Eye lens monitoring: How is it implemented in different countries?

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The framework
Statement on Tissue Reactions

Approved by the Commission on April 21, 2011

(1) The Commission issued new recommendations on radiological protection in 2007 (ICRP, 2007), which formally replaced the Commission's 1990 Recommendations (ICRP, 1990). The revised recommendations included consideration of the detriment arising from non-cancer effects of radiation on health. These effects, previously called deterministic effects, are now referred to as tissue reactions because it is increasingly recognised that some of these effects are not determined solely at the time of irradiation but can be modified after radiation exposure. Previously, the Commission had reviewed various aspects of non-cancer health effects of low-linear energy transfer (LET) ionizing radiation in Publication 47 (ICRP, 1994), high LET radiation in Publication 58 (ICRP, 1990), the skin in Publication 59 (ICRP, 1991b), and the skin and the eye in Publication 85 (ICRP, 2000).

(2) The Commission has now reviewed recent epidemiological evidence suggesting that there are some tissue reaction effects, particularly those with very late manifestation, where threshold doses are or might be lower than previously considered. For the lens of the eye, the threshold absorbed dose is now considered to be 0.5 Gy.

(3) For occupational exposure in planned exposure situations the Commission now recommends an equivalent dose limit for the lens of the eye of 20 mSv in a year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.
Framework

• Reduction of the annual limit on the equivalent dose to the lens of the eye for exposed workers (international and European basic safety standards)
• Regulatory bodies, scientific committees, professional societies
• RPOs and RPEs
• WORKERS!

• To be implemented by ... **February 2018**
  - practical implementation of the reduced limit ???
Meanwhile...
Meanwhile ...

• Research projects (ORAMED, EURALOC...)

• Many publications involving measurements, simulations, regulatory issues, quantities to be used, calibration issues etc ...
Types of eye lens dosemeters
European Directive
What is foreseen in the EU BSS?

73 pages, 109 articles, and 18 annexes
European BSS

- **Recital no 14** “This Directive should also follow new ICRP guidance on the limit for equivalent dose for the lens of the eye in occupational exposure.”

- **Article 9** Dose limits for occupational exposure “(a) the limit on the equivalent dose for the lens of the eye shall be 20 mSv in a single year or 100 mSv in any five consecutive years subject to a maximum dose of 50 mSv in a single year, as specified in national legislation”

- **Article 11** Dose limits for apprentices and students “(a) the limit on the equivalent dose for the lens of the eye shall be 15 mSv in a year;”
European BSS

• Article 12 Dose limits for public exposure “(a) the limit on the equivalent dose for the lens of the eye shall be 15 mSv in a year;”

• Article 35 Arrangements in workplaces “…for the purposes of radiation protection, arrangements are made as regards all workplaces where workers are liable to receive an exposure greater than …an equivalent dose of 15 mSv per year for the lens of the eye…”
European BSS

- **Article 40** Categorization of exposed workers “(a) category A: those exposed workers who are liable to receive ...or an equivalent dose greater than 15 mSv per year for the lens of the eye ...;  
(b) category B: those exposed workers who are not classified as category A workers.”

- **Article 41** Individual monitoring “In cases where category A workers are liable to receive significant internal exposure or significant exposure of the lens of the eye or extremities, an adequate system for monitoring shall be set up”
European BSS

• Article 82 Radiation protection expert ....the advice of the RPE shall cover ... “(d) classification of workers;”

• Annex 10 Data system for individual radiological monitoring “The results of the individual monitoring of the exposed worker shall include the official dose record (year; .... equivalent doses in the different parts of the body in mSv; ...);”
Implementation by the end users
Implementation means ...

✓ How to measure the exposure to the lens of the eye
✓ How to estimate the eye lens
✓ Who should be monitored?
✓ Who is responsible to do the categorization of workers?
To get some answers for the practical implementation ...

• A questionnaire was developed by the members of WG12 of EURADOS in order to establish an overview of the status of eye lens radiation dose monitoring in hospitals (2014)

• The questions about:
  o knowledge of the proposed eye lens dose limit;
  o monitoring and dosimetry issues;
  o training and radiation protection measures.
Status of eye lens monitoring in European hospitals

- 195 responses from 23 European countries
- 93% of the responses stated that they are familiar with the change in the eye lens limit
- 55% have already performed some specific eye dose monitoring pilot studies
How do you measure/estimate eye lens doses?

In many cases eye lens monitoring was not performed or, it is done within a framework of specific studies.
Position of the eye lens dosemeter

- On the shoulder: 3%
- On the collar: 26%
- Between the eyes: 15%
- Near the eye, in front of the lead glasses: 37%
- Near the eye behind the lead glasses: 19%

The position of the dosemeter varies considerably.
Status of eye lens monitoring in European hospitals - 2014

• There was good awareness of the reduced eye dose limit
• Many specific eye dose studies had already been performed or were in progress
• The new eye lens dose limit could be exceeded for those working with IR
• Harmonisation about the position and method of estimation of the eye lens dose was suggested
Regulatory status
Implementation means ...

✓ Modification of the national regulations
✓ Registration to the NDR
✓ In line with GDPR (May 2018)

Also...

✓ Guidance on appropriate quantity, algorithm, correction factor, position of dosemeter
Overview of the regulatory status of eye lens monitoring

Eurados WG12 organized a survey through a questionnaire addressed to regulatory authorities

➢ to investigate how the various countries are dealing with the:
  ✓ estimation of the effective dose, \( E \), and
  ✓ equivalent dose to the lens of the eyes, \( H_{\text{lens}} \)
when protective garments such as thyroid collars, lead aprons or lead glasses are worn.
Design of questionnaire

• country’s regulations
• double dosimetry
• monitoring of the dose to the lens of the eye
• methodology for the estimation of the effective dose and the dose to the lens of the eye
• national dose register

• few months before the February 2018 deadline for the implementation of the reduction in annual limit European Union member states
• information gathered need to be interpreted in light of foreseen modifications
Answers from

26 countries responded to the questionnaire
Level of regulatory provisions for determination of the effective dose and/or the operational quantities for individual monitoring

All of the 26 countries have certain provisions in their regulatory framework.

However, 12 out of 26 have no legal requirement for the estimation of the dose to the lens of the eye!
What type of dosemeter is required for the estimation of the eye lens dose?
Is there an algorithm in place for the estimation of the eye lens dose $H_{\text{lens}}$?

no! 23/26

Yes! 3/26

- $H_{\text{lens}} = f \, H_p(3)$,
- $H_{\text{lens}} = f' \, H_p(0.07)$,

when eye lens dosemeter is used above the radiation glasses

Yes! 5/26 for the effective dose

Approved by the competent authority
### Parameters to be included in the NDR

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Countries with Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_p(10)$ below</td>
<td>18</td>
</tr>
<tr>
<td>$H_p(0.07)$ below</td>
<td>14</td>
</tr>
<tr>
<td>$H_p(10)$ above</td>
<td>14</td>
</tr>
<tr>
<td>$H_p(0.07)$ above</td>
<td>11</td>
</tr>
<tr>
<td>E (estimated from the operational quantities)</td>
<td>12</td>
</tr>
<tr>
<td>Extremity doses</td>
<td>17</td>
</tr>
<tr>
<td>$H_p(3)$ below</td>
<td>6</td>
</tr>
<tr>
<td>$H_p(3)$ above</td>
<td>3</td>
</tr>
</tbody>
</table>

All of the responding countries use some kind of national database for keeping individual monitoring data. The operational quantity $H_p(3)$ is stored in the NDR of only 7 out of 26 countries.
Parameters to be included in the NDR
Changes foreseen

• 15 out of 26 are considering changing their NDR to be able to record additional parameters, such as
  • the results of double dosimetry,
  • the measured values of $H_p(3)$,
  • the correction factor for the applied protective measures ...

• To be in line with the new GDPR
A. Data to be included in the data system for individual radiological monitoring

3. Data on the worker's identity shall include the worker's:

   (a) surname;

   (b) first name;

   (c) sex;

   (d) date of birth;

   (e) nationality, and

   (f) unique identification number.

4. Data on the undertaking shall include the name, address and unique identification number of the undertaking.

5. Data on the employment of the worker shall include:

   (a) the name, address and unique identification number of the employer;

   (b) the starting date of individual monitoring; and where available, the end date;

   (c) the categorisation of the worker in accordance with Article 40.

6. The results of the individual monitoring of the exposed worker shall include the official dose record (year, effective dose in mSv, in the event of non-uniform exposure, equivalent doses in the different parts of the body in mSv, and in the event of an intake of radionuclides, the committed effective dose in mSv);
An example
Greek implementation

- ORAMED and EURALOC
- pilot study <2013
  • November 2014
  • Around 50 interventional cardiologists
  • Average monthly dose 0,22 mSv
  • Maximum monthly dose 2,5 mSv
Greek implementation

Number of exposed workers

Year: 2015, 2016, 2017, 2018, 2019

Values: 70, 60, 80, 60, 90
Greek implementation
Greek implementation
Actions taken
Actions taken

Implications for Occupational Radiation Protection of the New Dose Limit for the Lens of the Eye

To reduce the risk for cataracts in the lens of the eye, the IAEA, General Safety Requirements, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (No. GSR Part 1) states that occupational exposure of the lens of the eye should be limited to an equivalent dose limit of 20 mSv per year, averaged over three years, with no single value in a single year exceeding 50 mSv. This dose limit is in line with the recommendations in the International Commission on Radiological Protection (ICRP) Publication 103.

Optimizing protection:

Appropriate protective actions need to be taken to ensure that doses to the lens of the eye do not exceed the dose limit. Workers potentially at risk include those working in radiopharmaceutical laboratories, medical imaging departments, and laboratories using radiopharmaceuticals. Workers in industrial radiography, medical imaging departments, and laboratories using radiopharmaceuticals are at risk. Effective strategies to reduce the radiation dose to the lens of the eye include:

- **Administrative controls:**
  - Adequate shielding of the lens of the eye, especially against scatter.
  - Use of personal protective equipment such as protective goggles, shields, etc.

- **Engineering controls:**
  - Use of barriers and shields to protect workers from direct exposure.

- **Operational controls:**
  - Use of barriers and shields to protect workers from direct exposure.

The lens of the eye is sensitive to radiation, and exposure to high doses can lead to cataracts. Therefore, it is important to monitor radiation exposure to ensure that it remains below the dose limit.

New Dose Limit for the Lens of the Eye

The new dose limit for the lens of the eye was introduced in 2012 to reduce the risk of cataracts due to occupational radiation exposure. The limit is based on the International Commission on Radiological Protection (ICRP) recommendations and is intended to protect workers from the long-term effects of radiation exposure.

The IAEA recommends that the occupational exposure limit for the lens of the eye be set at 20 mSv per year, averaged over three years, with no single value exceeding 50 mSv. This limit is in line with the recommendations of the International Commission on Radiological Protection (ICRP) and is intended to reduce the risk of cataracts due to occupational radiation exposure.

In addition, the IAEA recommends that employers take appropriate measures to reduce the risk of radiation exposure to workers, including the use of personal protective equipment, administrative controls, and engineering controls.

The IAEA also recommends that workers potentially at risk of radiation exposure be monitored regularly to ensure that their exposure remains below the dose limit.
Guidance is given about

• The energy and angle of radiation
• The geometry of the field

• The quantity to be used
• Dosemeters to be used

• Protective measures
• Where to wear the doseometers
Harmonisation ...

- The procedures for the estimation of the dose to the lens of the eye
- Type and position of the eye lens dosemeter
- Algorithms to be used
- Clear definition of the parameters to be registered in the national radiation protection database
Thank you very much for your attention!