

IMPLEMENTATION OF RAY SAFE i2 SYSTEM FOR STAFF DOSE MEASURING IN INTERVENTIONAL RADIOLOGY

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Abstract – Interventional radiology procedures usually delivered the highest radiation dose to the patients as well as to medical personal. Beside another factors like patient size, fluoroscopy time, machine calibration etc., a good clinical practice has strong effects to staff and patient's radiation dose.

Materials and methods: In August 2012, a Ray Safe i2 system was installed in a private hospital in Skopje. The main purpose of this dosimetry system is to provide real time indication for the current exposure level of the medical personal. Knowing that, the staff has prerequisites to adjust their behavior to minimize unnecessary exposure like changing distance from exposed volume, C-ram angulations, field of view etc. and on this way to develop a good clinical practice. The Ray Safe i2 system is consisted by ten digital dosimeters, two dock stations, real time display, dose viewer and dose manager software. During interventional procedures, each involved staff wears dosimeter which measures and records X-Ray exposure every second and transfer the data wirelessly to the real time display. Color indication bars (green, yellow, red) represents the intensity of the currently received exposure, whereas green zone indicates < 0.2 mSv/h, yellow zone from 0.2 to 2 mSv/h and red zone indications from 2 to 20 mSv/h. Additionally, accumulated dose per individual is displayed next to the color indication bars. By using the software, information about personal dose history, such as annual dose, dose per particular session, hour, day or week, can be viewed and analyzed.

Results: In this work it was found that staff accumulated doses were constantly increased over time, but reported number of procedures does not correspond to this tendency. Our assumption is that there is a misleading between reported number and actual performed procedures.

Doctor1 received 55 times more dose than Doctor2 and Nurse1 received 11 to 3 times more dose than another Nurses.

It was found a correlation of $R^2 = 0.1247$ and $p=1.71303E-12$ between DAP and fluoroscopy time regardless of type of procedure.

Conclusions: Staff doses are proportional to number of procedures and fluoroscopy time, but depend also on patient size, exposure factors, type of procedure, etc. The main reason for discrepancies among personal doses is based on different number of performed procedures. According to Ray Safe dose records, it is very unlikely that personal will reach the annual dose limits.

Keywords – Ray Safe i2 system, interventional radiology staff doses

1. INTRODUCTION

Interventional radiology procedures usually delivered the highest radiation dose to the patients as well as to medical personal. Beside another factors like patient size, fluoroscopy time, machine calibration etc., a good clinical practice has strong effects to staff and patient's radiation dose. The RaySafe i2 System is an

electronic X-ray dose monitoring system. The intended use is to improve the awareness of people who work with or are in the presence of X-ray imaging equipment, about their occupational dose (also known as staff dose). The awareness focuses on:

- A graphical visualization of the real-time staff dose rate while working with X-ray equipment in examination rooms during medical procedures;

- Instant access to historical staff dose for reporting and analysis purposes.

The benefits of the RaySafe i2 System are to:

- Make people aware of their received staff dose during clinical work with X-ray imaging equipment;
- Instantly visualize the result of reducing measures of occupational dose by, for example, changing a person's position in the examination room.

2. MATERIALS AND METHODS

The RaySafe i2 System can contain the following components: dosimeter, real time display, dose viewer (computer software), dose manager (computer software) and cradle (dock station used to connect dosimeters and computer) [1]



Fig. 1 – Ray Safe i2 system overview

The dosimeter measures and records X-ray exposure every second and transfers the data wirelessly, via radio, to the real time display. The real time display shows real time dose exposure from up to eight dosimeters in range at a time. Color indication bars (green, yellow, red) represents the intensity of the currently received exposure. The accumulated dose per procedure for each individual is displayed next to the color indication bars. The dose rate scale is divided in three zones: green zone indicates < 0.2 mSv/h; yellow zone indicates $0.2 - 2$ mSv/h and red zone dose indications $2 - 20$ mSv/h. [1].

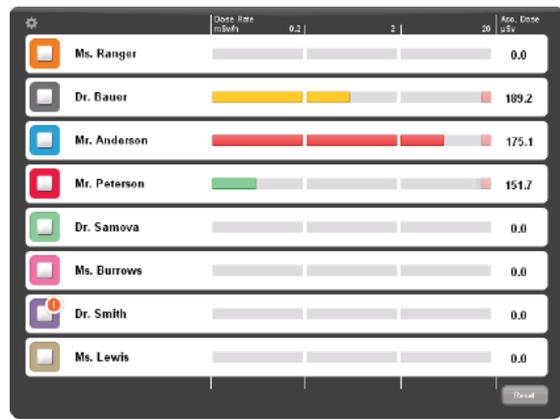


Fig. 2 – Example of current dose rates views

Accumulated dose in relation to the annual dose limit for the current year. The annual dose limit for the dosimeter is dependent of the shielding factor of the lead apron, as well as other radiation protection used. The more protection the higher the limit can be for the same effective dose to the user. The annual dose limit may or may not be chosen to reflect the legal dose limit where it is used. It could reflect the legal limit or for example a lower target for the clinical user case. Assuming that lead upon accumulated 80% of radiation, we set an annual limit of 100 mSv.

More detailed historical dose information can be transferred from dosimeters via the cradle connected to a computer and viewed using the computer software (dose viewer and dose manager). The dose viewer software is also used for administrating dosimeters, change dosimeter names, colors and reset dose history. The dose manager software is an advanced software for analyzing, reporting and archiving dose information.



Fig. 3 – Personal dose overview

In August 2012, a Ray Safe i2 system was installed in private hospital in Skopje. The system was used by staff which performs cardiology procedures by using an X-ray angiography machine GE Innova 2100. Dose parameters data, data about the type and number of procedures, as well as fluoroscopic time and Dose Area Product (DAP) values, were collected for eight months, until March 2013.

3. RESULTS

Since September 2012 to March 2013, according to the collected data, it was performed total of 276 interventional cardiology procedures. Number of procedures by type is presented on Figure 4.

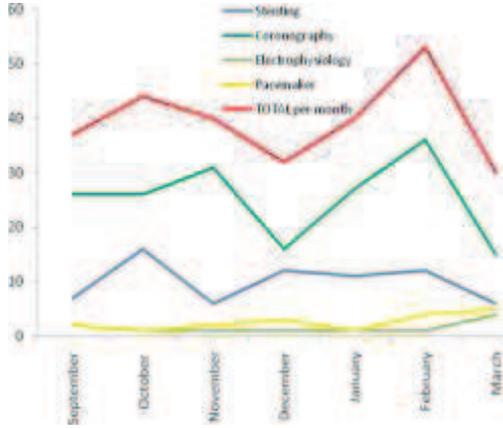


Fig. 4 – Number and type of procedures per month

Diagnostic coronarography was the most often interventional cardiology procedure, while stenting was the most fluoroscopic time demanding procedure.

Staff dose rate and staff accumulated dose history since September 2012 trough March 2013 are presented on the Figure 5-10 for each staff member. It is obvious that staff accumulated doses were constantly increased over time, but reported number of procedures does not correspond to this tendency. Our assumption is that there is a misleading between reported number and actual performed procedures.

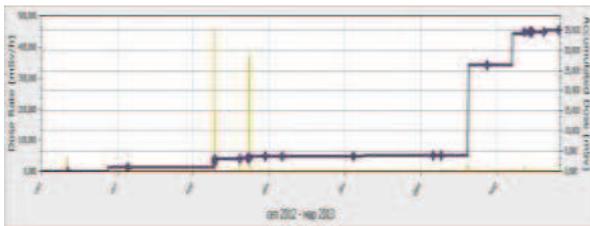


Fig. 5 – Doctor 1 dose history

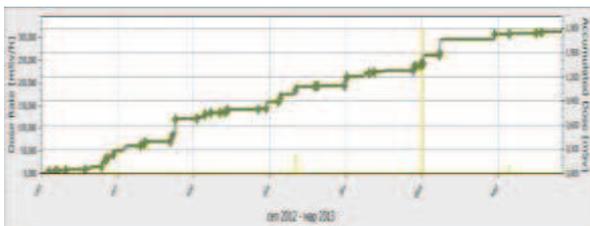


Fig. 6 – Doctor 2 dose history

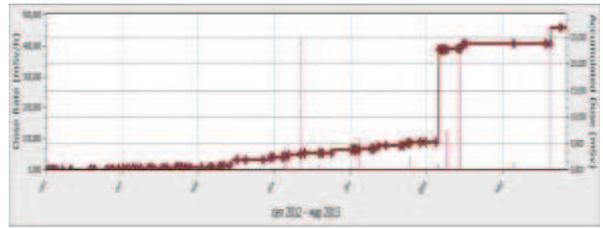


Fig. 7 – Nurse 1 dose history

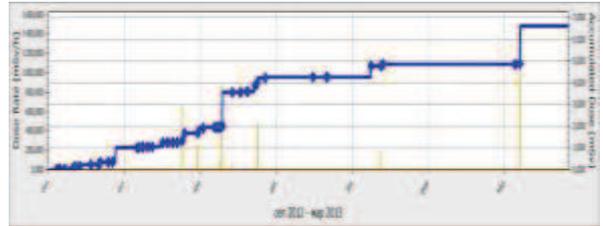


Fig. 8 – Nurse 2 dose history

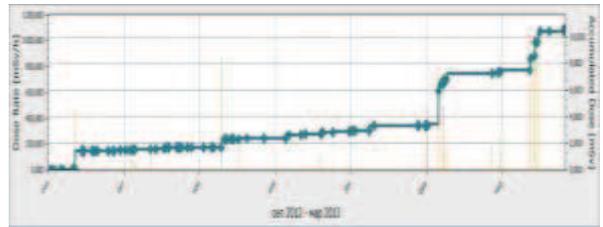


Fig. 9 – Nurse 3 dose history

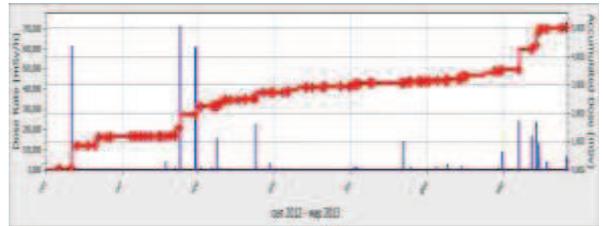


Fig. 10 – Nurse 4 dose history

In Table 1 are presented data about annual dose, percentage of set yearly maximum values and total received dose.

Table 1. Measured staff doses 1 Sept-31 March

Display name	Annual dose (mSv)	Yearly max (100 mSv)	Total dose (mSv)
Doctor1	30.9	30%	34.6
Doctor2	0.565	0%	1.76
Nurse1	23.1	23%	26.9
Nurse2	2.35	2%	6.6
Nurse3	7.5	7%	10.4
Nurse4	2.0	1%	5.01

Annual dose is received dose in 2013, while total dose is dose received from the beginning of dose measuring by the Ray Safe system.

On Figure 11 are presented DAP values related to fluoroscopic time for different type of procedures. It was found a correlating factor of $R^2 = 0.1247$ what indicates that identical fluoroscopy time for two different patients does not lead necessary to equal

DAP values. Due to different patient size, projection views, field sizes etc., the machine dynamically adjust technical parameters like kV, mA etc. It means that patient or staff in some cases can receive much higher dose for shorter that for longer fluoroscopy time in another case. From our data in four cases there are big deviation in DAP values (indicates by red spots on the graph) whereas in two cases DAP values are very high and in the another two, very low, compare to trend values. A further investigation for these cases is needed.

their clinical practice and for providing data about number and type of procedures.

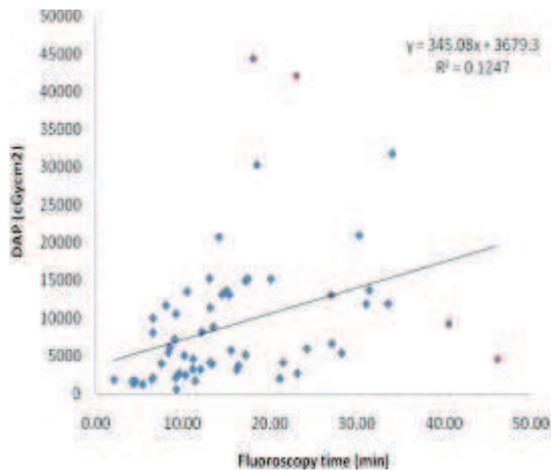


Fig.11 – Correlation between DAP and fluoroscopy time

In terms to assess the significance of correlation between DAP values and fluoroscopy time, a T.TEST was performed. It was obtain a value of $p=1.71303E-12$ what indicates that there is a statistically significance between both parameters.

4. CONCLUSION

Ray Safe i2 is a dosimetry system for measuring and displaying of dose rate and accumulated dose to personal during interventional procedure. Knowing of real time dose rate of each staff member can be useful to optimize clinical practice regards to radiation protection of staff and patients. Staff doses are proportional to number of procedures, fluoroscopy time, but also depend on patient size, exposure parameters, type of procedures etc.

5. REFERENCES

- [1] Ray Safe System, *User Manual*, 2012.03 Unfurls Ray Safe 5001047-A

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