RADIATION EXPOSURE REDUCTION TECHNIQUES FOR CT NURSING STAFF

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Learning Objectives

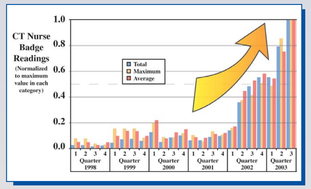
1. Review CT exam and equipment trends that may contribute to increased CT nurse exposures.
2. Identify CT nurse activities that affect CT nursing staff exposures.
3. Learn methods for reducing radiation exposures to CT nursing staff without compromising patient care.
4. Learn strategies for educating CT nursing staff on radiation exposure and risk.

Abstract

Measurements at our institution show that the average annual exposure per CT nurse increased by a factor of nearly 20 from 1998 to 2003. Quarterly exposure data was reviewed and a prospective weekly exposure monitoring study, considering nurse staffing levels, scanner vendor/model, workload, and type of CT exams, was performed for 4 scanners over 4 weeks. The data showed that no single variable was responsible for a significant majority of the measured exposures. Several novel methods were devised to increase nurse awareness to radiation exposure while not interfering with clinical nursing practices, including painting dose lines on scan room floors, rotation of signage on the doors, and educational sessions. Measurements from the 1st quarter of 2004 showed decrease in exposures of >50% compared to the previous pre-implementation quarter. Analysis of the survey data, exposure-reducing techniques, and educational strategies are presented.

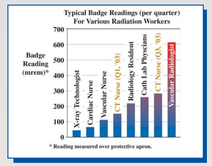
Background

Nurses at our institution routinely remain in the scan room during CT procedures that require intravenous contrast injections. This is done to monitor the injection site for extravasation, which is leakage of contrast material into the surrounding tissue. Extravasation is rare but is very serious, potentially resulting in loss of limb or death. Alternatives to direct monitoring, such as using pressure-sensor devices, had been investigated but were deemed inadequate to assure patient safety.



In January of 2003 the section of Radiation Safety was contacted by a CT nurse regarding a perceived increasing trend in his radiation monitoring badge reading. A review of radiation badge monitoring data showed that average nurse exposures increased by more than a factor of 3.5 over the year 2002. While this increase was being investigated the exposures continued to increase, peaking in the third quarter of 2003 with nursing staff exposures being over 6 times those from the first quarter of 2002.

Compared to other radiation workers at our institution, the increase in the CT nurse badge readings brought them to a level slightly greater than the average level received by cardiac catheterization lab physicians. The average CT nurse badge reading from a few quarters previous was comparable to other nurse radiation workers. Note that all exposures are well below the allowed maximum whole body exposure of 5000 mrem/year, even when the values are not reduced to account for the measurement being recorded over the protective apron.



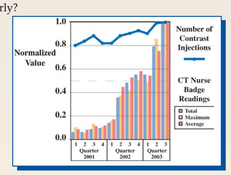
Methods

A Continuous Improvement (CI) team, consisting of members from Radiation Safety, Physics, Nursing and CT, was formed to investigate the increase in nursing staff exposures and explore exposure-reduction methods. The team considered several possible causes for the increase, which are illustrated by the following questions.

Has the number of CT examinations requiring injections during x-ray on-time increased (e.g., CT angiography)?
Do a few procedures deliver higher radiation levels than others?
Is the increase attributable to a specific scanner model or manufacturer?
Are the nurses always scheduled on the same scanners (doing similar procedures)?
Have there been significant changes in how the nurses monitor the injection site?
Is the exposure increase attributed to just a few nurses?
Are all the nurses wearing their badges properly?

Number of Contrast Injections

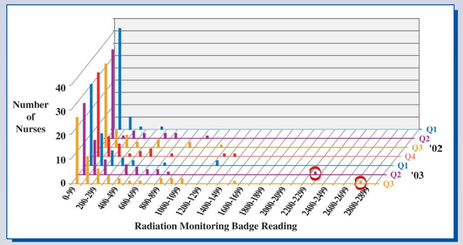
Review of the number of contrast injections over the past 11 quarters showed an increase by a factor of approximately 1.3, thereby accounting for only a fraction of the 6-fold increase noted in the nurse badge readings.



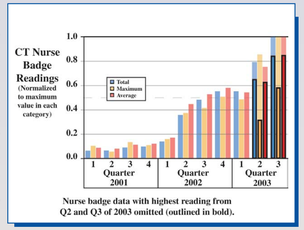
Correlation with scanner model or procedure

A collar badge was affixed to the outside of lead aprons to investigate any correlation of increased nurse exposures with a particular scanner model or procedure. Each apron was assigned to one of five different scan rooms, including a range of scanner models and manufacturers, and the nurses were instructed to wear the apron only in the assigned room. The procedures performed in each room were recorded during a 4-week monitoring period and the badges were collected weekly. The resulting data showed a range of exposure values, with no specific scanner model or procedure being associated with consistently high or low badge readings.

Bias from one or two nurses



Histogram data above show a general trend of higher exposures distributed among the nursing staff for the more recent quarters. This suggests that the increase of the average nurse exposure accurately reflects the experience of the entire group and is not biased by a few individuals. However, note the high readings of two nurses—one in each quarter of Q2 and Q3 in 2003 (circled in the plot). The influence of these two readings is shown in the plot on the right which presents the results with the two readings omitted. Clearly the individual readings have an influence on the maximum badge reading data but the average and total badge readings still show an increasing trend in the nurse exposures. We found no justification for removing the two high badge readings from the data.



Nurse badge data with highest reading from Q2 and Q3 of 2003 omitted (outlined in bold).

Practice issues and badge placement

There have been no significant changes in the method the nurses use to monitor injection sites or in any other CT nursing procedure over the time period in question (1998-2003). The CT nurses have periodic educational "refresher" sessions to insure that all nurses perform consistently. Proper radiation badge placement is included as part of the nurse radiation worker training and is occasionally included in the educational sessions.

Actions

No single variable was shown to be the primary cause for the increase in CT nurse badge readings. The CI team brainstormed possible remedies and constructed an affinity diagram (right) with all viable options. Items that were considered difficult to implement and of minor benefit included an arm holder that would assist the patient in holding their arm in an upright position away from the gantry and a hanging leaded-glass shield or rolling shield that the nurse could position between themselves and the gantry. All of these options were considered problematic because they would most likely interfere with activities in the room and therefore would not be used routinely. Items that would be of minimal effort to implement consisted of the following.

BENEFIT \ EFFORT	Minimal	Difficult
Major	• Audible dosimeters • In-service • Dose lines	
Minor	• Door signage	• Arm holder • Hanging shield • Rolling shield

Audible dosimeters

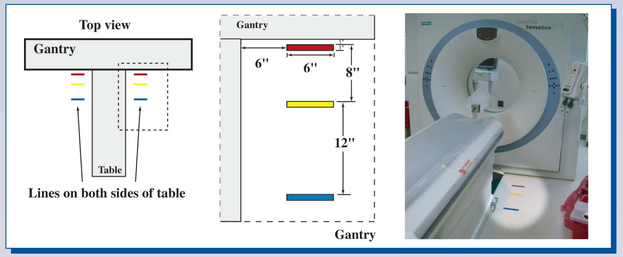
Audible dosimeters could be programmed to indicate when a pre-set radiation exposure level has been exceeded, thereby alerting the nurse to take precautionary measures to minimize future exposures. Upon closer evaluation the team concluded that implementation and effective usage of audible dosimeters may be problematic. Consequently, audible dosimeters were not utilized in this study but may be considered in future dose reduction strategies.

In-Service

Two educational sessions were presented to the CT nurses—one occurring shortly after the increase in badge readings was noticed and the other after actions to reduce the exposures had been implemented. Both sessions included discussion of general radiation safety practices (minimize time, maximize distance, and use shielding), proper badge placement and how to interpret the badge readings. The post-implementation session included discussion of the remedial actions that were in progress. Both sessions also included a survey with questions pertaining to personal impressions of job-related radiation exposures.

Dose lines

Three colored lines were painted on either side of the table in every CT scan room. The lines indicate the relative distance at which the exposure level from scatter is reduced by a factor of two. That is, standing on one line and stepping back from the gantry to the next line implies that the exposure is halved.

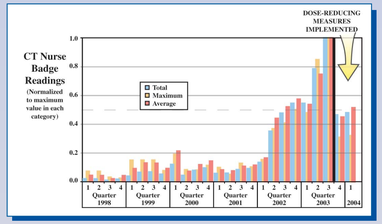


Door Signage

Small signs were placed on the control room doors as reminders of good radiation safety practices. The signs were designed to be eye-catching and feature a recurring iconic character called "Badge Man", who delivers a simple message in an informal and humorous manner. The signs are changed every 2-3 weeks. Sample signs are shown below and along the bottom of this exhibit.

Results

The two quarters following implementation of the exposure-reducing methods showed a decrease by a factor of 0.32 (68%) in the maximum nurse exposure and a reduction by a factor of 0.48 (52%) for both the total and average badge readings (averaged over the two quarters). This represents a significant reduction in the nurse radiation exposures compared with the previous two quarters.



A less tangible effect of the dose reducing methods is noted in a comparison of the pre- and post-implementation survey results, as shown in the two samples below. The attention given to nurse exposures has had a positive effect on the nurses' knowledge of radiation and perceived risks as well as demonstrating Radiology's and Radiation Safety's active role in addressing radiation-related concerns.

Survey Question

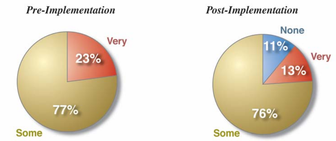
What is your level of concern regarding the radiation exposure you receive at work?

No concern at all. I believe that I receive a harmlessly small amount of radiation.

Some concern. I don't really think that anything bad will come from my exposure, but I still occasionally think about it.

Very concerned. I believe that eventually I will likely have some health problem from my exposures.

Survey Result



Survey Question

Do you feel Mayo provides you with opportunities to reduce your radiation exposure (e.g., extra protective equipment, instructions, etc.)?

Survey Result

Conclusions

The dose-reducing methods used for this project were inexpensive, easily implemented, and effective. The lines on the floor provide a non-invasive visual indication of how the nurses can easily reduce their exposures by a factor of two or more. The signs on the door are continuous informal reminders of radiation safety practices. Frequent changing of the signs promotes keeping attention focused on radiation safety issues. Additionally, the dose-reducing methods emphasize that both Radiology and Radiation Safety are sincere in assuring that the exposures are as low as reasonably achievable (ALARA) and that resources are available to address any concerns with radiation-related issues.