Eight decades of ICRP recommendations in medicine: a perspective

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Since the very beginning, ionizing radiation has been associated to medical diagnosis and treatment.
1895 – Discovery of X-rays
Since the discovery ... 

1896 – Discovery of radioactivity
1898 – Discovery of Radium
Almost every professional working with X rays had to use his own hand very frequently to check the output of the X ray tube.

Much experimental work placing the hands directly in the beam.
The first X-ray tubes had no shielding
yesterday, 21 days after the experiment, all the hair came out over the space under the X-ray discharge. The spot is now perfectly bald, being two inches in diameter. This is the size of the X-ray field close to this tube. We, and especially Dr. Dudley, shall watch with interest for further developments.
Dental X rays shortly after X-ray discovery

- Long exposure because of extremely low sensitivity of the photographic plate
- Loss of hair of patients at beam entrance
In summary: injuries in the first two decades were

- Primarily, researchers, manufacturers, radiologists and radiation therapists
In response to growing concerns about the effects of ionizing radiation being observed in the medical community …

The second International Congress of Radiology, held in Stockholm in 1928, established what is now ICRP under the name of the International X-ray and Radium Protection Committee.

The first Chairperson was the 32 year old Rolf Sievert.
First set of international recommendations
Stockholm July 1928, entirely focused on occupational protection in medicine

- Basically three rules
  - Distance
  - Shielding
  - Limitation of working time

- In addition, there were a set of recommendations on electrical safety
Distance

11. An operator should place himself as remote as practicable from the X-ray tube. It should not be possible for a well rested eye of normal acuity to detect

15. In the case of X-ray treatment the operator is best stationed completely outside the X-ray room behind a protective wall of a minimum lead equivalent
12. The X-ray tube should be surrounded as completely as possible with protective material of adequate lead equivalent.

13. The following lead equivalents are recommended as adequate:

<table>
<thead>
<tr>
<th>X-rays generated by peak voltages</th>
<th>Minimum equivalent thickness of lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not exceeding 75</td>
<td>1 mm.</td>
</tr>
<tr>
<td>*</td>
<td>1 1/2 mm.</td>
</tr>
<tr>
<td>*</td>
<td>2 mm.</td>
</tr>
<tr>
<td>*</td>
<td>2 1/2 mm.</td>
</tr>
<tr>
<td>*</td>
<td>3 mm.</td>
</tr>
<tr>
<td>*</td>
<td>4 mm.</td>
</tr>
<tr>
<td>*</td>
<td>5 mm.</td>
</tr>
<tr>
<td>*</td>
<td>100</td>
</tr>
<tr>
<td>*</td>
<td>125</td>
</tr>
<tr>
<td>*</td>
<td>150</td>
</tr>
<tr>
<td>*</td>
<td>175</td>
</tr>
<tr>
<td>*</td>
<td>200</td>
</tr>
<tr>
<td>*</td>
<td>225</td>
</tr>
</tbody>
</table>

14. In the case of diagnostic work, the operator should be afforded protection from scattered rays by a screen of a minimum lead equivalent of 1 mm.
I. Working Hours etc.

2. The following working hours etc. are recommended for whole-time X-ray and radium workers:
   (a) Not more than seven working hours a day.
   (b) Not more than five working days a week. The off-days to be spent as much as possible out of doors.
   (c) Not less than one month's holiday a year.
   (d) Whole-time workers in hospital X-ray and radium departments should not be called upon for other hospital service.

16. Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures.
These ICRP recommendations were published as papers in various scientific journals in the fields of medicine and physics.
The field of radiological protection had widened from protection in medical radiology (X rays and radium) to embrace all other aspects of protection against ionising radiation.

The organization was renamed in 1950, taking its current name, International Commission of Radiological Protection.

The parent organization continues to be the International Society of Radiology.
The following Committees were appointed

1. permissible dose for external radiation;
2. permissible dose for internal radiation;
3. protection against X rays generated at potentials up to 2 million volts;
4. protection against X rays above 2 million volts, and β rays and γ rays;
5. protection against heavy particles, including neutrons and protons; and
6. disposal of radioactive wastes and handling of radioisotopes

There was no Committee on protection in medicine.
With “present maximum permissible exposure levels no special treatment of radiation workers with respect to working hours and length of vacation is needed”

The report stated that “no recommendations are given with regard to the dose to the individual from medical exposure”
Beginning of patient protection (1966)
... citing the 1962 UNSCEAR report, recognized that medical exposure could be reduced without loss of medically important information.

Soon after this statement in Publication 9, the first task group charged with patient protection in x-ray diagnosis was established,

The task group prepared Publication 16 (ICRP, 1970).
First publication entirely devoted to patient protection

- “the establishment of efficient measures for patient protection will in no way impede the continuing development of radiological diagnosis.

- It may be stated that, ..., such measures contribute to the highest standards of clinical radiological practice.”
Technical contents of Publication 16

• This publication addressed the following topics, with recommendations that are still applicable today:
  • properties of the radiation beam,
  • size and position of x-ray beam,
  • organ shielding,
  • antiscatter grids,
  • sensitivity of the recording system,
  • processing control and recording of radiation exposure, and
  • reduction in number of retakes.
1977 Renaming and refocusing Committee 3

Radiological protection in medicine

“Matters requiring particular attention include the protection of the patient…”
Chairpersons of Committee 3 on Radiation protection in medicine since 1977

1977–1985
Charles B. Meinhold, USA

1985–1993
Julian Liniecki, Poland

1993–1997
Henri Jammet, France

1997–2005
Fred J. Mettler, USA

2005–2009
Claire Cousins, UK

2009 to date,
Eliseo Vañó, Spain
Series of comprehensive reports on the protection of patients were published in the 80’s.
ICRP 34: patient protection in diagnostic radiology

- Parameters influencing exposure
- Methods for optimization
- Education and training
- Appendices on organ dose calculation from entrance doses

**APPENDIX 1**

*Determination of Organ Doses from Diagnostic X-ray Examinations*†

There are several methods for estimating the dose to specific organs of a patient from diagnostic x-ray examinations (A-1).† One method is to refer to tables of organ dose for a reference patient. An example of such data is presented in Table A1, which gives the calculated

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**Table A2.** Average absorbed dose (1 mGy) in the thyroid for selected x-ray projections.† 1 Gy entrance kerma (air kerma in air without backscatter)

<table>
<thead>
<tr>
<th>Projection</th>
<th>View</th>
<th>SID (cm)^2</th>
<th>Image receptor size (cm)^2</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull</td>
<td>AP</td>
<td>102</td>
<td>25.4 × 30.5</td>
<td>216</td>
<td>273</td>
<td>316</td>
<td>351</td>
<td>378</td>
<td>399</td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>102</td>
<td>25.4 × 30.5</td>
<td>9</td>
<td>15</td>
<td>23</td>
<td>31</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>LAT</td>
<td>102</td>
<td>30.5 × 25.4</td>
<td>87</td>
<td>110</td>
<td>137</td>
<td>160</td>
<td>180</td>
<td>188</td>
</tr>
<tr>
<td>Abdominal*</td>
<td>AP</td>
<td>102</td>
<td>35.6 × 43.2</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>102</td>
<td>35.6 × 43.2</td>
<td>0.02</td>
<td>0.07</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>LAT</td>
<td>102</td>
<td>35.6 × 43.2</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Lumbar spine</td>
<td>AP</td>
<td>102</td>
<td>35.6 × 43.2</td>
<td>0.06</td>
<td>0.2</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>LAT</td>
<td>102</td>
<td>35.6 × 43.2</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Scapula (one side only)</td>
<td>AP</td>
<td>102</td>
<td>25.4 × 30.5</td>
<td>13</td>
<td>17</td>
<td>25</td>
<td>32</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>Full spine</td>
<td>AP</td>
<td>183</td>
<td>35.6 × 91.4</td>
<td>643</td>
<td>808</td>
<td>936</td>
<td>1040</td>
<td>1110</td>
<td>1170</td>
</tr>
</tbody>
</table>
In 1997 Committee 3 recognized that:

- Comprehensive ICRP reports were used by radiation protection specialists in hospitals,
- But not by the medical community
- The impact was, therefore, limited
A decision was made to

- Identify specific demands by specific audiences within the medical community,
- address them in short concise reports, worded in plain language understandable to these audiences
- but still in a scientific manner and consistent with all the ICRP recommendations
- accept high-quality translation by professional societies to local languages
- accompany them with a set of slides to be used or adapted by professionals in lectures
Pregnancy and medical radiation
Guidance for physicians: Radiation and your patient

Annals of the ICRP
Supporting Guidance 2
Radiation and Your Patient: A Guide for Medical Practitioners

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION
Diagnostic reference levels in medical imaging: Review and additional advice

ICRP Supporting Guidance 2
Approved by ICRP Committee 3 in September 2001

Abstract—Diagnostic reference levels (DRLs) should be used by regional, national and local authorised bodies. The numerical values of DRLs are advisory, however, implementation of the DRL concept may be required by an authorised body.

The concept of DRLs allows flexibility in their selection and implementation.

The present ICRP advice does not specify quantities, numerical values or details of implementation for DRLs. This is the task of the regional, national and local authorised bodies, each of which should meet the needs in its respective area. ICRP considers that any reason-
Education and training
Radiation therapy
Radiation Safety in Radiation Therapy
Emphasis on Prevention of Accidental Exposures

Conventional Radiotherapy

ICRP
Annals of the ICRP
Publication 86
Prevention of Accidental Exposures to Patients Undergoing Radiation Therapy

New technologies external beam
Radiation safety in ion beam radiotherapy
Specific issues in radiation safety in brachytherapy

HDR brachytherapy

Prostate treatment with permanent implants
Fluoroscopy and interventional
Avoiding radiation injuries

Interventions outside the imaging department
Digital radiography
Transition from conventional to digital radiology
Computed tomography
Radiation protection in computed tomography

Single slice CT

Multi slice CT

Cone beam CT
Special groups: paediatry
Paediatric imaging
In summary, 20 concise publications from 2000 to date

ICRP 84 Pregnancy
ICRP 85 Interventional
ICRP 86 Prevention of accidental RT
ICRP 87 CT
ICRP 93 Digital
ICRP 94 Release of patients
ICRP 97 HDR Brachytherapy
ICRP 98 Brachytherapy prostate
ICRP 102 MDCT
ICRP 106 Radiopharmaceuticals
ICRP 112 Radiotherapy new technologies
ICRP 113 Training
ICRP 117 Outside imaging department
ICRP 118 Statement on Tissue Reactions
ICRP 120 Cardiology
ICRP 121 Protection Pediatric Radiology
ICRP 127 IBRT
ICRP 129 CBCT
Committee 3 current work

- Occupational radiological protection in brachytherapy,
- Occupational radiation protection issues in radiation imaging guided interventions,
- Justification: framework for justification in medical uses of ionizing radiation,
- Diagnostic reference levels for diagnostic and interventional imaging
- Radiological protection in therapy with radiopharmaceuticals,
- Radiological protection in medicine related to individual radiosusceptibility
Conclusions
Conclusions

- Since its birth in 1928, the ICRP has been intimately related to protection in medicine. It was born at the International Congress of Radiology, in response to growing concerns about the effects of ionizing radiation observed in the medical community.
- During the first 30 years its recommendations were devoted to protection of the radiological professionals.
- In the 50’s the ICRP widened its scope to embrace other areas of protection.
Conclusions

- In 1977 undertook a significant re-orientation of priorities assigning Committee 3 radiation protection in medicine, including the patients.
- In the 80’s, comprehensive publications were devoted to patient protection in radiology, nuclear medicine and radiotherapy and
- From year 2000 about 20 concise publications have been published, addressing specific concerns from specific audiences within the medical community
Thank you for your attention