Practical Methods for Reducing Radioactive Contamination Incidents in the Nuclear Cardiology Laboratory

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Objective: The purpose of this study was to determine the extent and cause of radioactive contamination in our nuclear cardiology laboratory, and to develop possible solutions to minimize future occurrence.

Methods: We conducted a retrospective review to determine the underlying causes of the 15 minor radioactive contamination events that have occurred in the exercise areas of our laboratory since 1986. Of the 15 documented events, 8 were caused by failure of intravenous apparatus and 7 were due to syringe mishandling. Based on a staff questionnaire, we determined the most prevalent causes of radioactive contamination. Other than problems associated with intravenous setup, the causes were lack of experience by the individual performing the injection, followed closely by radioactive syringe disposal problems, injection technique, and unclear designation of duties during the exercise procedure.

Results: Based on these findings, we formulated a 4-part plan: a training program; a closely inspected intravenous apparatus; a mobile radioactive waste container; and a clear designation of duties for personnel to be included in the exercise procedure protocol.

Conclusion: We have implemented a sensible and practical plan for reducing radioactive contamination, which is currently being evaluated.

Key Words: radiation safety; nuclear cardiology; radioactive contamination; staff training; performance improvement; injection technique

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Radioactive contamination can take place any time a radioactive material is introduced unintentionally into its surrounding area. This can occur due to a drip from a syringe containing a radioactive drug, a radioactive solution leak from an injection port, or a multitude of other possibilities. There are many consequences of radioactive contamination incidents. The first is the notification of the NRC if the incident is severe enough (*1*). Second, there is unnecessary radiation exposure to the patient and personnel in the area. Third, there is the possibility of tracking the radioactivity outside the imaging area, thus enlarging the area that will need to be decontaminated. Finally, there is the potential interruption of the patient imaging schedule as the room will need to be closed during decontamination, therefore, increasing the patient's waiting time.

We have noted that several minor radioactive contamination incidents have occurred in the exercise rooms of our nuclear cardiology laboratory. The purpose of this project was to evaluate the root causes for these incidents, and to develop a plan to reduce the occurrence rate of radioactive contamination in our nuclear cardiology laboratory.

MATERIALS AND METHODS

Our radiation safety office has classified radioactive contamination incidents into 2 categories. The first is a major spill that results in more than 50,000 cpm at 12 in. In the case of a major spill, several procedures must be followed. First, the exercise room must be closed off and patients deferred to another treadmill. If the spill is large enough, the NRC also must be notified (*1*). The spill must be recorded in the *Radiological Occurrences Report,* kept at the radiation safety office of our institution. The second classification is a minor spill that results in less than 50,000 cpm at 12 in. In the case of a minor spill, the nuclear medicine technologists may perform decontamination to bring radiation levels down to background. Minor spills are recorded in the in-house *Nuclear Cardiology Department Laboratory Log Book*.

Performance Improvement Process

We followed a 3-step process to develop our plan to reduce radioactive contamination in the nuclear cardiology laboratory.

In the first step, we evaluated all radioactive contamination (i.e., minor and major spills) reports from 1986–1997. In doing this, we discovered 11 potential different causes of radioactive contamination events (Table 1).

The second step was to issue an opinion survey to each of our nuclear cardiology technologists to rank the 11 causes in their order of prevalence. Based on the survey results, the 3 most prevalent causes of radioactive contamination incidents were:

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TABLE 1
Causes of Radioactive Contamination Incidents

Inexperience by the individual performing the injection
Faulty equipment (e.g., syringe, stopcock, intravenous tubing)
Unsafe disposal technique postinjection
Improper intravenous assembly
Patient movement during injection
Lack of radiation safety training
Difficulty in accessing intravenous injection port due to its location
Patient interference
Unsafe injection technique
Unclear responsibilities in addition to injection (i.e., EKG and BP monitoring, patient observation, recording data)

(a) the inexperience of the person who administers the radiopharmaceutical; (b) failure of the intravenous apparatus; and (c) improper disposal technique.

As step 3, we developed a plan with possible solutions to help eliminate radioactive contamination in the nuclear cardiology laboratory.

Nuclear Cardiology Exercise Protocol

To become familiar with how radioactive contamination can occur, we will examine a common exercise protocol. It begins with the ECG lead placement on and intravenous placement in the patient. The patient is exercised on the treadmill to 80% of his maximum heart rate. Radioactive contamination becomes a concern with the introduction of the radiopharmaceutical during its injection at peak exercise. The final step is the disposal of the radioactive syringe. The injection and disposal steps are further complicated by the fact that the individual who makes the injection needs to be watching the patient for signs of fatigue, as well as watching the ECG monitor for any arrhythmias.

RESULTS AND DISCUSSION

Survey Outcomes

Inexperience of the Individual Making the Injection. As part of their basic training in our nuclear cardiology laboratory, cardiovascular fellows rotate through the laboratory every 8 wk. Each fellow is unfamiliar initially with the equipment used in our laboratory. Our plan outlines 2 solutions. The first is the use of a fluorescent dye in place of the radiopharmaceutical to train the fellows in proper injection technique (Fig. 1). By using the fluorescent dye, the fellows can practice injecting the ‘‘radiopharmaceutical’’ into the intravenous tubing, and then check for any contamination by looking at their gloves under ultraviolet light (Fig. 1). This method allows the fellows to test their proficiency without the use, and the inherent danger, of a radioactive material. The second solution to the problem of inexperience is to educate personnel as to how the needleless cannula (B-D Interlink Syringe Cannula; Becton Dickinson and Co., Franklin Lakes, NJ) fits into the intravenous injection port. This is important because the needleless cannula is more difficult to insert into the intravenous port than is a standard metal needle.

Failure of the Intravenous Apparatus. This can occur in several ways, including the loosening of the tube connections or crimping of the tubing in the patient’s arm. Our plan outlines 2 solutions. The first is to reconfirm the patency of the intravenous setup before injecting the radiopharmaceutical. This simply means that the connections should be tightened, and the physiological saline should be running freely into the patient. The second solution is to clearly designate the duties of the personnel in the exercise room to maximize the efficiency of teamwork (Table 2). This is especially important in the nuclear

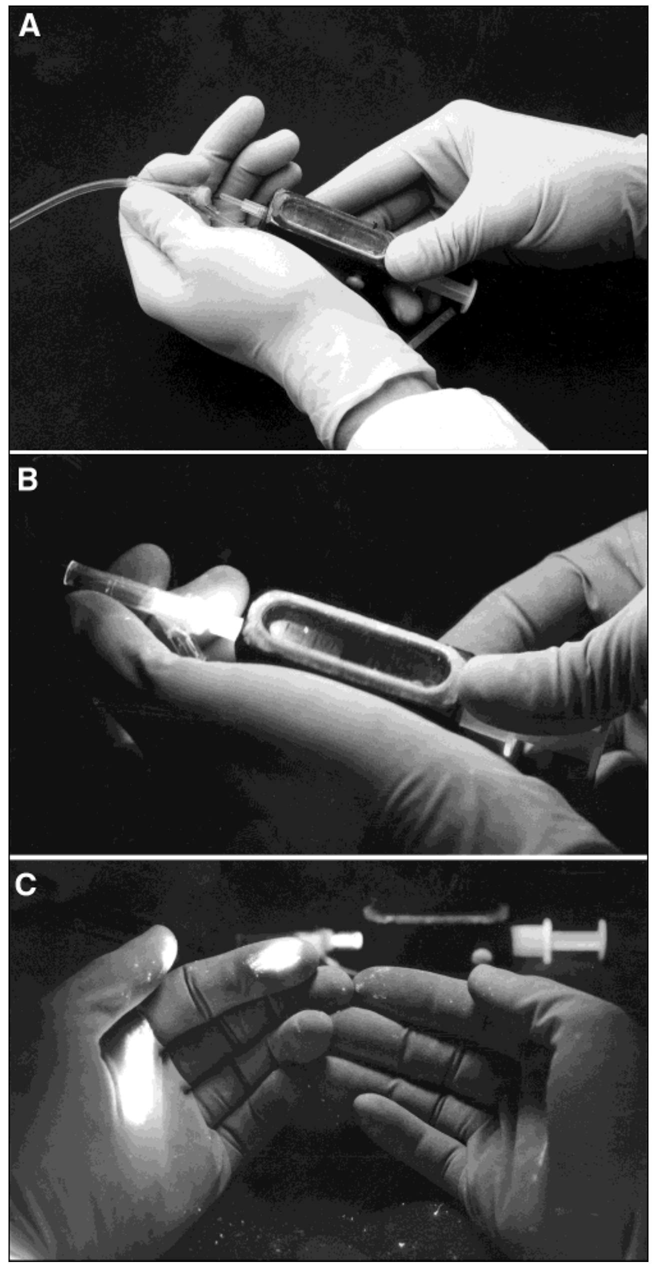

FIGURE 1. The recommended training sequence for teaching an individual the proper injection technique with a fluorescent dye. (A) Insertion of shielded syringe containing the fluorescent dye, which has replaced the radioactive material injected into the intravenous tubing. (B) Fluorescent dye is injected into the intravenous tubing. (C) The gloves of the individual are shown to be contaminated with the fluorescent dye under ultraviolet light.

TABLE 2
Chart of Duty Designations in a Nuclear Cardiology Exercise Room

Technologist	Physician and nurse
Initiate and operate intravenous setup	Inject radiopharmaceutical
Monitor ECG	Measure blood pressure
Control treadmill operation	Monitor patient condition
	Dispose of radioactive syringe

cardiology laboratory because it is not only the nuclear cardiology technologist but also the nurses and physicians who combine their efforts to provide quality care for the patient.

Improper Disposal Technique. Radioactive contamination also can occur during the disposal of the syringe that contained the radiopharmaceutical postinjection. Our solution is to use a transportable lead-lined radioactive waste container (Fig. 2). In the past, the fellow would walk from the exercising patient across the room to the radioactive waste bucket, which usually would be located on a countertop behind a lead shield, to dispose of the radioactive syringe (Fig. 3). With a transportable waste container, the fellow merely drops the syringe into the bucket at the completion of the injection. The second solution is to immediately recap the syringe after the injection. This will reduce the amount of contamination due to drips from the syringe before disposal. Although this seems contrary to universal precautions, needleless cannulas are used instead of a ‘‘sharp’’ metal needle in our nuclear cardiology laboratory, so there is no chance for an accidental needlestick.

FIGURE 2. Transportable lead-lined radioactive waste container.

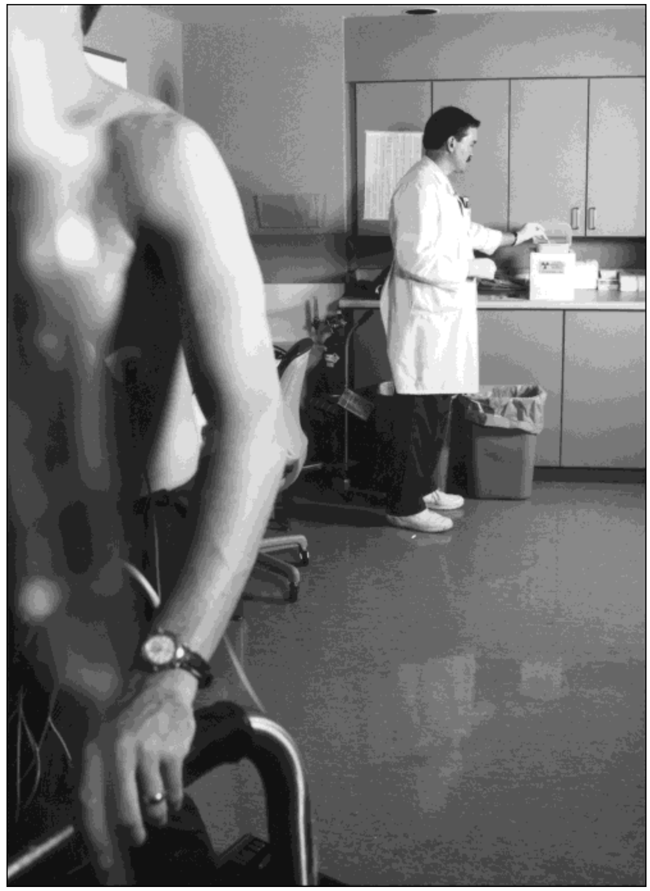

FIGURE 3. After the injection of a radiopharmaceutical, the individual who made the injection walks across the room to discard the used radioactive syringe into the shielded waste box.

CONCLUSION

We have outlined a 4-part plan to reduce the incidence of radioactive contamination in the daily operations of a nuclear cardiology laboratory: (a) proper training in injection technique, especially with a needleless cannula; (b) reconfirmation of the patency of the intravenous setup; (c) clear designation of duties; and (d) proper waste disposal procedures. While this plan is being implemented currently, its success will be monitored over the next few years. We hope to document a decrease in contamination incidence in our nuclear cardiology laboratory.

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REFERENCE

1. US Nuclear Regulatory Commission. *Notification of Incidents.* 10 CFR, Part 20.2202. Washington, DC: NRC; January 1998.