International Radiation Safety Standards and Systems

Madan M Rehani, Ph.D.
International Atomic Energy Agency
M.Rehani@iaea.org

Why International System?

Bad & Good example of international systems
Despite Standards some may do things differently, but still Standards are necessary

Why International system?

- You work in country A and dose limit is 20 mSv/yr, another country 50 mSv, yet another 100 mSv, and also 10 mSv. Result- confusion.
- One month leave for all occupationally exposed
- Badge over lead apron or under lead apron
- Person sitting in the room next to X-ray room wants to be labelled as “occupationally exposed”
- Separate areas for attendants in NM dept

National Regulatory Authority

- How to frame regulations?..... Let these be consistent with UK.....No...No...with USA. … Oh no..It should be India, S. Africa...no Europe…
- Is there some Harmonised set of regulation?
Organisations in the Cosmic Scheme

- Basic Scientific Studies
- Scientific Evaluations (UNSCEAR, BEIR etc.)
- ICRP Recommendations
  - Regional (EC, PAHO, NEA) & Topical (ILO, WHO, FAO) Standards
  - International Safety Standards: ISS (IAEA)
  - Industry Standards (ISO, IEC)
- National Regulations
- Demonstration of Compliance

The Basis for the International Safety Standards

- UNSCEAR (*) Radiation Effects
- ICRP (**) Principles and Recommendations
- STANDARDS (IAEA)

(*) United Nations Scientific Committee on the Effects of Atomic Radiation
(**) International Commission on Radiological Protection

A matter of interpretation
International Radiation Safety Standard

• Is it mandatory?
  • No

• Then what is legally applicable?
  • National. In Europe European Directive

• What is the role of International Standards?
  • Robust, sound standards that countries can adopt
  • Where national regulations are lacking, international standards provide acceptable system for legal authorities
  • Since it is based on WIDE consensus, most countries tend to adopt it. Essential for seeking IAEA assistance

What people know MOST

ICRP--- Dose limits
IAEA--- Iran, Iraq actions
UNSCEAR---??

What you think that they do?

ICRP
  • Establishes principles of radiation protection
  • Provides protection philosophy

IAEA
  • Has programs for promoting
    • Nuclear medicine, radiotherapy and medical physics
    • Radiation protection of patients
UNSCAR

- UNSCEAR was established by the General Assembly of the United Nations in 1955.
- Its mandate in the United Nations system is to assess and report levels and effects of exposure to ionizing radiation.
- Governments and organizations throughout the world rely on the Committee's estimates as the scientific basis for evaluating radiation risk and for establishing protective measures.

UNSCAR

- The original committee was composed of senior scientists from 15 designated UN Member States, namely Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, Egypt, France, India, Japan, Mexico, Sweden, the UK, the USA and the USSR.
- Currently 21 countries
- Last report 2010
- HQ in Vienna
- Meeting once every year

ICRP | IAEA
--- | ---
Independent Charity | Independent international organisation under UN family
Established to advance for the public benefit the science of Radiological Protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation | Pillars: Safety and Security; Science and Technology; and Safeguards and Verification.
### Main Commission

<table>
<thead>
<tr>
<th>Task Groups (TG)</th>
<th>Working Parties (WP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>C3</td>
<td>C4</td>
</tr>
<tr>
<td>C5</td>
<td></td>
</tr>
</tbody>
</table>

### Chairperson

- **Dr. Claire Cousins**, UK
- **Chris Clement**, Sc Secretary

### Main Commission Chair + 12 members

- **C1 - Radiation Effects**: Dr. William F. Morgan, US
- **C2 - Doses from Radiation Exposure**: Dr. H. Menzel, CH
- **C3 - Protection in Medicine**: Dr. Eliseo Vano, Spain
- **C4 - Application of ICRP Recommendations**: Dr. Jacques Lochard, FR
- **C5 - Protection of the Environment**: Prof. J. Pentreath, UK

### Membership of the International Commission on Radiological Protection

**Main Commission**
- Chairperson: Claire Cousins (Chair)
- Members: Various experts from different countries

**Secretariat**
- Chairperson: Claire Cousins (Chair)
- Secretary: Various experts from different countries

**Committee 1 - Effects**
- Chair: Various experts from different countries
- Members: Various experts from different countries

**Committee 2 - Doses**
- Chair: Various experts from different countries
- Members: Various experts from different countries

**Committee 3 - Medicine**
- Chair: Various experts from different countries
- Members: Various experts from different countries

**Committee 4 - Implementation**
- Chair: Various experts from different countries
- Members: Various experts from different countries

**Committee 5 - Environment**
- Chair: Various experts from different countries
- Members: Various experts from different countries
Ethical Basis for the ICRP System

**Utilitarian ethics**
Judge actions by the consequences

- **Justification**
  Do more good than harm

- **Optimisation**
  Maximise good > harm

**Deontological* ethics**

- **Justification**
  Some duties are imperative

- **Optimisation**
  Maximise good > harm

**Limitation**

- **Deontological ethics**
  No individual unduly harmed

*how people accomplish their goals (e.g. by duty, obligation)

Changes in occupational Dose Limit (ICRP)

<table>
<thead>
<tr>
<th>Year</th>
<th>1931</th>
<th>1947</th>
<th>1977</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>mSv/yr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Past ICRP Recommendations

- **At first**: Occupational exposures in medicine
  - Avoid deterministic harm
    - 1928: Working hours limited (~1000 mSv)
    - 1934: ~500 mSv
- **Then**: Occupational exposures
  - 1950: ~150 mSv
- **Now**: Exposures and minimise stochastic harm
  - 1956: 50 mSv; 5 mSv
  - 1959: Publ. 1; 1964: Publ. 6
  - 1966: Publ. 9, reduce doses if readily achievable
  - 1977: Publ. 26, ...if reasonably achievable
  - 1990: Publ. 60: 20 mSv, 1 mSv

Lens of the eye, threshold in absorbed dose is now considered to be 0.5 Gy (against 0.5 to 2 for detectable opacities and 5 for visual impairment).

Occupational Exposure Lens of Eye Limit
- 20 mSv in a y (against 150), averaged over defined periods of 5 y, with no single y exceeding 50 mSv

(4) Although uncertainty remains, medical practitioners should be made aware that the absorbed dose threshold for circulatory disease may be as low as 0.5 Gy to the heart or brain. Doses to patients of this magnitude could be reached during some complex interventional procedures, and therefore particular emphasis should be placed on optimisation in these circumstances.
**Tissue Weighting factor $W_T$ (ICRP 103 vs 60)**

- Breast, gonads, and the treatment of remainder tissues.
- The $W_T$ changes in question are:
  - Breast (new 0.12, old 0.05); Increase by factor 2.4
  - gonads (new 0.08, old 0.20); Decrease by factor 2.5
  - remainder tissues (new 0.12, old 0.05 using a new additive system)

**2007 recommendations**

Tissue weighting factor for breast increased from 0.05 to 0.12 (2.4 times, by 140%) and for gonads decreased from 0.2 to 0.08, by $\approx 60\%$

Remainder tissues (new 0.12, old 0.05 using a new additive system)

**The Genetic Risk Estimate Is Smaller, But…**

Gonad shielding is still imperative in order to keep doses ALARA!
Implementation Takes Time

- **ICRP 1977 Recommendations**
  - International standards 1984
  - National standards ~1989
- **ICRP 1990 Recommendations**
  - International standards 1996
  - National standards ~2000
- **ICRP 2007 Recommendations**
  - International standards 2012
  - ...national standards after 2014?
IAEA

- Headquarter in Vienna
- 2400 staff from > 90 countries
- Director General, 6 Deputy DG, Directors, SH, UH

IAEA- Development of Standards

- The IAEA is the world’s center of cooperation in the nuclear field.
- It was set up as the world’s "Atoms for Peace" organization in 1957 within the United Nations family.

Plus consensus of >140 Member States
International BSS

- Most important document for Member States of the IAEA pertaining to radiation safety regulatory requirements

Requirements

- Governments - what they are supposed to do
- Regulatory bodies
- Licensees
- Professional bodies, e.g. medical physics
- Safety Guides and Safety reports - to help in implementation of requirements

http://rpop.iaea.org
Website: http://rpop.iaea.org

10 million hits/y
≈ 200,000 visits/y, 190 countries
Is there information from the IAEA for PATIENTS?

IAEA Radiation Protection of Patients (RPOP)

Computed Tomography

Patient Information
- Computed Tomography
- International Procedures
- Nuclear Medicine
- Radiography
- Radiation Therapy for Physicians & Students

IAEA Radiation dose CT

IAEA Radiation Protection of Patients: The radiation exposure from CT has a significant range depending on the type of the test, the area of the body scanned...

IAEA Manual on Radiation Protection of Patients: What is the radiation...
New terms

• Distinguishing the roles of the "referrer" and the "doer", namely:
  • Referring medical practitioner
  • Radiological medical practitioner
    (Note: these can be the same person, e.g. a dentist, a radiation oncologist)
• Medical physicist (based on IOMP definition)
• Medical radiation technologist
  • Radiographer, …

Key players

• Crucial to radiation protection in medical exposure
  • Radiological medical practitioner
  • Medical physicist
  • Medical radiation technologist
  • Radiopharmacist
• But who is such an expert?
  • Education, training & competence
  • Specialization
  • Formal recognition

Key players, continued

• All definitions have a similar format:
  • A health professional, with education and specialist training in ……, competent to ……
• Explanatory note to each definition:
  • Competence of persons is normally assessed by the Member State by having a formal mechanism for registration, accreditation or certification of ….
  • Member States that have yet to develop such a mechanism need to assess … based either on international accreditation standards or standards from another country ….
Revised BSS & the medical physicist

• The MP has a mandated role in:
  - Therapeutic uses of radiation:
    • The requirements for calibration, dosimetry and QA, including the acceptance and commissioning of medical radiological equipment
    • Are fulfilled by or under the supervision of a medical physicist
  - Diagnostic uses & image-guided interventional procedures
    • The requirements for imaging, calibration, dosimetry and QA, including the acceptance and commissioning of medical radiological equipment
    • Are fulfilled by or under the oversight of or with the documented advice of a medical physicist
    • Whose degree of involvement is determined by the complexity of the radiological procedures and the associated radiation risks

Principles of radiation protection for medical exposure

• Justification
  • Expanded in line with ICRP 73, 103
  • Responsibilities assigned

• Optimization
  • Much technical detail removed (to go into SG)
  • Medical physicist has a major role

Optimization of protection

• Calibration
  • Medical physicist assigned responsibility

• Dosimetry of patients
  • Medical physicist assigned responsibility

• Diagnostic reference levels (DRLs)
  • Strengthened through link made to dosimetry of patients requirements
Level 3 justification

- The justification of medical exposure for an individual patient shall be carried out through consultation between the radiological medical practitioner and the referring medical practitioner, as appropriate....

Does BSS recognize Medical Physicist?

YES

Medical Physicist

A health professional,

- with specialist education and training in the concepts and techniques of applying physics in medicine, and
- competent to practise independently in one or more of the subfields (specialties) of medical physics.
Education and Training Requirements

What is responsibility of the Government?

Governments Responsibilities

The government shall ensure that requirements are established for:

• (a) education, training, qualification and competence in protection and safety of all persons engaged in activities relevant to protection and safety;
• (b) the formal recognition of qualified experts;
• (c) the competence of organizations that have responsibilities relating to protection and safety.

Responsibilities of Regulatory bodies

• Shall ensure the application of the requirements for education, training,
• Qualification and competence in protection and safety of all persons engaged in activities relevant to protection and safety.
Responsibilities of principal parties

- The relevant principal parties and other parties having specified responsibilities in relation to protection and safety shall ensure that all personnel engaged in activities relevant to protection and safety have appropriate education, training and qualification so that they understand their responsibilities and can perform their duties competently, with appropriate judgement and in accordance with procedures.

Is there a requirements for specialization?

Yes, this is “New” in revised BSS

- The regulatory body shall require that health professionals with responsibilities for medical exposure are specialized in the appropriate area and that they meet the requirements for education, training and competence in the relevant specialty.
Who should assess competence?

- Competence of persons is normally assessed by the State by having a formal mechanism for registration, accreditation or certification of medical physicists in the various specialties (e.g. diagnostic radiology, radiation therapy, nuclear medicine).

States that have yet to develop such a mechanism would need to assess the education, training and competence of any individual proposed by the licensee to act as a medical physicist and to decide, on the basis either of international accreditation standards or standards of a State where such an accreditation system exists, whether such an individual could undertake the functions of a medical physicist, within the required specialty.

Recap

- Why international system?
- Which parties are involved?
- Consensus of >140 members states, besides co-sponsors
- ICRP, UNSCEAR, IAEA
- Main points in international BSS for medical physicists