ESTIMATION OF OCCUPATIONAL WHOLE BODY EFFECTIVE DOSE IN A CARDIAC CATH LAB

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1) Introduction and Objectives

Cardiologists are amongst the highest occupational exposed group using medical X-ray equipment. Interventional procedures are also increasingly being performed at specialist centres and have the potential for much higher patient doses and therefore higher operator doses.

In the UK the standard approach for estimating effective dose (*E)* is to wear a single dosemeter (SD) on the trunk underneath a lead apron. The drawback of this widely adopted monitoring approach is that the estimate of Hp10 and *E* does not take into account the dose to unprotected parts of the body, mainly in the head and neck region. ICRP have recommended in different reports that *E* should be determined by employing two dosemeters, one worn on the trunk underneath the lead apron and the other worn in front of the apron at the level of the collar or the left shoulder. The key objective of this preliminary study is to compare estimates of *E* derived from double dosimetry (DD) and recommended algorithms with the UK standard SD approach.

2) Method

Cardiologists working in specialist Heart and Chest Hospital were asked to wear 5 additional monitoring devices, in addition to the standard whole body film badge worn on the trunk underneath the lead apron. Of the 6 dosemeters worn, 3 were worn under the lead apron. The devices worn in front of the apron were worn so that one dosemeter (Instadose) was worn at the collar level in front of the thyroid shield. The other two passive dosemeters (Film Badge and TLD) were worn on the left breast pocket of the wearers lead apron. All dosemeters were worn over a time period ranging from 4 to 6 months. At the end of each monthly monitoring period all dosemeters were returned for processing, except for Instadose, which was immediately read on a local workstation at the wearers location. Monthly and extrapolated annual estimates of *E* were then calculated for each wearer and dosemeter, using the Webster (NCRP report 122) and Niklason algorithms. For SD the NCRP divider algorithm was applied. All dosemeters were kindly supplied by Mirion Technologies.

3) Results

Algorithm	Monitor type	Mean annual *E* for all operators (mSv)	Mean annual *E* from under apron dosemeter (mSv)	Min. *E* for all operators (mSv)	Max. *E* for all operators (mSv)
Webster	Instadose	0.59	0.27	0.51	1.22
	Genesis Ultra TLD	0.55	0.48	0.48	2.18
	Film Badge	0.99	0.10	0.52	2.30
Nicklason with TS *	Instadose	0.64	0.27	0.70	1.46
	Genesis Ultra TLD	0.73	0.48	0.70	3.12
	Film Badge	0.88	0.10	0.40	2.24

Table 1 - Comparison of mean estimates of *E* specific to each respective algorithm and dosemeter (* = Thyroid shield)

Algorithm	Monitor type	Mean annual *E* for all operators (mSv)	Mean annual *E* from single dosemeter worn on the collar (mSv)	Ratio of Single collar dosemeter/ DD
Webster	Instadose	0.59	0.86	1.46
Nicklason with TS	Instadose	0.64	0.86	1.34

Table 2 - Comparison of NCRP SD mean estimate of *E* comapred to DD algorithms.

4) Discussion and conclusion

In this study, mean annual estimates of *E* for all dosemeters, when using both the Webster and Nicklason algorithms, ranged from roughly 0.6 mSv to 1 mSv. When annual estimates of *E* are made from the summation of under apron dosemeter results, the range is roughly 0.3 to 0.5 mSv, a factor of two lower than the double dosimetry methods. The largest difference when comparing the DD estimates of *E* to the SD summation approach is given by film badge, with the annual estimate of *E* roughly 9 times higher than the annual estimate of *E* derived from under apron film badge results.

When the mean annual estimate of *E* is intercompared for each different type of dosemeter the film dosemeter estimate is on average 1.3 -1.7 times higher than the Instadose and TLD estimates when using the Nicklason and Webster algorithms. Mean operator estimates of *E* using both algorithms revealed a range of E from 0.4 to 3.12 mSv. A smaller range was observed with Instadose, on average 0.6 to 1.34 mSv, compared to 0.5 to 2.46 mSv for TLD and film badge. Mean single collar dosemeter results as derived from the NCRP report 122 algorithm yielded an estimate of *E*, 1.4 times higher than DD estimates.

In conclusion, DD results incorporating both algorithms were a factor of 2 higher than the SD (no algorithm) approach used widely in the UK. The largest differences were seen with film badge and could in part be attributable to the fact that film badge has a higher minimum detection level (i.e. 0.1 mSv compared to 0.01 mSv for Instadose and TLD). In this study film badge appeared more sensitive to radiation exposure than the other technologies for the beam energies and scatter geometry typically encountered in a cardiac catheter lab. A single collar badge worn in front of the apron could be used to estimate *E* but would yield a more conservative estimate compared to the DD algorithm results. From the range of dosemeters used in the study the optimal combination that could potentially be employed for DD is an over apron film badge and either the Instadose or the TLD worn under the apron.

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