositis, dysphagia and haemopoeatic toxicities were observed in arm A compared to arm B.

Conclusion: The study showed effective approach for combining chemotherapy with radiotherapy. Higher response rate was observed in patients treated with concurrent chemo-radiation with acceptable significant toxicities.

Three Dimensional Brachytherapy: A Possibility for Better Outcome of Cervical Cancer Management in Bangladesh.

Kamaluddin A F M

Brachytherapy (BT) plays a major role in the therapeutic management of patients with cervix cancer from stage I to IV. The rapid dose fall-off allows a very high dose to the tumor and central pelvis, while relatively sparing surrounding organs at risk bladder, rectum, sigmoid and small bowel. Concomitant chemo-radiation followed by BT represents the standard of care in patients with stage IB2 to stage IVA.
Gross Tumor volume (GTV) is well recognized as one of the most important prognostic factors in terms of local control. Therefore, a complete coverage of GTV and the GTV related Clinical Target volume (CTV) is crucial and is to be expected to be related to a better outcome.

In most part of the world including Bangladesh still BT is practiced on the Principle of Manchester system. The main guideline for this was ICRU recommendation. But this procedure has some limitation which did not allow us to ensure the proper coverage of the tumor area.

In 2000, GEC-ESTRO decided to support 3D image based 3D treatment planning approach in cervix cancer with the creation of a Working Group. This working group recommended identifying High Risk Clinical Target Volume (HRCTV) and Intermediate Risk Clinical Target Volume (IRCTV) in addition to GTV with the help of MRI and CT image. Special devise like CT /MRI Compatible Applicator and specific guideline is used in this recommended 3D Brachytherapy procedure.

After applying this technique remarkable improvement in treatment outcome is achieved and it was published on and after 2005. Application of 3DBrachytherapy technique is very much possible in our country as all the required equipments and trained manpower is available.

**OP – 25**

**The Effects of Electromagnetic Fields on Human Health**

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Since The beginning of the 20th century, we are overwhelmed by the increasing sources of the Electromagnetic Field (EMF) that is coming from telecommunication, electricity, appliances, medical equipment, and many other apparatus that we use in our daily life. Although these new technologies became inevitable and indispensable, the EMF they produce may cause health risks and hazards to human. Some studies show a link between exposure to EMF and increased rate of Leukemia, cancer, brain tumors and other health problems. Also, there is some uncertainty about the actual mechanisms responsible for these biological hazards and which type of fields magnetic or electric or both are of great concern. It is needless to say that no matter the effects of these EMF be trivial or catastrophic, we should take all the necessary precautions to reduce our exposure to EMF as low as reasonably attainable. For this reason, all those involved or affected by this exposure should follow the RF safety standards and guidelines set forth by the regulatory authorities like the IEEE, WHO, ICNIRP, and other likewise organizations. Any failure in taking immediate actions to the above guidelines, the public would be at a high epidemic risk of potentially fatal diseases in the future.
Activity Concentrations of Selected Natural Radionuclides in Some Commercialized Bottled Drinking-Waters in Nigeria and Consequent Radiation Doses to Consumers

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Purpose: Activity concentrations of the selected radionuclides $^{40}\text{K}$, $^{226}\text{Ra}$ and $^{228}\text{Ra}$ were measured in some bottled drinking-water samples produced in Nigeria for the purpose of estimating the radiation doses and possible health detriments to their consumers and determine where remedial actions should be taken.

Methods and Materials: The measurement was carried out using high-purity germanium (HPGe) detector (Canberra Industries Inc.) coupled to a multichannel analyzer computer system. The measured activity concentrations of the radionuclides were used with their ingested dose conversion factors and average water consumption rate to estimate annual effective doses for the age groups 0-1y, 1-2y, 2-7y, 7-12y, 12-17y and 17y and above from consumption of the water samples.

Results: Measured activity concentrations of the selected natural radionuclides $^{40}\text{K}$, $^{226}\text{Ra}$ and $^{228}\text{Ra}$ ranged from 7.44±2.10 to 22.61±7.02; 0.06±0.02 to 2.21±0.38 and 0.12±0.05 to 3.47±1.23 Bq l$^{-1}$ respectively. Potassium-40 accounted for most of the activity. Calculated total annual effective doses ranged from 0.87 to 22.90; 0.22 to 5.69; 0.15 to 3.95; 0.21 to 5.36; 0.53 to 13.02 and 0.09 to 2.20 mSv y$^{-1}$ respectively for the different age groups. While the largest total annual effective dose was determined in Oakland bottled water, the least was determined in Olivia bottled water.

Conclusions: All samples (except Olivia and only to ≥17y age group) gave total annual effective dose larger than the average worldwide ingestion exposure dose value of 0.12 mSv y$^{-1}$ from uranium and thorium series reported by the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR). All the bottled drinking-water samples are therefore recommended for treatment that will remove radium from them to lessen the health burden of radiation exposure on the consumers.

EMG Signal Classification Using Support Vector Machine with Respect to Wavelet Decomposition

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Electromyography (EMG) signals can be used for clinical/biomedical applications, Evolvable Hardware Chip (EHW) development and modern Human Computer Interaction. EMG signals acquired from muscles require advanced methods for detection, decomposition, processing, and classification. For properly analyze EMG signal there need good quality of decomposition so that it can reveal the total characteristics of EMG signals. Because EMG signal is Non-
Stationary signal so it needs such a method that can decompose non-stationary signal thus wavelet decomposition is a good choice for this type. There are different types of wavelet available. Henceforth, it is necessary that proper attempt should be taken to choice the best one. Here analyses of EMG Signals were made by Various Wavelet Decomposition method with different types of wavelet and it illustrates the comparative study on best possible energy localization in the time-scale plane. In a second phase for training we use decomposed known EMG signal; then use decomposed unknown sample EMG signal for classification. EMG signals obtained from normal (NOR), myopathic (MYO) and motor neuron diseased (MND) subjects were analyzed. The success rate to extract MUAPs was highest in wavelet decomposition. In classification for multi-class SVM show better performance than the statistical pattern recognition technique. The EMG signals used for this study - were found both from locally collected as well as from www.emglab.net which provides EMG signal related raw data and other facilities.

**OP – 28**

**Aiding Autistic Children Employing Computer Technology**

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Autism is a potential threat to the present world. A great number of individuals have been suffering from autism worldwide. It is a noncurable developmental neural disorder characterized by social interaction and communication impairments and by restricted interests as well as behavior. Specific causes of autism have not yet been known and there’s no medication of it. A number of therapies or treatments for autism are announced frequently, but most of them have not been proven by adequate scientific research.

To facilitate the development of individuals with autism, the potential of the computer based systems is quite promising. For many years computer technology is being used for therapeutic teaching of autistic children as well as adults. Kenneth Mark Colby developed one of the first applications of computer-based education system for language acquisition of nonspeaking autistic children. In 1981 Geoffrion and Goldenberg showed further evidences that computer based exploratory learning systems can increase the ability to response in autistic children. Strickland experimented with two autistic children using Virtual Reality as a learning tool and found that both infants could successfully identify familiar objects. For the development and rehabilitation of infants with autism, various computer-based systems, like robotic system, virtual environment, Avatars, TEACCH Methods have been studied in the present work. The purpose of this paper is to create awareness about autism by discussing its characteristics, diagnosis, and computer-based educational techniques with a view to enhance skills of autistic children.
Zinc Status in Children with Hb-E-β-Thalassemia

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Hb-E-β-Thalassemia is a major congenital hematological disease of Bangladesh. The patients have poor growth and delayed maturation mainly due to iron overload but zinc deficiency also has been suggested as a contributing factor. This cross sectional study Hb-E-β-Thalassemia was undertaken in the out-patient department of Paediatric Haematology and Oncology department of Bangabandhu Sheikh Mujib Medical University from July 2009- May 2010. The objective of this study is to investigate and compare the serum zinc Hb-E-β-Thalassemia patients and normal children and to see the relationship between serum zinc and growth status. Total 31(Thirty one) children with zinc Hb-E-β-Thalassemia had been enrolled for this study and matched 30 (thirty) healthy children were taken as control. Diagnosis of zinc Hb-E-β-Thalassemia was based on peripheral blood smear evaluation and hemoglobin electrophoresis of the patients. After initial assessment the cases were thoroughly examined by the investigator and family history, transfusion interval, weight, height were measured properly and were plotted in NCHS chart. Blood samples (3ml) were drawn from patients and normal control children, then centrifuged, then collected and stored at -20°C until analyzed. Serum level of zinc was measured by using Flame Atomic Absorption Spectrophotometry.

Mean age of the thalassemic group and control group was 79.8 months (SD-38.3) and 74.4 months (SD-36.3) respectively. Male: female ratio of the cases was 13(42%):18(58%) in thalassemic group and that for control group was 13(43%):17 (57%).

Among 31 (thirty one) Hb-E-β-Thalassemia patients 22 (71%) cases present with an enlarged liver and 29 (93%) cases present with enlarged spleen with varying sizes. Haematological parameters e.g. haemoglobin, MCV, MCH and MCHC were significantly lower in Thalassemic group than control group. In Hb-E-β-Thalassemia patients mean Hb, MCV, MCH and MCHC were 6.1 gm/dl (SD-0.7), 62 fl (SD- 4.4), 20.2 pgm (SD-1.9) and 26.5 gm/d (SD-2.3) respectively. These parameters in control group were much higher than in the group of cases.

Mean weight and weight for age were 17.4 kg (SD-5.5) and 75.9% (SD-9.4) respectively in children with Hb-E-β-Thalassemia. But in control group mean weight and weight for age were 17.6 kg (SD-5.9) and 81% (SD-6.9) respectively. There was no significant difference between these two groups (p=0.47).

Mean height and height for age were 106 (SD-14.7) and 89% (SD-4.8) in children Hb-E-β-Thalassemia and those were 106.8 (SD-17.9) and 93%(SD-2.5) in control group. There was a significant difference height for age between both the groups (0.05).

Mean serum zinc level in thalassemic group and control group was 97.4µg/dl (SD-18.4) and 99.6 µg/dl (SD-18.7), respectively. There is no significant difference between the two groups (p=0.47). There is no significant alteration of zinc level in patients with Hb-E-β-Thalassemia (p=0.47).
Preterm Delivery: Role of Zinc and Copper

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Preterm delivery is a very challenging obstetric complication in Bangladesh. Reduced serum Zn and Cu concentration of the pregnant mother may have some role in causing preterm delivery. To measure serum zinc and copper level in mother with preterm delivery and also to observe their relationship with fetal outcome. This cross sectional study was carried out in the Department of Physiology, Sir Salimullah Medical College Mitford Hospital, Dhaka, during the period of 1st January 2009 to 31st December 2009. A total number of 136 subjects were included in this study, of whom 27 were full term delivery mother with their respective neonates (control) and another 27 were preterm delivery mothers with their respective neonates (study group). Age ranged of preterm and full term mother were from 20-40 years. Again, 28 non pregnant women with age range from 20-30 years were taken as reference value. Statistical analysis was done by using appropriate method as applicable. Mean serum Zn and Cu level were significantly lower (p<0.001) in preterm mother in comparison to those of full term mother. Again, cord serum Zn and Cu concentrations were significantly (p<0.001) lower in preterm neonates when compared with those of full term neonates. The present study revealed a lower level of serum zinc and copper in pre-term delivery mother and their neonates. These hypozincemia and hypocupremia may be responsible for poor fetal outcome.

Key words: Zinc, copper, preterm.

Effects of Electromagnetic Fields: Electromagnetic Hypersensitivity
(A case study)

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It is only about 100 years since electricity generation started, 70 years since radio transmission and 30 years mobile telephone system came into existence. As the world is being industrialized and technological revolution continues, there has been an unprecedented increase in the number and diversity of electromagnetic (EMF) sources. While all these devices have made our lives richer, safer and easier, they have been accompanied by concerned possible health risks due to their electromagnetic field (EMF) emission.

For some time a number of individuals have reported a variety of health problems that they relate to exposure to EMF. While some individuals report mild symptoms and react by avoiding the field as much as they can, others are so severely affected that they cease work and change their entire lifestyle. So, repeated sensitivity to EMF has been generally termed
“electromagnetic hypersensitivity” or “EHS”.

There is a wide range of estimates of the prevalence of EHS in the general population. A survey of occupational centers estimated the prevalence of EHS to be a few individual per million in populations. However, a survey of self-help groups yielded much higher estimates. Approximately 10% reported cases of EHS were considered severe.

There is also considerable geographical variability in prevalence of EHS and in the reported symptoms. The reported incidence of EHS has been higher in Sweden, Germany and Denmark than in the UK, Austria and France. VDU related symptoms were more prevalent in Scandinavian countries and they were commonly related to skin disorders than elsewhere in Europe. Symptoms similar to those reportedly by EHS individuals are common in the general population.

EHS is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary on their severity. Whatever it causes, EHS can be a disabling problem for the affected individuals.

A case study has been carried out very recently among the employees of a NGO organization (office block). It was found that people (working near high voltage field) had various sufferings due to the exposure of high electromagnetic field only within a few weeks, it may be considered as hypersensitivity of the people towards the effect of EMF.

**OP – 32**

**Low Cost, Noiseless and Patient Safety ECG Amplifier and Filter**


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**Purpose:** The purpose of this work is to design and implement a low cost, noiseless, safe for patients ECG amplifier and filter.

**Methods:** Three clamp electrodes were used to receive ECG signals from the body. The whole implementation includes an active ground, amplification stage, filtration stage and isolation unit. Active ground minimizes the effect of displacement currents in the body. Pre-amplifiers initially amplify the very low voltage ECG signal. An instrumentation amplifier with adjustable gain amplifies the pre-amplified signal. Voltage follower lowers the output impedance of instrumentation amplifier. A low cut-off frequency high pass filter passes the small frequency ECG signal. Then another voltage follower is used. An eighth order low pass filter stage was used to eliminate the 60 Hz power line interference. Finally an isolation unit prevents the patient from electric shock. Batteries were used to power the amplifiers. A digital oscilloscope was availed to display the ECG signal.

**Materials:** The used equipment are ICs of type LMC6484, AD620, AD210, LM358, and PC111, clamp electrodes, a digital oscilloscope and further small materials such as resistances, capacitors.

**Result:** An amplified, noiseless and well distinguishable ECG PQRST signal can be observed on the oscilloscope.
Conclusion: The acquired signal can be digitized and processed to detect defects of the heart.

OP – 33

On chip si-microring resonator for bio-medical applications at µm wavelength

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Nowadays, Optical resonator has generated wide interests in the detection and sensing field. This is possible only for a small change on the refractive index can be detected from the shift of resonance wavelength and the splitting of the resonance modes. The synergy between microresonator and nanoparticle can be used for various applications, such as biological imaging, fluorescent markers for biological processes, contrast agents in bio molecule sensing, cancer therapies and photothermal tumor ablation etc. We experimentally demonstrate a high-Q silicon microring resonator operating at wavelength of 1.55µm with/without Au nanoparticles. We consider the micro ring resonator (4µm in diameter) and the ring waveguide (width is 200nm) as a single mode waveguide. SiO2 as the bottom cladding and air as the top cladding. The two bus waveguides are evanescently coupled to the micro ring resonator, with the coupling gap 100nm and the thickness of the ring resonator and bus waveguide is 250nm. We used 2D Finite Difference Time Domain (FDTD) method & Perfect Matched Layer (PML) as absorbing boundary condition. The Au nanoparticle was placed at the outside edge of the micro ring resonator and found resonance wavelength shift and broadening of the splitting bandwidth with the increase number & size of Au nanoparticles but irrespective of position up to certain limit – when the interaction between metallic nanoparticles and micro ring resonator is becoming so strong that they completely degrade the resonance – the Q is strongly degraded and the intensity at output port is approaching zero. This unique result by Au nanoparticles is used extensively for sensing and nano medicine field.

OP – 34

Pleading for an Increased Role of Monte Carlo simulations for Education and Training in Medical Physics

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Education and training are important factors for adopting, using and supporting medical physics activities. Of course, education of medical physicists should be tailored towards the requirements of healthcare institutions. The educational programs usually comprise of general courses in physics and mathematics, and more specific courses in medical physics with special emphasis on radiation protection and radiotherapy physics. As an example, such courses have now been implemented as master courses in almost all countries of the Asian region (Hartmann, Bangladesh Journal of Physics 7&8, 2009). Although many of these courses appear
quite well organized, a typical problem is left which is caused by the limited access to radiotherapy related equipment. In general, this may render the definition of solid scientific topics to be treated within the master thesis more difficult.

The introduction and working with Monte Carlo based simulations already during this step of academic education is suggested to overcome this difficulty. For a long time, Monte Carlo calculations in Medical Physics were considered to be a very complicated material only accessible for some specialists. Today, however, there are quite convincing reasons to venture a jump into this area: (a) PCs are nowadays available almost for everyone and everywhere; (b) there are Monte Carlo codes specially addressing the physics of radiation as involved in radiotherapy which are easily available just by downloading from the internet. The most prominent example for that is the EGSnrc system offered by the National Research Council Canada. (c) implementation of particular this system is relatively simple (and can even be further simplified as shown in this talk), and (d) when working with modern Fortran compilers such as the Intel Fortran Composer (which enormously supports the visualization of code writing and testing), even for beginners it is quite easy to start meaningful code developments and applications, i.e. not being dependent to use a Monte Carlo code as a black box tool.

This talk gives some examples of how Monte Carlo methods can be introduced and applied to interesting medical physics topics. In addition it is also shown how a combination of Monte Carlo calculations with computer graphics can be accomplished which opens a new world of simulation tools. Therefore, having established the competency to work with Monte Carlo simulations in radiation therapy physics, such tools can also be used to further increase the field of E-training.

**OP – 35**

**Medical Physics and Biomedical Engineering Education in Gono Bishwabidyalay (University)**


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Cancer is usually being treated with three modalities: surgery, chemotherapy and radiotherapy. Oncologist and medical physicist together contribute to perform the radiotherapy treatment. In developing countries like Bangladesh the cancer patients are estimated to be 2000 out of 1,000,000 inhabitants per year according to WHO. The inhabitant of Bangladesh is 160,000,000. Therefore radiotherapy can play a major role to offer adequate treatment to the cancer patient in the country. We don’t have a sufficient number of medical physicists to give the radiotherapy treatment to these cancer patients. The purpose of this study is to provide detailed information about the education of 4 years (8 semesters) B.Sc & 2 years (4 semesters) M.Sc in Medical Physics & Biomedical Engineering in Gono Bishwabidyalay for the national & international students, teachers and the concern people of radiotherapy units of Bangladesh.

History to establish this department, Location of the campus, Criteria to get admission, Course content, Duration, Semesters, Permission of University grand commission (UGC) of Bangladesh, Collaboration with Universities and Institutions, Faculty members, Class rooms,
Support of other departments, Examination procedures, Answer script evaluation, Final result (cGPA) calculation, Library facilities, Reading materials, Teaching techniques, Laboratory facilities, Project and Thesis works are considered to make the information. University prospectus for last ten years and document files from the university office were used for this study.

The eligibility criteria: for B.Sc and M.Sc in Medical Physics & Biomedical Engineering is minimum 2.5 GPA in science group with mathematic & physics in intermediate level and is MBBS or minimum bachelor degree in medical physics, biomedical engineering, electrical & electronic engineering, mechanical engineering, physics, applied physics, computer science, mathematics, biochemistry and biology respectively. B.Sc project and M.Sc thesis are supervised by local and German eminent medical physicists & biomedical engineers. The graduates who obtained their degree from this department are placed in teaching, reputed radiotherapy units of government hospitals, private institutions and also in companies. The graduates are contributing significantly to the cancer patient treatment in Bangladesh.

Medical physics & Biomedical Engineering education in Gono Bishwabidyalay (University) is a successful story. Public University can come forward to establish the department for the education of Medical Physics & Biomedical Engineering in the country. Only then medical physics education will expand, quality will increase and sufficient numbers of man power will be available in radiotherapy treatment. Finally, the cancer patient will benefit in the country.

VP-04

Radiosurgery with the SmartKnife - cheap, effective and precise:
The SmartKnife system as an economic solutions for high precision radiation therapy.

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Purpose: Industrial developments in Radiotherapy of the past decade strive towards high complexity – high investment solutions only affordable by financially well equipped healthcare providers and systems. Yet the clinical benefit does not always justify the cost. To provide highest standard, yet affordable and economic solutions for radiation therapy, Precisis launched the SmartKnife system.

Solution & Advantage: The Precisis SmartKnife system mainly consists of a manual add-on multileaf collimator with 1mm leaf size for highest precision, fixation systems for various applications and the dedicated radiosurgery treatment planning system Virtuos. It is clinically proved and designed for highest adaptability.

The feasibility for use in conjunction with both, existing Linac as well as Co-60 teletherapy systems combined with the unmatched robustness due to the manual design makes it a cost effective tool to provide high precision radiotherapy.

Application: Depending on the applicants requirements, the system can be used for both,
cranial radiosurgery in including hypofractionated methods and extracranial therapy, namely SRS and SBRT. It can therefore replaced dedicated cranial-only radiosurgery devices as well as serve as useful add-on for any general external beam radiotherapy machine.

**Outlook:** Due to the SmartKnife’s advantages regarding precision, cost-benefit ratio and the adaptation possibilities, a beneficial impact on improving healthcare provision for developing and emerging countries and other cost conscious personnel in radiotherapy is expected.
Comparison between Cobalt-60 Teletherapy Machine and Linear Accelerator - Choice of Teletherapy Unit in a Developing Country

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In Bangladesh at present cancer management is turning in a new evolving science. It is the transitional period from conventional to conformal radiotherapy. Previously cancer cases were mainly treated by Cobalt radiotherapy machine in government hospitals. There were 11 Co-60 machines in Bangladesh. At present 10 Linear Accelerators (linacs) are in treatment position and further linacs are expected to come. So the questions naturally arise whether these Linear Accelerators should be used in replace of Cobalt machine or these both should be used simultaneously. The aim of this study is to reveal these answers by discussing their physical, technical, medical and economical aspects. Linac can provide either megavoltage electron or X-ray therapy with a wide range of energies in comparison with Co-60, which provides only one gamma energy of 1.25 MeV. The physical aspects of Linear Accelerator are also superior to Co-60 in respect of source surface distance, Dmax, dose rate, more uniform dose, percentage depth dose and penumbra. These physical properties combined with multileaf collimator (MLC) the Linear Accelerator and computer treatment planning system (TPS) with 3D calculation algorithm open the possibility of conformal therapy technique, which is the precondition of curative therapy. Though the initial cost of linac appears to be high, over a ten-year period maintenance costs are less as it does not require change of source as well as disposal of decayed source (Co-60). Despite the clear technological and practical advantages of linacs over Cobalt-60 machines, the latter still occupy an important place in radiotherapy armamentarium in the developing world for the foreseeable future, mainly because of considerably lower capital, installation, maintenance costs, simplicity of design, ease of operation. Also from the therapy intent view, palliative treatment is more than curative therapy in our country, as palliative therapy need less sophisticated machine and less planning precision, rather than more precision used for curative purposes. So in summary an ideal radiotherapy facility in developing countries like us ought to have as minimum equipment a sturdy cobalt teletherapy machine for palliative work, modern linac machine for elaborative curative work and also a remote afterloading machine for gynaecological cancer of our vast female patients.
Dosimetric Parameters of Physical and Enhanced Dynamic Wedges: Calculation with Treatment Planning System and Verification by Measurement

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Both Enhanced Dynamic Wedge (EDW) and Physical Wedge (PW) of modern linear accelerators are required for treatment planning and dose delivery to patients. In this study, wedge beam characteristic of Physical and Enhanced Dynamic Wedge were calculated and verified by measurement. All measurements were performed with a linear accelerator (Clinac 2100C, Varian Medical Systems) at 6 MV X-ray beams. Wedge factors and profiles for PW and EDW were measured by a PTW cylindrical ionization chamber and a Scanditronix-Wellhoefer LDA-99 linear array detector in a water phantom respectively. Measured profiles were compared with calculated profiles from the Eclipse Treatment Planning System (TPS) for PW and EDW. Measured Wedge factors for PW and EDW were also compared. The comparison of measurement and calculation of PW shows in the middle-field region a deviation of less than 1%. However, on field boundaries, a greater deviation (maximal 4%) is present, which is largely independent on the wedge angle. For EDW, the deviation between measurement and calculation in the middle-field are in general slightly larger than for PW (maximal 2%). Additionally, on field boundaries a higher deviation is present which increases with the wedge angle. By using PW, the maximum variation in normalized wedge factor NWF with field sizes is 4.5% for thick wedge (60°) and decreases with decreasing wedge angle. Whereas for EDW, the maximum variation is from 20 % to 40% from thinner to thicker wedge. In this study it was found that, the deviation between measurement and calculation for both PW and EDW has no relevant effect in the clinical practice. However, one should be noted that the irradiation of patients with fields using EDW could lead to errors due to non-constant movement of the collimators. Therefore it must be examined at frequent intervals.

Development of Low Cost EMG Signal Acquisition Hardware and Software Using Sound Card and INA 128

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ICS, Bangladesh Atomic Energy Commission

Electromyography (EMG) signals can be used for clinical/biomedical applications. Demonstration of surface electromyography (EMG) to medical students in the physiology laboratory will facilitate better understanding of muscle electrophysiology and expose them to a procedure used for clinical investigation and medical research. Traditionally, demonstrating the EMG requires expensive EMG machines with data-acquisition systems. Here, we present a
simple EMG display and recording system for student laboratory use that costs less than $10 excluding the computer. The system consists of an EMG amplifier, a computer with a sound card. The main part of the circuit is single integrated circuit IC instrumentation with two additional components to effect high-pass filtering. The EMG signal is picked up by two electrodes (E1 and E2). The electrodes may be chloridized by immersing them in sodium hypochlorite solution (bleach) for a few seconds to form silver/silver chloride electrodes. The electrodes are connected to the IC input pins, pins 2 and 3, of INA 128. The IC is powered by two 9-V batteries connected in series, with the central common terminal being the circuit ground. The positive and negative terminals of the 9+9V battery are connected to the respective power supply pins (pins 7 and 4) of INA 128. The circuit ground is connected to pin 5. Subject ground is obtained by placing an electrode over electrically inactive tissue on the subject and is connected to the circuit ground. Pins 1 and 8 determine the amplifier gain if a simple resistor is connected across. In our design, a reactive impedance, comprising a capacitor and a resistor in series, is connected between pins 1 and 8 so that a high-pass filter is also achieved in the single chip circuit. Using a resistance of 120 and a capacitance of 50 µF, an amplifier gain of 400 and a high-pass cut-off frequency of 15 Hz are obtained. It must be mentioned that the gain at 0 Hz is unity in this circuit configuration. Since a non-polarized capacitor was not available, two 100-µF electrolytic capacitors were used in series back to back to effect a 50-µF polarity indifferent capacitor. The output from pin 6 is connected to the sound card. The PC software was developed in MATLAB.

AA – 04

Education and Training of Medical Physics in Bangladesh: Problems and Perspectives

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Cancer management is a rapidly evolving science. Whereas there has been relatively ample time for affecting this evolution in the industrialized countries, the situation in Bangladesh is quite different. Cancer treatment is entering a new era from conventional therapy to conformal therapy in Bangladesh so the necessity of medical physicists is growing. From 1996-1999 a series of seminars were arranged by the task group of “DGMP” Medical physics in developing countries” in the Physics department of Bangladesh University of Engineering and Technology (BUET) where the physicists and physicians were informed and encouraged to become medical physicists. Dr. Golam Abu Zakaria, Professor of medical physics was the initiator of the seminars. As a consequence of these seminars in 2001 a private University Gono Bishwabidyalay (GB) came forward to accept his proposal of starting a master program both in Medical Physics and in Biomedical Engineering. From then till now it is the only department where honours and master course in medical Physics is offered. A collaboration program between GB and Heidelberg University along with the cooperation of the German Cancer Research Centre (DKFZ) was implemented between 2002 and 2006 under the German Exchange Service (DAAD). Education and training are the primary objectives of this
collaboration. As a result basic instruments for Medical Physics and Biomedical Engineering, teaching materials have been donated to Gono University and about 12 students, 4 teachers have been visited in DKFZ under this collaboration. Till now 20 students (12 M.Sc and 8 B.Sc) have got the degree in medical physics with specialty in Radiation Oncology Physics. All of them are working in different public and private radiotherapy hospitals and in the department for teaching. The need for rapid expansion of radiation treatment technology demands for urgent development of manpower in Medical Physics. For 140 Million population we need 140 centres for radiotherapy, approx 500 medical physicists. A minimum of 50 qualified medical physicists will be needed for all presently available radiotherapy departments. For this a crash program already started with the collaboration of Germany where 4 radiation oncologists, 3 medical physicists finished their training. Very soon another team comprises of medical physicists and radiation oncologists will undergo this training and this process will go on. Overview all the aspects both in education and training there are still some problems and perspectives. In education project such as the permanent quality assurance procedure to improve quality of academic education, the lengthy accreditation process, or the shortage of local supervisors for master and Ph.D thesis, the lack of certification for “Qualified Medical Physicists (QMP)” etc. Regarding training of the manpower the main problem of this collaboration is the arrangement of financing. In spite of all these difficulties, the establishment of this Department in Gono University is a success story. For overcome the problems a society named Bangladesh Medical physics Society (BMPS) is formed. For training it is recommended financial support could be arranged by the Bangladesh Government, vendors of machines or international organizations like the IAEA or even the German government.

AA – 05

Dosimetry of Brachytherapy sources: Comparison of different international protocols in different methods

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It has generally been recognized that calibration of brachytherapy sources at the hospital is an essential component of a well-designed QA programme. The calculation of dose to a patient depends on the accuracy source calibration. The aim of the calibration is two-fold: to ensure that the value entered into the treatment planning system agrees with the source calibration certificate to within some predetermined limits and to ensure traceability to international standards. The uniformity and precision of the radiation from the brachytherapy source can be greatly affected by the distribution and encapsulation so that sources need to be measured. The air kerma rate in air at a refer distance of 1 meter from the source is the recommended quantity for the specification of gamma source in brachytherapy. The absorbed dose for the patients is directly proportional to the air kerma rate. At present in worldwide remote afterloading unit (RAL) using Ir-192 source is more practicable than remote afterloading unit using Co-60 source. Comparing with Ir-192, Cobalt source has advantages like long half life, low purchasing and disposal costs. Considering this Co-60 RAL are more suited in developing countries. In this work calibration of these two sources are done different measurement methods (with a cylindrical chamber in solid phantom and in free air and
a well chamber) using 3 protocols (TG 41, TECDOC 1274 and DIN 6809 2). Three protocols | | been modified in three techniques of calibration in this study.

Among three methods, well chamber based dosimetry system is a reliable tool for the calibration of photon sources. This statement is based on the fact that it shows the lowest deviation from the certificate value and the standard deviations of the measured air kerma rate for the Co-60 source are generally larger than those of the Ir-192 source. But the solid phantom method can be recommended as quick check and quality control purposes. For measurements in all protocols and methods the deviations stood for both nuclides by a maximum of about 1.2% for Ir-192 and 2.5% for Co-60-sources respectively. It is recommended that these three protocols have to be updated on a uniform level with the latest version, also as a "Code of practice" and with other nuclides, especially Co-60.

AA – 06

Radiation Safety Training in Medicine

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The objective of this presentation is to ensure the following:
1. Implementing an effective radiation safety strategy
2. Examining the role of the hospitals in creating a radiation safety program
3. Enforcing radiation safety practice for patients, staff, physicians and visitors
4. Providing regular radiation safety education to concerned staff
5. Identifying opportunities to improve radiation safety performance

AA – 07

Pilot Study of Patient Doses from Conventional Diagnostic Radiology in Lebanon

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The widespread use of x-ray examination and the increased utilization of recent development of remarkable x-ray equipment have improved the lives of patients in Lebanon; however, this evolution of imaging has also resulted in a significant increase in the population’s cumulative exposure to ionizing radiation.

The objective of this study is to assess the patient doses for most frequent x-ray examinations in Lebanon by measuring the entrance skin dose for patients within the weight range of 65 to 70 kg taken in some of the Lebanese hospitals.

This study gives preliminary results of a pilot project on “improvement in x-ray image quality and reduction in patient dose in radiology” launched by the IAEA and Lebanon –LAEC as a first step towards the standardization of medical imaging procedures in Lebanon.
Quality control checks on the x-ray machines used for the study should be performed prior to the experimental investigations.

The results will be compared between involved hospitals and compared to the international reference levels of patient dose; this study will help to provide a more unified diagnostic radiology practice and help to reduce patient exposure levels to those comparable to IAEA standards.

We hope through this effort to establish in the near future national reference dose levels in Lebanon.

AA – 08

The Medical Physicist and Advanced Technology in the Field of Science and Medicine

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Medical Physics is the branch of physics concerned with the application of physics to medicine, particularly in the diagnosis and treatment of human diseases. The main areas of interest at present are in the treatment of cancer by ionizing radiation (Radiation Oncology), in diagnostic imaging with x-rays, ultrasound and nuclear magnetic resonance (Diagnostic Radiology), in diagnostic imaging and treatment with radioisotopes (Nuclear Medicine) and in the study of radiation hazards and radiation protection (Health Physics).

Medical physicists are scientists. It is through science that they are able to identify problems and unveil deficiencies. It is also through science that they solve the problems and correct the deficiencies.

From the time when Wilhelm Roentgen and other physicists made the discoveries which led to the development of Diagnostic Radiology, Radiotherapy, Brachytherapy and Nuclear Medicine, medical physicists have played a pivotal role in the development of new technologies that have revolutionized the way medicine is practiced. In today's health care scene, the medical physicist is essential to the safe and cost effective operation of any creditable medical institution.

There will be exciting and difficult challenges in the field of health care during this century. Count on the science of Medical Physics to help you meet the challenge.
Developing and application of an E-Training module for education in Medical Physics: Calibration of High Energy Photon and Electron Beams According the IAEA Code of Practice TRS 398


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Medical physicists make a major contribution to the safe and effective application of radiation to patients with cancer. Academic education as well as clinical training is required prior to being able to practise radiation oncology medical physics. However, in particular in developing countries the problem frequently exists that resource with respect to both, qualified teachers and equipment that are at disposal for teaching and training, are lacking. It is expected that concepts and methods of e-learning may contribute to overcome this problem. Whereas for academic teaching e-learning material is more and more available, material for clinical training is still rare. This has motivated us to develop a virtual training module for the calibration of high energy photon and electron beams which is considered to be a key competency to be mastered by medical physicists working in a radiotherapy unit. A PC based program simulates the required equipment, the measurement set-up, and the measurement itself; it also serves as a guide through the evaluation of the virtually measured data. All procedures are modelled according to the IAEA Code of Practice, TRS 398. This training module has already successfully tested at different occasions such as ESTRO courses or the European School of Medical Physics.

Integrating Technology, Quality and Safety in Radiotherapy

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The last two decades has witnessed quantum jumps in technological innovations. Both planning and delivery processes of radiotherapy have undergone significant changes. Such rapid changes have constantly put pressures on the existing logistics both infrastructural and human resources. The bigger as well as smaller centers have been trying to cope with such changes world over. The heath care boom in India resulting from the economic growth has put us in a unique situation and almost everybody is under pressure to chew more than they can bite.

Best practices in radiotherapy are an outcome of how well integrated the processes are. They are as weak as the weakest link is. Multidisciplinary hospitals are adding radiotherapy. The advantages of multimodality imaging and inputs from pre radiotherapy procedures are of vital importance today. Equipment selection is not limited to delivery set ups only, but has to take into account the integration with planning and dosimetry upfront. Strengths and weaknesses of vendor specific solutions have to be analyzed and the constant pressure to upgrade by the
vendors has to correlate with qualitative and quantitative gains.

Intensity Modulated Radiotherapy (IMRT) delivery processes are constantly getting upgraded and the Image Guided Radiotherapy (IGRT) tools are getting modified with introduction of Volumetric Modulated Arc Therapy or similar technologies. Significant paradigm shift is needed to understand these processes before they can be either integrated into your existing practices or a new set up is put into use.

A review of the various guidelines published by AAPM, IAEA and ICRU by way Task group reports and technical documents is to be done. Complex processes have warranted several layers of checks and the error probabilities have increased manifold. We are rather fortunate not to unlearn several of the aspects that our counterparts in the west have undergone. We however have bigger challenges like shortage of trained manpower and rapid movement of people. A priori knowledge of many of the pitfalls of these technologies when used without proper justification will help evade catastrophes. The linear accelerator based technologies face competition from newer technologies like Cyber knife, Tomotherapy and future technologies like Protons. Regulatory interventions though mandatory, are not sufficient for a constantly changing field. And self-regulations based on best practices developed internally are the key to successful integration of technology by ensuring highest quality and no compromise on safety.

AA – 11


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The Determination of absorbed dose to water for high energy photon and electron beams is performed in Germany according to the German dosimetry protocol DIN 6800-2. The IAEA Code of Practice TRS 398 (2000) and AAPM dosimetry protocol TG-51 (1999) are above all the two main protocols applied internationally. In the mean time, the DIN 6800-2 (1997) has been revised by a German task group and its latest version published in 2008 as National Standard DIN 6800-2 (2008). The new version has adopted widely the methodology and dosimetric data of the Code of practice TRS 398.

This work compares systematically the procedures and results obtained by using these three dosimetry protocols. The investigation was done with the Siemens linear accelerators, ONCOR Impression (6 MV photon and 5, 7, 8, 10, 12, 14 MeV electron beams) and ONCOR Avant garde (6 and 18 MV photon and 6, 9, 12, 15, 18 and 21 MeV electron beams). While cylindrical chambers were used for photon beams, measurements of electron beams were performed using both cylindrical and plane-parallel chambers.

The discrepancies in the determination of absorbed dose to water between the three protocols were found 0.23% for photon beams and 1.2% for electron beams. Comparative measurements showed a deviation of less than 2% between our measurements following protocol DIN 6800-2.
(2008) and TLD inter-comparison procedure by the measurement technical control (MTK).

AA – 12

Evaluation of an Optimal Treatment Plan Using both Physical and Biological Criteria for Tele-Radiotherapy

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Selection of an optimal treatment plan needs the calculation of physical and biological criteria of all plan variants calculated for the patient. We have developed a software for the estimation of those criteria (ICRU conformity, mean dose and dose homogeneity of the planning target volume PTV, dose load, tumour control probability TCP and normal tissue complication probability NTCP) using dose-volume histograms (DVHs) and clinical dose-response data.

The radiobiological models included in the software are sigmoidal dose response NCTP model introduced by Lyman and Kutcher and the Poisson TCP model of Källman and Brahme. The dose-volume histograms for each organ of risk and planning target volume are obtained from a 3D dose distribution calculated by a treatment planning system.

Our software programme was written in JAVA language. The program uses the DVH file output from the treatment planning system Oncentra Master Plan (Nucletron B. V.) based on dosimetric data from Siemens linear accelerators Oncor Impression and Oncor Avantgarde. Parameters for the calculation of NTCP for 27 normal tissues were provided by Burman et al. and of TCP for 62 tumor types by Okunieff et al. These parameters are stored as default values in the user database. The software also allows the user to input and store new parameters available in the current literatures without any difficulty, due to its friendly user programming option.

We will demonstrate in this report the ranking of treatment plans for different clinical cases. Our program provides a useful tool for medical doctors and medical physicists.

AA – 13

How to Analyze the CT Performance

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It is important that we analyze performance of the CT equipment for good CT examination in clinical. And if we know performance of the CT equipment, we can get the best image, and the reduction of the radiation exposure is enabled. This time, we explain the performance evaluation method of multi slice CT equipment.
Tumor Motion Management by Dynamic Compensation Techniques

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The theoretically promising depth dose characteristic of the Bragg peak, observed for charged particle beams, makes proton and heavy-ion beams a most attractive treatment modality in radiation oncology. However, although the rather complex issues of charged particle dose delivery are solved, a number of inherent uncertainties seem to prevent a full exploitation of the projected advantages of this innovative therapy form.

First, daily setup uncertainties of the radiation target and the effects arising from organ motion, both well known from radiation therapy with high energy photons, reveal a severe degrading effect on optimized dose distributions. Moreover, particle therapy specific uncertainties, like erroneous estimates of the particle range within the patient or the relative biological effectiveness of heavy-ion beams, further dilute the correlation between planned and delivered dose distributions.

One strategy to overcome these problems in modern hadron-therapy is the development of robust inverse planning methods. We will discuss a couple of approaches, how any of these known risks in particle therapy can be directly considered at the stage of treatment planning. The basic idea of the devised strategies is, to exploit the degeneracy of the inverse problem defined by the treatment optimization and select only plans of high quality that are insensitive to the anticipated dose delivery errors.

Starting with an introduction to inverse treatment planning for particle therapy, we will demonstrate the influence of the considered uncertainties on optimized dose patterns, before the concepts of robust optimization will be discussed in terms of clinical examples. Moreover, aspects related to the biological optimization of heavy-ion therapy will be addressed.

New Developments in Image Based Gynaecological Brachytherapy

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For many decades, Gynaecological Brachytherapy using standardized applicators and techniques, such as the Manchester or Stockholm systems, has proved to be an effective treatment e.g. of cervical cancer. Presently, the use of image based treatment planning is opening the possibility to further improve treatment outcome by visualisation of the both cancerous tissues and the neighbouring risk organs using CT and MRI with compatible applicators in place during imaging. This allows a better adaption of dose distribution to the
clinical target while simultaneously controlling the dose to organs at risk. Guidelines have been formulated to adapt image guided Gynaecological Brachytherapy to the previously used techniques [1] and to plan and report the new techniques [2]. However, the intrinsically inhomogeneous dose distributions in Brachytherapy make the production of reproducible treatments from patient to patient or even from fraction to fraction an issue. Therefore, at least during a transition phase, the standard systems and applicator loadings (with which one has gathered experience) should still be used as a starting point for treatment planning from which the closer adaption of dose distribution can follow. To quantify and compare dose coverage, [2] recommends the use of dose volume parameters derived from cumulative dose volume histograms such as e.g. D100 and D90, the minimal doses to 100% and 90% of the volume of interest (VOI), e.g. the target, V150 and V200, the VOI volumes covered by 150% and 200% of the prescription dose or D0.1cc, D1cc and D2cc, the minimum dose to the “hottest” 0.1cm³, 1cm³ and 0.1cm³ of an organ at risk. Applying these recommendations to 3D image guided Gynaecological Brachytherapy, treatment dose prescription to traditional reference points such as ICRU point A becomes less mandatory, however reporting dose to point A should be continued.


AA – 16

Changing Brachytherapy source specification from air Kerma rate to absorbed dose rate to water – new developments in Brachytherapy physics

Hensley F. W.

In a joint project a number of European standards laboratories and a Canadian working group are working towards a transition of Brachytherapy source specification from air Kerma rate to absorbed dose rate to water. This transition aims to reduce the uncertainty in Brachytherapy dose calculations from nowadays around 5% to less than 2%. This will also require a number of adjustments in dosimetric protocols and methods. Today’s TG 43 dosimetry formalism can be adapted by minor adjustments, mainly the replacement the product of source strength and dose rate constant S_k by a directly measured dose rate at 1cm distance from the source. Additionally, the transition will require (re-) calibration of field instruments used to verify the source specification such as well chambers and phantom arrangements in terms of absorbed dose to water. Details of the required adjustments and other ongoing developments in Brachytherapy physics will be presented.
The Realization of the Course “Medical Physics” at the Martin-Luther-University Halle-Wittenberg, Germany

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General information:
In 1998 the Martin-Luther University Halle-Wittenberg (Department of Physics) started a fully graduated course of "Medical Physics" studies as the first university in Germany. Since 2007 the study course "Medical Physics" has been offered as a modular consecutive course. The prerequisite for the academic studies concerns in a successful completed general qualification for university entrance. The complete course of studies is made up of a three-year course (6 semesters) for attaining the B.Sc. degree and a postgraduate of two-year course (4 semesters) leading to the M.Sc. degree. The contents of education and training in medical physics comply with the recommendations of international [1, 2, 3] and national scientific [4] organisations. The evaluation of the course intentions and achievements is made in accordance with the European Credit Transfer and Accumulation System (ECTS credits). The course of studies has been accredited and certified by the German Physical Society and the German Society of Medical Physics respectively.

Specifics:
The course “Bachelor in Medical Physics” (ECTS=180) mainly teaches the essentials of physics and extensively corresponds to the B.Sc. course of “Physics” with regards to the contents. However, there are three specifically medical-physics modules integrated with the following credit points: “Biochemistry” (ECTS=5), “Physiology for medical physicists” (ECTS=10), and “Cell Biology / Microscopic Anatomy” (ECTS=5). Therefore 30 ECTS credits in the medicine-physical area in this course of studies are acquired. The B.Sc. course is completed by a bachelor thesis (ECTS=10) in the field of medical physics or physics. The course “Master in Medical Physics” (ECTS=120) is intended to enhance the competence in medical physics. Thus, contents in medical physics with major importance for the later professional practice gain increasing priority this course segment. The following special modules belong here are: “Biophysics” (ECTS=7), “Optics and Physics of Medical Imaging” (ECTS=6), “Biomedical Techniques” (ECTS=8), “Radiation Physics (including a broad practice training in this field with medical Linac, CT, Afterloading device, SPECT-and PET-camera) and Radiation Therapy” (ECTS=14). A special lecture provides the legal foundations in the area of radiation protection according to the German radiation protection legislation. Furthermore, two orientation training periods (ECTS=5) of one months duration each in two different medicine-physical or physical fields serve as a useful contribution to the preparation of the final master thesis. The master thesis covers a period of six month and is evaluated with 30 ECTS credits.
High Precision Radiotherapy requirements and techniques

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Radiation is used for treatment of neoplasms and has started from early 1900s. Subsequently over the years, its usefulness, hazards and dosimetry were studied and in the recent years it is used as a very safe tool for treatment of tumours, both malignant and benign in nature.

Tremendous improvements took place in the development of radiotherapy techniques and the different kinds of equipments and radiation sources. Cobalt 60 sources and conventional X-rays for teletherapy and Radium for brachytherapy were only used in the early days. Subsequently high energy X-rays and electrons from Linear Accelerators and other substitutes like Ir-192, I-125 etc become more acceptable for clinical use and have become almost the standard for radiotherapy.

With the developments in Radiotherapy equipments in its positional accuracy, introduction of MLCs and Micro MLCs, the techniques of high precision radiotherapy are considered to minimize the irradiation volume to just sufficient for the tumour volume. Due to this, the dose to surrounding critical structures and normal tissues could be minimized. As a result, the complications and morbidity in radiotherapy are reduced and kept under control. Such techniques are 3Dimensional Conformal Radiotherapy (3D CRT), Intensity Modulated Radiotherapy (IMRT), Stereotactic Radiotherapy and Radiosurgery (SRS/SRT).

In parallel, Treatment Planning Systems (TPS) were also developed and the recent high technologies in computer hardware and software made the complicated planning and complex dose calculations very fast and accurate. Nowadays complex treatment plans are made in few minutes and various evaluation tools give us the opportunity to select the best plan for treatment.

It has been proven that some of the tumours require higher doses of radiation to control the disease to an acceptable level. In such situations, escalation of tumor dose might lead to excessive dose to normal tissues and nearby critical structures. This is avoided by the high precision radiotherapy techniques (HPRT). A suitable selection of the above mentioned HPRT can satisfy the requirement of dose escalation to tumour without excessive morbidity. Thus, in modern radiotherapy, IMRT or SRS play a major role in tumor control with less radiation morbidity.
Radiation protection in diagnostic radiology: Estimation of the effective dose of the personnel from personal dosimetry

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In diagnostic radiology where the personnel usually is wearing lead aprons the individual monitoring of external exposure [personal dose equivalent H_p(10)] is frequently performed with personal dosimeters worn on the body below the lead apron. Because this place normally represents the most protected area of the body the effective dose in most cases is underestimated. The most simple solution would be a measurement in front of the apron, but in this way the effective dose would be considerably overestimated. Therefore a general approach with single dosimeter measurements assumes an algorithm with the reading either divided (over-apron case) or multiplied (under-apron case) with a certain correction factor. The combination of one dosimeter worn below the apron and another one above the apron allow to determine the effective dose more accurately. In this "double dosimetry" concept the resulting effective dose can be validly estimated by a linear combination of both measurements.

In this contribution we derive coefficients for the one-dosimeter and two-dosimeter situations using organ dose conversion coefficients according to ICRP 60 and ICRP 103. The recent recommendations of the ICRP 103 emphasize the contribution of the head and neck region to the effective dose E. For the example of cardiac catheterization (apron 0.5 mm Pb, with thyroid protection; ICRP 103) for a single dosimeter reading in the anterior thoracic region (H_p,c,u) (chest underneath the protective apron) E = 2.0 x H_p,c,u and with a dosimeter worn on the front area (H_p,n,o) of the neck over of the protective garment E = H_p,n,o / 11.3.

According to ICRP 103, a conservative general algorithm with thyroid protection is

E = 0.84 H_p,c,u(10) + 0.051 H_p,n,o(10)

and without thyroid protection

E = 0.79 H_p,c,u(10) + 0.100 H_p,n,o(10).

Study on the application of relativity statistics analysis model in prostate cancer IMRT planning

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Purpose:
To study the application of statistics relative analysis based tool in the prostate cancer IMRT plan optimization procedure

Methods and Materials
A statistics relative analysis model was established in our trail. The experiment was carried out with five prostate cancer IMRT treatment plan randomly chosen on the ADAC PINNACAL
7.6 version planning system. The beam and objective function of the target of the primary plan was kept unchanged. The main optimization parameter (EUD parameter a weight (w) and MaxEUD) of OAR was adjusted in succession and taken part in optimization procedure. The correlation analysis (CF) and optimization efficiency analysis (OF) were carried out on the result of optimization. According to the analysis the optimum value of parameter MOR with best dose distribution was obtained. With them, the corresponding parameter were substituted in primary plan and optimization be carried out again. The dose distribution of the new IMRT plan was compared with that of the primary plan.

**Results:**

There exists a significant selected optimization phenomenon with different optimization methods. Our experiment demonstrated that the EUD parameter a and the weight factor (w) have basically no effect on volume dose of OAR (OF<0.01), but have obviously more effect on maxdose and meandose (OF>>1). The CF analysis shows that there are different correlation between the PTV (V95) and OAR’ dose when the EUD parameter a and the weight factor were applied, where the discrepancy is directly proportional to the distance between target and OAR. The mean dose of the OAR was decreased and the mean dose of PTV was more similar to the DT when the optimization parameter of the primary plan was substituted with MOR.

**Conclusions:**

The scope of optimization parameter can be determined accurately with the statistics relative analysis model in the prostate cancer IMRT planning procedure. And a IMRT plan satisfied for clinical requirement can be obtained with high efficiency.

AA – 21

**Role of Dosimetrist in Radiation Oncology**

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The role of dosimetrist in radiation oncology is well established in developed countries. However in developing countries role of dosimetrist is yet to be realized. This paper gives details of the potential role played by the dosimetrist in radiation oncology and of qualification and training required. Their responsibility and activities are dealt with.

The qualification for dosimetrist training shall be any one of the following 1. A graduate in science with physics as a main subject. 2. A diploma in radiotherapy technology with a couple of years of experience with an aptitude for physics. 3. BSc in medical physics. Candidates have to be given some lectures in anatomy, physiology, radiation detectors, dosimetry, medical physics instruments CT-SIM, PET-CT, MRI, mould room, treatment planning systems, quality assurance, net working related aspects and special techniques like SRS and radiation therapy equipment like telecobalt, linear accelerators, simulators, HDR brachytherapy systems and radiation safety.

In addition to theoretical knowledge, a practical hand on training has to be given in the following areas so as to assist the medical physicists in performing their duties. It is emphasized that they have to perform only under the direct supervision of the medical...
The practical training shall include the following procedures: Daily check for stability and output of linear accelerators for beams, absolute calibration, planning CT scans in CT-SIM, transferring of data from CT, MRI and PET-CT to TPS, periodic check of applicators for HDR brachytherapy and accessories, QA procedures, maintenance of physics records and treatment planning. Knowledge of TLD, film, and personnel monitoring methods are very useful. The training shall be spread over a period of one year. A formal examination shall be conducted both in theory and practice.

A number of universities in USA are conducting dosimetrists courses. American Association of Medical Dosimetrists AAMD certification board have contributed a lot for the development of this subject. Certification of dosimetrists will go a long way in maintaining a high standard in this profession.

AA – 22

Brachytherapy HDR Facility Planning

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Radiation Therapy facility is incomplete without brachytherapy unit as in a majority of cases treatment is resorted to brachytherapy in addition to beam therapy as supplement. Today the majority of the centres use High Dose Rate afterloading systems considering convenience of patient and hospital. However the type of sources varies as either $^{192}\text{Ir}$, 370 GBq or $^{60}\text{Co}$, 74 GBq.

In this paper various aspects such as space, equipment installation, location, safety considerations, instruments etc. are discussed elaborately. Typical layout plans for using HDR $^{192}\text{Ir}$ and $^{60}\text{Co}$ are presented giving details of shielding calculations. For shielding calculations a work load of 20 cGy/wk at 1 meter for $^{192}\text{Ir}$ and a load of 15 cGy/wk for $^{60}\text{Co}$ were assumed. The assumed permissible dose were 2 mrem/wk for public and 40 mrem/wk for occupational workers in the controlled area. Logistics of location of room with respect to operation theatre is discussed. Inner space shall be a minimum of 6 x 5 m$^2$ for accommodating the unit as well as the team consisting of radiation oncologist, anaesthetist, physicist, nurse and technologist. However plinth area has to be higher including shielding walls. The room design shall have a maze to reduce direct radiation at the entrance and normal wooden door for easy operation. The maze shall have a minimum width of 1.6 m for easy maneuvering of a patient trolley.

Using the room as a minor operating room and facilities required for this is also discussed. Safety as well as physics instruments like gamma area monitor, well type chamber or secondary standard dosimeter, radiation survey meter, rectal probe, pocket dosimeters, personnel monitoring badges and QA accessories are presented. The installation requirements like power, trenches, load bearing, A.C., humidity, dosimeter conduit are considered. Future planning is also taken into consideration.
Image Guided Radiotherapy; Past, Present and the Future

Ravindran B. P.
Christian Medical College, Vellore, India

Introduction:
The anatomical information, usually derived from x-ray CT is used for planning the patient treatment, but this anatomical information may not be an accurate representation of the patient anatomy during treatment due to systematic differences in patient position between imaging and treatment. Moreover, radiation delivery techniques such as 3 D Conformal Radiotherapy (CRT) and Intensity Modulated Radiotherapy (IMRT) require that the dose delivery be precise to enable dose escalation for better tumour control. The aim of image guided radiotherapy is to improve the knowledge of the anatomy during treatment by visualizing the internal structures to ensure accurate targeting of the tumour tissue.

Methods of Image guidance in Radiotherapy:
Portal Imaging: Use of imaging for positioning in radiotherapy has been in practice for several years. A simple image guidance system would be the port films. This is performed with therapy verification films either with cassettes or wrapped in packages. In order to increase the contrast for mega voltage imaging with port films, Enhance Contrast Localization films (EC-L films) are used. Electronic portal imaging devices were developed as an alternative for port films. Several workers have used radio-opaque markers such as gold seeds to localize the target with the EPID during treatment and to assess the inter-fractional organ motion and intra-fractional organ motion particularly with reference to prostate treatment.

3D Image Guidance:
A new integrated CT/LINAC combination, in which the CT scanner is inside the radiation therapy treatment room and the same patient couch is used for CT scanning and treatment (after a 180-degree couch rotation), should allow for accurate correction of interfractional setup errors. Jeffrey et al have worked on the use of kilo voltage cone beam CT for image guidance in Radiotherapy. In the system developed by this group, a Kilo voltage X ray tube is fixed on to the linear accelerator at 90 degree to the linear accelerator head. A flat panel detector (Amorphous silicon) is used to form 2 D images from the transmitted kilo voltage x-ray. They have used the Cone Beam CT technique to obtain volumetric CT images for patient positioning and verification. With the introduction of high resolution and high contrast aSi flat panel detectors a few vendors have introduced MV Cone Beam CT images using the projection images obtained with the EPID.

Conclusion:
The image-guided radiotherapy has brought in a significant change in the method of localization and targeting of the tumour and thus increasing the accuracy of radiation delivery. There are several other methods such as stereo-radiographic localization and 3D Ultrasound used for image guided Radiotherapy in addition to the methods discussed.
Development of Medical Physics Service: My experience and a possible model for Bangladesh

Mostafa A. B.
Principal Medical Physicist (Retired) from Dept of Medical Physics & Nuclear Medicine, Sandwell & West Birmingham, Hospitals NHS Trust, Birmingham B18 7QH, UK

After finishing a Ph D in radiation physics in 1971, I joined a Medical Physics (MP) Service in the UK when MP was still in its infancy. I worked in a team offering a patient related physics service. I received no formal training, ‘on the job training’ was provided by colleagues and proficiency was gained from supervision by more experienced scientific and clinical colleagues.

The UK NHS and MP services have changed a greatly since. To demonstrate competency in an MP discipline and to gain professional registration with the Health Professions Council (HPC), new graduates undertake a four year training scheme overseen by the professional body, the Institute of Physics and Engineering in Medicine (IPEM), www.ipem.ac.uk. Successfully completing a MP related MSc and generalised in-service training in years 1/ 2 followed by specialised in-service training in years 3/ 4, leads to Membership of the Institute (MIPEM) and state registration with the HPC.

Bangladesh could benefit from working towards such a training model. Major universities will need to introduce an option of medical physics disciplines in their syllabus. Graduate students would receive basic core knowledge underlying a range of medical physics related disciplines through class and lab work. Competency to work with patients and provide a service could be jointly supervised and assessed by the universities, Bangladesh MPS and MPBME.

MP services cover a wide variety of hospital functions. Many of these functions involve expensive modern technologies and techniques e.g. imaging and oncology. Well trained clinical scientists, both physicists and engineers, possess the innovative and interpretive skills to ensure the best possible use of any resources available and are a cost effective means of assisting with the modernisation of any technology based health care service. However, creating a well trained MP service is expensive. Can a developing country like Bangladesh afford to develop such a service? With the inevitable demand for high-tech services from an ever increasing population, can it afford not to? My view is that Bangladesh should progressively develop MP services using the training model I have outlined as its foundation.

IMRT QA using the 2D-ARRAY and the DAVID System

Poppe B. 1, Looe H. K. 1, Lüllau T. 1, Chofor N. 1, Harder D. 2, Willborn K. 1

1) Carl von Ossietzky Universität und Pius Hospital Oldenburg
2) Georg-August Universität Göttingen

In this work we present our experiences with an IMRT QA program based on a combination of the 2D-ARRAY (a flat, two dimensional 729 ionization chamber array with 10 mm mesh
width) and the DAVID system (a transmission monitor with spatial resolution, permanently placed below the MLC, with one detection wire per leaf pair), both from PTW-Freiburg, Germany. The described procedure is implemented in our clinic to verify all IMRT deliveries daily, before a treatment series, and permanently. We will discuss these steps in detail.

The program consists of three different steps:

1) A daily constancy check with the 2D-ARRAY is performed to check the stability of dose output, energy, beam flatness and symmetry as well as MLC calibration. The daily QA using the 2D-ARRAY allows the acquisition of the most important machine parameters within one measurement.

2) A pre-treatment IMRT plan verification using the 2D-ARRAY and a mechanical gantry mount system is applied to compare planned and measured dose distributions. The combination of the gantry mount and 2D-ARRAY allows convenient dosimetric verification with minimum workload. In parallel to this step, reference values for the DAVID system are measured.

3) In a final step a permanent in-vivo dosimetry is accomplished in which the measured values of the DAVID system are compared to the reference values. The DAVID system closes the loop by securing the independent, on-line monitoring of the IMRT plan delivery. The results collected can be analyzed at regular intervals and errors can be identified and corrected before the next fraction if necessary. With the combination of the 2D-ARRAY and the DAVID system, deviations in the machine parameters are immediately recognized and identified.

This QA program - covering the whole treatment process from daily constancy checks and pre-treatment dosimetric plan verification to permanent verification of the treatment delivery - enables us to detect any discrepancies that would occur before or during treatment. The DAVID system is used regularly in our clinic to verify the treatment delivery and has been shown to be a convenient and fast tool to pin-point errors and their impact on the quality of treatment that may occur during any fraction delivery.

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Reduction of radiation-induced tooth damage during therapeutic tumor irradiation

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2) Martin-Luther-University Halle, Clinic for Radiation Therapy, Halle, Germany

It is often inevitable that neighboring tissues are damaged by a tumor therapeutic irradiation in head and neck regions. For the teeth, this means that defects are identified due to standard fractionated irradiation after the first dose application of 2 Gy. The mechanical properties are significantly deteriorated; cracks and increasing roughness of the surfaces are observed. An additional damage to the salivary gland leads to changes in the oral cavity environment and strengthens the radiogenic causing tooth destruction. The goal is to reduce tooth damage due to irradiation.

One approach is the use of fluoride-containing substances during radiation therapy. For this
purpose freshly extracted wisdom teeth were prepared and divided into a reference group and three experimental groups. After mechanical characterization of the initial state with the method of the nanoindentation, test groups were exposed up to 60 Gy and, in accordance with the clinical situation, fractionated. Immediately before each radiation fraction, the teeth were treated with a fluoride-containing substance:

- The first experimental group with 1.25% fluoride gel (substance A),
- the second test group with 5.63% fluoride solution (substance B),
- the third test group was treated with a fluoride-0.22% and 0.5% ACP (amorphous calcium phosphate)-containing substance (substance C).

After each irradiation the teeth were stored in neutral calcium-phosphate solution. Then the mechanical properties were measured again. The reference group has received no treatment but was only irradiated. It appears that radiotherapy alone reduces the mechanical parameters of the tooth tissue dramatically and permanently. If a treatment to the teeth with fluoride-containing agents happens during radiation, the reduction of the mechanical properties is not so drastic. When using the substance A, a reduction in the hardness of enamel to 50% and dentin to 70% of initial values is detected after an irradiation of 60 Gy. The elastic modulus is 47% for enamel and 58% for dentin. For substance B a reduction in hardness to 60% and in the dentin to 68% is measured. For the elastic modulus the values reduce to 66% in enamel and dentin to 80%.

Under the influence of substance C, the hardness of enamel changes to 58% and in dentin to 64%, the elasticity value for enamel and dentin to 51% and to 82% of the initial values after irradiation of 60 Gy. The substances C and B proved to be equally suitable to diminish the decrease in hardness: 40% in the enamel, as opposed to 95% after radiotherapy alone, and only 30% instead of 75% in dentin. The mechanism of action requires further study. Substance B contains 5.63% fluoride compared to only 0.22% in substance C, but the content of ACP in substance C is apparently as effective as the established substance B in remineralizing the fluoride layer by building a hydroxyapatite layer.

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Single Institutional experience with Electron Conformal Therapy (ECT) and Modulated Electron Radiotherapy (MERT) for superficial tumors

Ahmed Z. ¹, Tunio M. A.²

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Objective: Skin cancers are generally treated with electron therapy. For electron therapy the simulation is not a regular practice. The selection of electron energies and electron applicators is normally based on the clinical judgment of depth of tumor and available imaging (CT/MRI). With current advances in X ray therapy (conformal and intensity modulated radiotherapy), the electrons have gained less attention; only few centers are using the electron conformal therapy (ECT) and modulated electron radiotherapy (MERT). We share our experience of ECT and MERT with merits and demerits.

Patients & Materials: Seventeen patients of superficial cancers were treated with conformal
and modulated electron therapy in four steps (a) virtual simulation using CT scanner Siemens® followed by (b) data acquisition and DICOM transfer to Coherence and Prowess Panther TPS for contouring of skin, gross tumor volume (GTV), CTV, PTV and organs at risk (OARs), (c) conformal and modulation treatment planning interconnected with computer assisted fabrication device (Autimo 2D) for lead cut outs and wax blocks and finally (d) quality assurance and modified treatment delivery.

**Results:** In comparison to conventional techniques, ECT and MERT plans showed, better tumor delineation, appropriate energy selection, optimal tumor dose coverage, maximal sparing of OARs without any dose inhomogeneity. Phantom and in vivo dosimetric measurements showed excellent agreement with calculated doses with difference of ±2%. Segmented electron delivery with cutouts and in house custom made multileaf collimators in applicators (eMLC) did not show any significant difference.

**Conclusions:** ECT and MERT can safely be utilized for superficial targets to improve the electron radiotherapy and treatment outcome with more accuracy in electron energy selection. Efforts are required to make commercially available eMLC in modern linear accelerators supported with current treatment planning systems.

**Monte Carlo based small field dosimetry: Implementing a new correction factor formalism for a comprehensive set of diode detectors**

**Cranmer-S. G.**¹,², Weston S.²,³, Sidhu N. P.¹, Thwaites D. I.²,³

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²) Academic Unit of Medical Physics, Faculty of Medicine and Health, University of Leeds
³) St James’s Institute of Oncology, Leeds Teaching Hospitals NHS Trust, Leeds, UK

**Purpose:** The accuracy associated with small field dosimetry is tied to experimental conditions which include detector selection and set-up uncertainties. However, as Alfonso et al indicate the accuracy may be more intimately tied to replacement correction factors obtained using Monte Carlo simulation. The goal of this work was to rigorously apply the newly proposed small field dosimetry formalism for a comprehensive set of diode detectors.

**Methods:** DOSRZnrc was used to develop models of the IBA stereotactic field diode (SFD) as well as the PTW T60008, T60016 and T60017 field diodes. Simulations were run and isocentric output factors calculated at depths of 1.5, 5.0 and 10.0 cm. This was performed using the following source parameter subset: 6.1 and 6.2 MeV with a FWHM = 0.100, 0.110 and 0.120 cm. The source parameters were finalized by comparing experimental OFs with simulation. OFs in water were then simulated and the replacement correction factors calculated according the newly proposed formalism.

**Results:** At both 6.1 and 6.2 MeV the simulated OFs were found to be greater than, equivalent to and less than experiment for spot size FWHM = 0.100, 0.110 and 0.120 cm respectively. This is due to the change in source occlusion as a function of FWHM at the smallest field size. With the source parameters finalized, the replacement correction factors were calculated. The corrections required for the 0.5 cm field size were 0.95 (± 1.5%) for the SFD and T60017
diodes and 0.90 (± 1.5%) for the T60008 and T60016 diodes - indicating measured OFs to be 5% and 10% high respectfully. Our results also revealed the correction factors to be statistically equivalent at all depths.

**Conclusion:** Two general conclusions come out of working through the proposed small field dosimetry formalism; (1) small field OFs are very sensitive to the simulated source parameters and therefore rigorous linac model commissioning must be pursued prior to applying this new methodology and (2) the corrections required for diode detectors are design dependent and therefore complete detector modelling is required and should not be assumed as a chip in water only.
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- Radiation Oncology Club
- Varian Medical System
- Elekta Medical System
- PTW
- Nucletron
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