NEW IAEA CRP:
E35010 Applications of biological dosimetry methods in radiation oncology, nuclear medicine, diagnostic and interventional radiology (MEDBIODOSE)

Oleg Belyakov
Radiation Biologist
Applied Radiation Biology and Radiotherapy Section
Division of Human Health
Project summary

- Biological dosimetry is one of the most developed branches of radiobiology.
- The aim of this CRP is to address various uses of biological dosimetry methods in radiation oncology, nuclear medicine, diagnostic and interventional radiology.
- It will include filling in gaps in knowledge and developing new approaches to assist with the transition to personalised medicine.
- The proposed CRP will build upon the success of a previous IAEA project E35008 on Strengthening of Biological dosimetry (2012-2016).
- This project will bring together a number of institutions from LMI and HI MSs to progress toward the common goal.
The CRP was prepared based on the conclusions and recommendations of:

- **2nd and 3rd RCMs of CRP E35008** (2014 and 2016, IAEA HQ);
- **Technical Meeting** on the Future of Biodosimetry in Asia: Promoting a Regional Network (organised jointly by ARBR/NAHU and NIRS, Japan 2015);
- **Consultants' Meetings** (June and July 2016, IAEA HQ) organised by the ARBR/NAHU section.
On-going activities in the IAEA Member States

- Recent Fukushima accident has reinstated the importance of biological dosimetry estimation in exposed individuals especially in mass casualty situations.
- Emergency preparedness is of utmost importance in any untoward incidences.
- Contingency of biodosimetric services is not sufficient, therefore use of these methods in medical settings might reinforce biological dosimetry and benefit radiation therapy.
On-going activities in the IAEA Member States

Currently, Biological Dosimetry became one of the most advanced, formalised and standardised branches of radiation biology.

Two ISO standards related to biodosimetry were published:

To sustain and enhance the scope of biodosimetry services to radiation oncology, nuclear medicine, diagnostic and interventional radiology as well as assist with the transition to personalised medicine.
Specific Research Objectives

• To facilitate dialogue between biodosimetry specialists and radiation oncologists.
• Collect biodosimetry data on patients exposed to radiation for medical purposes to fill in knowledge gaps and assist with the transition to personalised medicine.
• Develop biodosimetry based methods for prediction or prognosis of adverse radiotherapy effects and late complications allowing refinement of radiation treatment plans.
Specific Research Objectives, cont.

• Propose and test biodosimetry methodology for comprehensive assessment of consequences of medical radiation exposures, including accidental overexposure.

• To transfer biodosimetry methodology into clinical practice in order to improve outcome of radiation medical services in terms of survival, safety and quality of life.

• Establish a research biological dosimetry network for clinical applications.
Expected Results

• **Operational links** between biodosimetry specialists and radiation oncologists are **established**.
• **Increased understanding** of relationships between radiation biomarkers and conditions of medical exposure.
• **Significant progress** to established biodosimetry methods for prediction or prognosis of adverse radiotherapy effects and late complications.
• **Significant progress** on biodosimetry methodology for comprehensive assessment of consequences of planned and accidental medical radiation exposures.
• **Biodosimetry methodology tested** in clinical settings.
• **Research network** for clinical applications of biological dosimetry is **initiated**.
Expected Results

- **Operational links** between biodosimetry specialists and radiation oncologists are established.
- **Increased understanding** of relationships between radiation biomarkers and conditions of medical exposure.
- **Significant progress** to established biodosimetry methods for prediction or prognosis of adverse radiotherapy effects and late complications.
Expected Results, cont.

- **Significant progress** on biodosimetry methodology for comprehensive assessment of consequences of planned and accidental medical radiation exposures.
- **Biodosimetry methodology tested** in clinical settings.
- **Research network** for clinical applications of biological dosimetry is **initiated**.
Overall Expected Outcomes and Nuclear Component

- **Overall Expected Outcomes**
  - Increased expertise quality of biological dosimetry service in clinical settings;
  - Sustained emergency preparedness and capacity for radiological incidents and accidents, especially in LMICs.
- The project is highly relevant to the project objectives and has significant Nuclear Component since it dealing with application biological radiation dosimetry methods to radiation oncology, nuclear medicine, diagnostic and interventional radiology.
Outputs

- Operational links between biodosimetry specialists and radiation oncologists are established.
- Increased understanding of relationships between radiation biomarkers and conditions of medical exposure.
- Significant progress to established biodosimetry methods for prediction or prognosis of adverse radiotherapy effects and late complications.
- Significant progress on biodosimetry methodology for comprehensive assessment of consequences of planned and accidental medical radiation exposures.
- Biodosimetry methodology tested in clinical settings.
- Research network for clinical applications of biological dosimetry is initiated.
Clinical application example 1

• Lack of information regarding to individual patient response undergo radiation therapy treatment or diagnostic exposure.
• The proposed solution is related to the fact, that there are three possible approaches to use biomarkers:
  • Genetics plays an important role in determining a patient’s radiation sensitivity; determining an individual’s radiation sensitivity may allow modification of treatment plans.
  • Normal tissue tolerance is a determinant of clinical outcome; therefore testing it prior to treatment will help to predict early and/or late adverse reactions of patients.
  • Determination if the particular tumour sensitive/resistant to radiation or to standard of care will improve the clinical outcome.
Clinical application example 2

- Presently available biomarkers are insufficient for prediction and prognosis of radiotherapy complications.
- Solution: use of dosimetric biomarkers will provide the necessary information regarding the accumulated dose and its distribution in radiotherapy patients.
- If measurements of normal tissue damage biomarker will be used, it will help to account for interindividual variability in response to radiation.
Duration Budget and MSs’ participation

- **Planned duration:** 4 years (2017-2021)
- **Budget:** €395,000
- **MSs’ and international organizations participation:**
  - Algeria, Argentina, Australia, Azerbaijan, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Cuba, Ecuador, Egypt, European Union, Finland, Former Democratic Yemen, Former USSR, Former Yugoslavia, France, Georgia, Germany, Ghana, Greece, India, Indonesia, Israel, Japan, Kazakhstan, Korea - Republic of, Latvia, Lithuania, Malaysia, Mexico, Mongolia, Netherlands, Norway, Pakistan, Peru, Philippines, Poland, Qatar, Russian Federation, Saudi Arabia, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Thailand, Ukraine, United Arab Emirates, United Kingdom, United States of America, Uruguay, Viet Nam.
- World Health Organization (WHO), Food and Agriculture Organization (FAO), the European Organization for Nuclear Research (CERN).
Link to TC Projects

- PHI9025 - Strengthening National Capability to Respond to Radiation Emergencies
- LAT9011 - Upgrading Radiation Biology Laboratory Infrastructure and Capability
- COS9009 - Establishing a Biological Dosimetry Service
- UKR9034 - Establishing a National Centre of Competence in Biological Dosimetry
- ISR6027 - Developing a National Biological Dosimetry Capability
This CRP is coupled with the approved PUI proposal, pending for funding.

**Clinical applications of biological dosimetry in low and middle income countries**

**THE CHALLENGE**

Biological dosimetry is a powerful tool that uses markers induced by ionising radiation to estimate the radiation absorbed by an individual. It is especially useful when physical dosimetry methods are absent or need to be verified, such as following accidental internal contamination. A national biodosimetric reference laboratory is not available in many low and middle income countries. Overly conservative biodosimetric response to radiation exposure is due to limited resources and lack of trained personnel.

**IAEA RESPONSE**

This project will complement and reinforce efforts in low and middle income countries within the framework of the Technical Cooperation Projects (CRPs) related to biodosimetry. It is expected that participating institutions, subject to evaluation and renewal on a yearly basis.

**EXPECTED RESULTS**

Participating low and middle income countries will improve their ability to use biodosimetry techniques, resulting in a greater capacity to determine radiation exposure based on biological measures. This will enhance quantification and understanding of radiation exposure, thereby improving medical services and contributing towards improved preparedness in the case of large scale accidents.

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>12 000</td>
</tr>
<tr>
<td>2017</td>
<td>77 000</td>
</tr>
<tr>
<td>2018</td>
<td>77 000</td>
</tr>
<tr>
<td>2019</td>
<td>77 000</td>
</tr>
<tr>
<td>2020</td>
<td>77 000</td>
</tr>
<tr>
<td>Total</td>
<td>320 000</td>
</tr>
</tbody>
</table>