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# A Survey of Radiation Protection Utilization and Accessibility Within Australian Cardiac Angiography Laboratories

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A B S T R A C T

Continuing improvements in both catheterization and imaging equipment have resulted in greater numbers and increasingly more complex angiographic cases being performed, which has led to higher patient and staff doses. Occupational radiation exposure to staff within fluoroscopic suites has been demonstrated to elevate the risk of carcinogenesis and radiation-induced cataracts. A survey was undertaken to compare the accessibility and utilization of radiation protective equipment by staff within a selection of cardiovascular suites throughout Australia. A number of Australian cardiovascular suites were invited to complete an online survey comprising 10 questions. The survey questions focused on the availability and use of head, thyroid, and eye radiation protection by doctors and nurses present in the room during cardiac angiography procedures. The study identified that the utilization of ceiling-mounted lead and thyroid shields was adequate within the surveyed departments but has highlighted that there are areas that staff could further reduce their risk of the occupational exposure. There is very strong evidence proving the importance of additional shielding such as lead caps and glasses in minimizing dose, and there needs to be a focus on education to ensure that staff are cognizant of the benefit of wearing them. It is advisable that staff working within angiography suites have access to appropriate radiation protection devices to minimize their exposure to ionizing radiation. In addition, training should be provided to staff regarding the risk of occupational exposure and dose optimization.



## Introduction

As ionizing radiation is required to image the patient during cardiac angiography, in-room staff are also at risk of exposure. Over the last 2 decades, both imaging and catheterization equipment have notably improved, resulting in a greater number of patients and increasingly more complex cases performed leading to higher patient and staff doses (Einstein, 2012; Ingwersen et al., 2013; Silkoset, Widmark, & Friberg, 2015).

It is vital that staff understand the importance of using the available radiation protection. This study seeks to determine the current usage and accessibility of occupational radiation protection equipment, such as thyroid shields, lead glasses and caps, and ceiling-mounted lead within a selection of cardiovascular suites throughout Australia.

### *Radiation Exposure to the Brain*

The International Atomic Energy Agency has indicated that the orientation of the fluoroscopic workplace leads to more exposure to the head of operators than other parts of the body (International Atomic Energy Agency, 2014). Brain and neck tumors are also of concern to occupationally exposed staff (Chohan, Sandoval, Buchan, Murray-Krezan, & Taylor, 2014), and there is some epidemiologic evidence of an increase in radiation-induced brain cancers in fluoroscopy operators (Roguin, 2014; Roguin, Goldstein, & Bar, 2012; Roguin, Goldstein, Bar, & Goldstein, 2013). One study found a threefold increase in death from brain cancer in radiologists as compared with doctors not occupationally exposed to radiation (Matanoski, Seltser, Sartwell, Diamond, & Elliott, 1975). Roguin (2014) identified that of 26 brain or neck tumors reported in interventional operators, 86% were left sided. This is noteworthy in that interventionists receive approximately twice as much radiation exposure to their left side than their right side because of the proximity of the left side of their bodies to the x-ray tube (Roguin, 2014; Roguin et al., 2012; Reeves et al., 2015; Vano, 2003).

### *Radiation Exposure to the Lens of the Eye*

Radiation cataracts, evidenced by the development of posterior lens opacities, do not appear immediately after exposure but

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require a latent period to elapse before expression. Recent epidemiologic studies of occupationally exposed individuals suggest that radiation-induced cataracts can occur at much lower doses than previously assumed (Haskal, 2013; Jacob et al., 2013a; Worgul et al., 1996). Fluoroscopic operators and other in-room personnel have demonstrated a significantly elevated incidence of radiation-associated lens changes (Koukorava et al., 2014; Vano et al., 2010).

*International Commission on Radiological Protection Guidelines*

The latest recommendation of the International Commission on Radiological Protection (ICRP) has dropped the occupational dose limit for the eye from 150 mSv (milliSievert) to 20 mSv per year, averaged over 5 years. The cumulative occupational dose received by interventionists without eye protection has the potential to far exceed the new ICRP recommended lifetime eye dose threshold of 500 mSv and leaves them at much greater risk of developing radiation-induced cataracts after only a few years of practice (Andreassi et al., 2015; Chohan et al., 2014; Jacob et al., 2013b; Martin & Magee, 2013).

## Materials and methods

Ethics approval was sought from the Research and Ethics Committee of a major Australian Hospital (approval number: 15/35). A survey was undertaken to compare the accessibility and utilization of personal radiation protective equipment by staff within cardiac angiography laboratories. A number of regional and metropolitan Australian cardiovascular suites were invited to complete an online survey comprising 10 questions. Fifty facilities were invited to participate including a mix of both government (n = 8) and private health care centers (n = 42).

The survey questions focused on the availability and use of head, thyroid, and eye radiation protection by doctors and nurses present in the room during angiographic procedures (Appendix). A number of questions were included to ascertain staff awareness regarding the potential damaging effects of occupational radiation exposure as well as perceived barriers to wearing protective equipment.

After an initial contact phone call, a total of 50 invitations were sent to selected facilities via electronic mail (e-mail). Either the nurse unit manager or the radiation safety officer was asked to complete one survey representative of the site. A single e-mail reminder was sent to the nonrespondents.

## Results

Of the 50 e-mail requests sent, 14 responded equating to a response rate of 28%. Of the responses, nine were from privately run facilities, whereas the remaining five were from government sites.

The results indicate that 64% (n = 9) of the respondent cardiac suites have lead head protection available for staff use. Of these, more than half of the respondents (n = 5) indicated that six or less lead caps were available for staff use. The remainder indicated that staff had access to 10 caps (n = 1), one department provided lead caps for each individual staff member, and one center used disposable lead caps during procedures. Of the departments that provided head protection, doctors (35%) and nurses (33%) had a similar frequency of use of the available lead caps (Figures 1 and 2).

Results demonstrated that most doctors (76%) and nurses (78%) use protective lead eye glasses (Figures 1 and 2), despite only two departments having this as a requirement. Of the qualitative responses regarding why staff did not use lead glasses, two clear themes were identified, namely:

1. Lead glasses are considered uncomfortable.

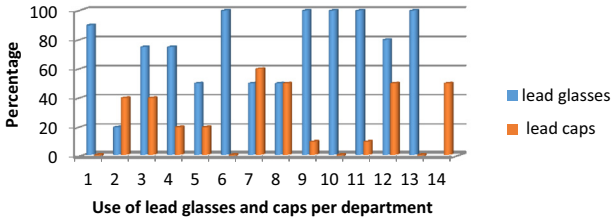


**Figure 1.** Doctors' use of lead glasses and lead caps during cardiac angiography procedures.

2. For those who wear prescription glasses, the fit over lead glasses is heavy and awkward, noting that custom-made prescription lead glasses were prohibitively expensive.

Most of the respondents (86%; n = 12) engaged the ceiling-mounted upper body shield during all procedures. The remaining respondents did not have access to the ceiling-mounted lead (n = 1) or did not use it routinely (n = 1). Thirteen of the 14 survey respondents indicated that the use of thyroid shields is mandated within their practices and that the vast majority of medical and nursing staff consistently wear them.

There were high levels of perceived awareness of potential radiation damage caused by exposure to low-dose radiation (Figure 3). Most of the staff were aware that any radiation exposure could cause cancer (n = 12), cataract formation (n = 11), and that there is evidence of an increased risk of brain cancer among fluoroscopic operators (n = 12). Just more than half (n = 8) of the respondent centers indicated that staff understood that damage to vasculature could result from exposure to low-dose radiation.

## Discussion

The wearing of protective equipment is one of the factors that influences occupational dose to an individual (Vano, Gonzalez, Fernández, & Haskal, 2008). This survey was designed to capture a snapshot of the utilization and accessibility of radiation protective equipment within cardiac angiography suites in Australia.

*Thyroid Shields*

The use of thyroid shields for fluoroscopic protection has been reported as inconsistent (Ainsbury et al., 2014), although recent research has indicated that there is a trend toward greater compliance (Jacob et al., 2013a; Lynskey, Powell, Dixon, & Silberzweig, 2013; Vidovich, Khan, Xie, & Shroff, 2015). Findings of this survey reflect this with an average of 93% of doctors and nurses wearing a thyroid shield. The reasons stated for noncompliance included discomfort because of temperature and proximity (n = 1) and claustrophobia (n = 1), which has previously been

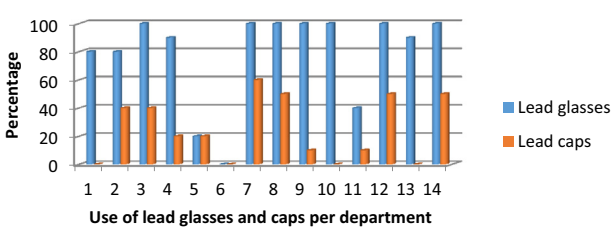


**Figure 2.** Nurses' use of lead glasses and lead caps during cardiac angiography procedures.