# Assessment of eye lens doses of interventional radiology and interventional cardiology workers in the period of 2016-2020

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## 1. Introduction

In 2011 the International Commission on Radiological Protection (ICRP) published a statement on tissue reactions [1] and recommended reducing an equivalent dose limit for the lens of the eye from 150 mSv per year to 20 mSv per year, averaged over defined periods of five years, with no annual dose in a single year exceeding 50 mSv [2, 3]. In 2014 reduced annual occupational equivalent dose limit to the lens of the eye was adopted in the IAEA Safety Standards [4]. This new provision was adopted in Lithuanian legislation in 2015. The new dose limit has become very important for interventional radiology (IR) and interventional cardiology (IC) workers because this category of workers receives the highest occupational exposure compared to other medical staff.

## 2. Materials and methods

### *2.1 Quantities measured and dosimeters used*

Routine monitoring and dose assessment of the dose to the lens of the eye should be undertaken if the provisional estimation indicates that the annual equivalent dose to the lens of the eye could exceed a dose of the order of 5 mSv [2]. The dose to the lens of the eye can be assessed by measuring personal dose equivalent $H_p(3)$ with the eye lens dosemeter at the level of the eye or $H_p(10)$ with the whole body dosemeter above the lead collar (Figure 1). Routine monitoring using the eye lens dosemeter should be undertaken if the provisional estimation indicates that the annual equivalent dose to the lens of the eye could exceed a dose of the order of 15 mSv. The monitoring period should also be reduced to one month.

***Figure 1.*** *The dose to the lens of the eye can be assessed by measuring personal dose equivalent $H_p(3)$ with the eye lens dosemeter at the level of the eye or $H_p(10)$ with the whole body dosemeter above the lead collar in Lithuanian hospitals.*

### *2.2 Development of the recommendations for the assessment of the equivalent dose to the lens of the eye*

Since the need of the assessment for the doses to the lens of the eye is very relevant recently, a large number of international studies are presented and analysed preparing the recommendations for the assessment of the equivalent dose to the lens of the eye (further – recommendations). The recommendations were developed and approved in Lithuania in 2016.

### *2.3 Correction factors*

For the assessment of the equivalent dose ($H_{lens}$) to the lens of the eye, the appropriate correction factors (K) have to be applied when lead glasses during IR or IC procedures are used. The information about used lead glasses and correction factors was taken from several international studies [5, 6, 7, 8]. The formulas (1) and (2) can be respectively applied when the eye lens dosimeter or whole body dosemeter above the lead collar is used:

$$H_{lens} = K \times H_p(3), \quad (1)$$

$$H_{lens} = K \times 0.75 \times H_p(10)_{above}, \quad (2)$$

The correction factor (K) of lead glasses is the ratio of the radiation dose (D1) received by the lens of the eye with lead glasses and the radiation dose (D2) received without lead glasses: K = D1/D2.

Using information from the literature and collected information about lead glasses used by IR and IC staff, the lead glasses were divided into five categories taking into account the lead equivalent, area of lenses and presence of side protection. The correction factor of 0.5 was assigned to the three categories of glasses. The correction factors of 0.3 and 0.15 were assigned for the two remaining categories of the lead glasses (Table 1).

***Table 1. Correction factors (K) for lead glasses***

| K | Lead equivalent, mmPb | Area of glass lens, $cm^2$ | Size of lens of glasses | Leaded side protection |
|---|---|---|---|---|
| 0,5 | ≥0.5 | unknown | unknown | Presence unknown |
| 0,5 | [0.07–0.5) | ≥50 | extra large | Present |
| 0,5 | ≥0.5 | <28* | small* | No side shield |
| 0,3 | ≥0.5 | <28* | small* | Present |
| 0,15 | ≥0.5 | ≥28** | large** | Present |

***small lens glasses are those with a lead lens area of up to 28 $cm^2$ without the side protection area or width of up to 7.5 cm or a side protection width of up to 4 cm.

****large lens glasses are those with a lead lens area, without a side protection area equal to or greater than 28 $cm^2$ or having a convex lens with a width equal to or greater than 7.5 cm or a side protection area equal to or greater than 4 cm.

## 3. Analysis of results

According to recommendations, eleven Lithuanian hospitals assessed the doses to the lens of the eye and annually submitted them to the National Dose Registry of Lithuania. In the period 2016 - 2020 the average annual equivalent doses to the lens of the eye were 2.2 - 4.6 mSv for IR and IC physicians and 0.6 - 1.3 mSv for IR and IC nurses. The maximum annual equivalent dose to the lens of the eye was 18.5 mSv for IR physician and 8.1 mSv for IR nurse. The maximum annual equivalent dose to the lens of the eye in 2020 was about 40 percent lower than in 2016. In the period 2016 - 2020, the maximum annual equivalent doses to the lens of the eye for physicians at 11 hospitals and nurses at five hospitals are presented in Figure 2 and Figure 3.

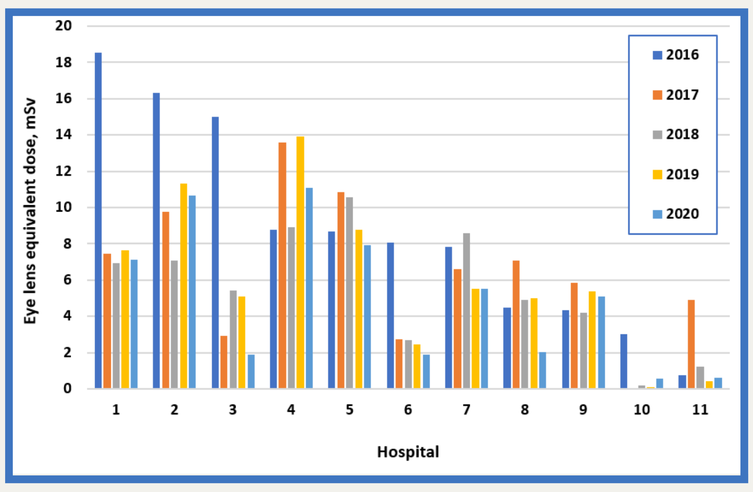


***Figure 2.*** *Estimated maximum annual equivalent dose to the lens of the eye for IR and IC physicians at eleven Lithuanian hospitals in 2016–2020.*

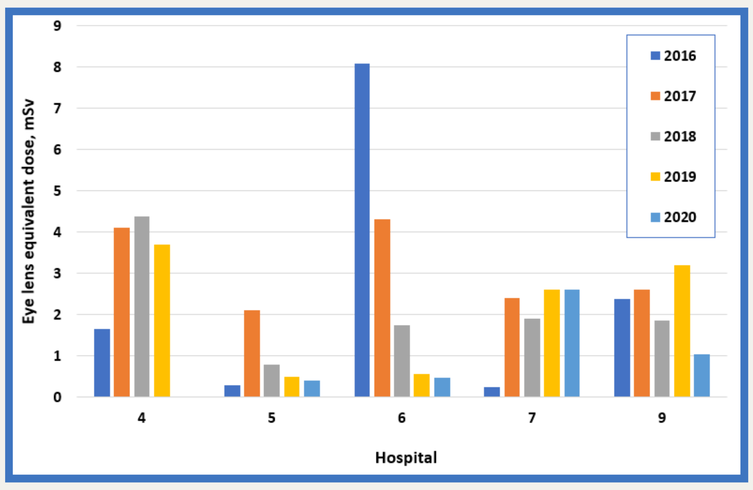


***Figure 3.*** *Estimated maximum annual equivalent dose to the lens of the eye for IR and IC nurses at five Lithuanian hospitals in 2016–2020.*

## *4. Conclusion*

The results of assessed eye lens doses of IR and IC workers showed that the new limit to the lens of the eye is not exceeded. This shows that operators adequately ensure radiation protection and that national and international legal requirements are being met.

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