A clinical study: Radiation exposure and anesthesia personnel

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In this article, the author addresses the potential hazard to anesthesia personnel of excessive ionizing radiation in clinical situations. She reviews the results of an 18-month study at a teaching facility in the Southeastern United States during which all members of the anesthesia department wore monitoring badges. The results of the study indicate that while there is a potential hazard, in actuality, minimal exposure is encountered.

For more information on this topic, refer to "Occupational hazards of radiation for the anesthetist," also featured in this issue, which presents basic facts concerning radiation and its possible effects on anesthesia personnel.

Procedures utilizing radiologic techniques are becoming more common in the operating suite. When invasive procedures which once required general anesthesia combined with radiologic techniques (that is, ventriculograms, encephalograms, angiograms, and so forth) were supplanted by use of the computer assisted tomography (CAT), the concomitant use of general anesthesia declined. However, with the development and innovative application of image intensification techniques, anesthetists are renewing their acquaintance with radiology.

Image intensification and the "C-arm" are used for, among other things, the stereotactic identification of operative sites, manipulation and reduction of bone fractures, intraoperative radiographic contrast dye studies, and confirmation of catheter and rod placements. Consequently, given the various procedures involved, exposure to hazardous amounts of radiation becomes a concern.

The National Committee for Radiation Protection and Measurement and the International Commission on Radiological Protection—1966 have advised that 1,250 millirems/quarter (5,000 millirems/year) total body dose is the maximum permissible exposure. These figures do not include diagnostic or therapeutic exposure.1 Having a greater awareness of potential for harm and perceiving an increase in utilization of radiologic techniques in the operating room, we questioned if there was, in fact, an exposure to radiation which exceeded that level deemed acceptable.

Clinical study

For an 18-month period (January, 1981 through July, 1982), each person in the Department of Anesthesiology at our institution whose duties required their presence in the operating room suite, was issued a radiation dosimeter badge on a monthly basis. The dosimeter badge used was of the photographic emulsion type. Operating room nurses assigned to the orthopedic service on a continuing basis and recovery room personnel also were assigned monthly dosimeter badges over...
the same period. All personnel were urged to take reasonable precautions.

The badges were collected at the end of each month, and new ones issued by the person in charge of the study. The used badges were then examined by the Department of Radiation Safety for degree of exposure. Exposure levels were designated as "m" (minimal) — <10 millirems or m+ > 10, 20, 30 millirems, etc. in increments of 10. The dosimeter readings were charted with high and low levels noted for each person and for each period.

During this 18-month period, the largest amount of radiation accumulated by a single individual was 100 millirems. The highest exposure in any one month for any one individual was 70 millirems, with one individual recording that amount. Two people incurred 60 millirems apiece in a month’s time; and three people incurred a 50 millirem dose in a month’s period. None of the exposures of 70, 60 or 50 millirems occurred simultaneously, but rather they were randomly scattered among personnel over the total 18 months of observation. Most personnel had only “m” exposure. (Figure 1.)

The maximum number of dosimeter badges reviewed for an individual was 17. Some personnel had only two badges reviewed during the 18 month period, the minimum number for an individual. The average number of readings per person was 10.6 anesthesia personnel, 5.3 operating room personnel, and 9 recovery room personnel.

The dosimeter reading of operating room nurses assigned to the orthopedic service on a continuing basis indicated the same level of exposure as that of anesthesia personnel who are assigned on a rotating basis.

Recovery room personnel also had exposure levels no greater than that determined for anesthesia personnel. On the average, there was a greater number of x-rays per month made in the recovery room than in the operating room. There was a maximum number of 13 badges reported per individual, with the highest total dose being 100 millirems accumulated over the 18-month recorded period. The highest single dose was 70 millirems accumulated over the total 18 months.

![Figure 1](image1.png)

**Figure 1**

*Maximum monthly millirems.*

![Figure 2](image2.png)

**Figure 2**

*Maximum cumulative millirems.*
millirems in a month, and there was no indication that there was an increased use of x-rays during that month. (Figure 2.)

The exposure to radiation as determined by the use of dosimeter badges was much less than expected, and well below the maximal permissible levels. If anything, the overall exposure to radiation situations was less than anticipated. During the 18-month period studied, the image intensifier “C-arm” technique was used on an average of 3.4 times per month. The greatest use in one month was 8 times; the least was 1 time. Conventional x-ray situations (such as cholangiograms) occurred on an average of 13.5 times per month. The maximum number of x-rays used in a month’s time was 29; the least was 7.

In the recovery room the maximum number of x-ray exposures were 53 during a one month period of time; the minimum being 28 and the mean 38 exposures. These were all conventional x-rays. (Figure 3.) Personnel were not just limited to operating room exposure situations, for anesthesia personnel rotate to all areas where anesthesia may be needed, including Cath laboratory situations and procedures done in the radiology department.

The majority of patients who received treatment with live radium implants usually have hollow or vacant capsules implanted in the operating room. At a later time, after recovering from general anesthesia, live radium is inserted in the hollow containers. During the 18-month study period, however, there were 14 patients who had live radium implants performed under anesthesia. Of these, 8 patients had radium ovoids or tandems placed, and 6 had gold seed implants for various reasons. These situations occurred at random over the 18 month study period; no correlation between live radium and increased exposure could be determined.

Because of the monitoring technique used, it would be possible for an individual to have accumulated approximately 160 millirems (18 x 9) for the period, and yet be reported as having had “minimal” exposure. This would be far below the permissible level, and even if added to all reported doses, every person would still be well below permissible levels of exposure.

Radiation sensitive badges

The body cannot sense exposure to radiation except when lethal doses have been incurred, so monitors are necessary to determine the degree of exposure. The most popular dosimeter badge is the photographic emulsion or body badge.

The badge used during this study was by R.F. Landauer, Jr., and Company. This badge uses x-ray film which darkens following exposure to ionizing radiation. There are several screens in it, lead, aluminum, and plastic, and when the laboratory develops the film it can read the density of the darkening which it translates into a report. (Figure 4.) The emulsion darkens with exposure and indicates the degree and type of exposure. It is an indicator and not an exact measuring device. It has a life span of one to two months and is affected by heat.
Another dosimeter type, very similar in external appearance to the photographic emulsion badge, is the thermoluminescent dosimeter. It contains crystals which become excited upon exposure to ionizing radiation, and stay agitated until heated. When heated, they give off light. The amount of light emitted is indicative of the degree of exposure. Thermoluminescent badges are non-permanent and quite expensive. They cannot be recorded except by light measure, but they can be reused.

A third method of measuring exposure to radiation is through the use of the ion chamber. The chambers are extremely fragile and very expensive. They are usually used by individuals caring for patients who are receiving radiation therapy, either pharmaceuticals or implants, and are read on a daily basis. The ion chambers contain crystals which change positions upon exposure to radiation. The degree of position change can be read and radiation exposure determined.

Although radiation badges are easy to use, can be economical, and are suitably sensitive, they are time-consuming to issue and to retrieve. Much time and effort can be expended in keeping adequate records. The badges are frequently left on scrub suits and wind up in the laundry, or are lost in a variety of other ways.

Conclusion

As a result of our determinations, and in concurrence with radiation safety experts, radiologic dosimeter badges are not routinely used by personnel in our department of anesthesiology. We believe that the potential for harmful exposure exists, but it is most probable that, in fact, actual exposure to radiation will be far below what is considered a permissible level.

REFERENCES


AUTHOR

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