Health Physics Considerations in Medical Radiation Emergencies

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Abstract: Preplanning and organization can facilitate the health physics response in the event of a medical radiation emergency. Anticipating the needs will allow for advanced assembly of needed information and supplies that would be useful in effectively responding to such events. Annual training of emergency care providers and an easy to read and understand poster will be of great benefit in guiding personnel until health physics arrives. Major events also need consideration, in advance, as they will place additional demands on health physics. Health Phys. 87(Supplement 1):S19–S24; 2004

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INTRODUCTION

When medical radiation emergencies occur, they are always accompanied by a great deal of confusion (Weidner et al. 1980; DeMuth and Miller 1982). The health physicist involved typically ends up in a tug-of-war in trying to attend to the many responsibilities and provide answers to those who are in a need-to-know. The confusion that surrounds such events can be lessened with preplanning and an organized approach (Miller and Weidner 1982; Mettler 2001; NCRP 1979). A checklist of things to consider in preparing for receipt of a contaminated accident victim(s) can help to make things go smoother. Quite often, the physician involved in medical radiation emergency response might not be especially well-versed in health physics or the unique aspects of radiation and/or radioactive materials. The level of expertise of the physician will direct the involvement and activities of the health physicist.

Initial responsibilities

• **Helping the physician to understand what is going on.** Handling medical radiation emergency cases is not an everyday occurrence. Although many physicians have received training in how to handle such cases, when the real thing occurs, they often need answers to questions so they can respond appropriately to not only the patient but to the concerns of the medical staff assisting with the patient. It is imperative that the health physicist obtain as much information as possible about the status of the patient and the possibility and extent of contamination before the patient arrives (NCRP 1979, 1991). Thus, the medical radiation emergency plan should provide for the collection of as much pertinent information as possible when the initial call is received, alerting healthcare professionals of the pending arrival of a possibly contaminated patient(s). It is extremely important that the person receiving the initial call obtain, among other things, a contact name and call-back phone number.

• **Providing reassurance.** There is a normal tendency for medical personnel who will be involved in the handling of medical radiation emergency cases to be apprehensive about the risk posed by the patient, the methods they will use to assure their own safety, and the correct procedures to use in dealing effectively with the patient. The health physicist will have the responsibility of responding to their concerns, answering their questions, providing them guidance, and providing them with reassurance.

• **Preventing panic.** Dealing with medical radiation emergency cases from the outside is often analogous to diving into unknown waters. While medical staff have few concerns about dealing with a contaminated individual from within the hospital, there is a mystique and uncertainty about a possible contaminated patient coming in from the outside. The health physicist can allay fears by interpreting the patient’s contamination condition for the medical staff and putting this into perspective for them. Comparison to nuclear medicine diagnostic or therapeutic patients (Miller et al. ...
1979; NCRP 1996; Achey et al. 2001) is an effective way of quickly explaining the situation and putting minds at ease.

- **Activating the medical radiation emergency plan.** Prior to arrival of the patient(s), the medical radiation emergency plan (Mettler 2001; Miller and DeMuth 1983) must be activated and the medical radiation emergency room(s) must be prepared for receipt of the patient. A clear and simplified poster (see Appendix A) of the medical radiation emergency plan that can be posted in the radiation emergency area and used to brief staff is useful.

**Initial steps by the health physicist**

- **Activation of the medical radiation emergency plan.** Every hospital should have a well defined Medical Radiation Emergency Plan (see Appendix A) that will guide the emergency participants in preparation of the medical radiation emergency room(s), assembly of supplies and instrumentation that might be needed in handling the patient, procedures for gowns, monitoring and protecting staff, and procedures for dealing with contamination, including its evaluation and effective removal.

- **Provide back-up health physics support.** The medical radiation emergency plan should identify the members of the radiation safety staff who will respond immediately and assist in activating the plan. If the hospital does not have a health physics staff, then the plan should include names and phone numbers of consultants who can be called in to assist the Radiation Safety Officer, if needed.

- **Assure that all necessary supplies are available.** Prior to patient(s) arrival, the health physicist should review the medical radiation emergency room(s) to assure that it has been prepared according to the medical radiation emergency plan, review the individuals who will participate in caring for the patient to assure that they are properly gowned and wearing appropriate personnel monitoring, and review the available supplies to assure that everything that will be needed for monitoring the patient, sample taking, and decontamination are available. A checklist for each of these will aid in performing quick inspections.

- **Brief staff on their respective duties.** Often, the medical radiation emergency physician will defer to the health physicist to brief staff on the procedures they will take to monitor, evaluate, sample, and decontaminate the patient. The health physicist will also need to brief staff on the proper procedures to safely handle contamination and assure that the medical radiation emergency room does not become unduly contaminated or that contamination spreads beyond the medical radiation emergency room. All health care workers understand the concept of using “universal precautions,” i.e., the use of protective barriers such as gloves, gowns, aprons, masks, or protective eyewear to reduce the risk of exposure of the health care worker’s skin or mucous membranes to potentially contaminating materials.

- **Answer questions and put things into perspective.** Hospital staff who will participate in the handling of the medical radiation emergency case(s) are usually apprehensive and have questions regarding the type of contamination, level of contamination and its implication for potential contamination and/or exposure, and the proper procedures for effectively dealing with the situation. Briefings by the health physicist can alleviate apprehension and provide guidance on effectively dealing with all aspects of the emergency situation. Putting things into perspective can best be accomplished by comparison to things normally encountered in the hospital such as the radiation reading from a nuclear medicine bone scan patient or the radiation safety precautions used with patients treated with radioiodine for thyroid cancer.

**Inform/instruct other departments**

The handling of medical radiation emergency cases might impact departments outside of the emergency department. These other potential groups (NCRP 1991) need to be apprised and advised by the health physicist as to the situation and what might be expected of them.

- **Administration.** Administration needs to know what is going on so that they can assure that everything needed to effectively deal with the situation is available. They also need to be able to respond effectively to inquiries from the media or the public.

- **Security.** Security is typically asked to help control access to the medical radiation emergency area and any other designated control area. An example might be that security would be asked to make certain that the ambulance that delivered the patient(s) not leave the hospital area until surveyed and decontaminated, if necessary. Security might also be asked to keep anyone from entering a contaminated ambulance until it has been decontaminated.

- **Radiology.** The radiation accident victim(s) might have trauma that requires x-ray procedures for appropriate evaluation of the patient’s medical condition. If so, Radiology personnel will need instructions on how to achieve the requested procedure without contaminating equipment or staff.
● Anesthesiology. If the radiation accident requires surgery, anesthesiology will need to be involved. If so, the anesthetist will need assurance and guidance from the health physicist on how to perform their function without receiving undue exposure or contamination.

● Surgery. Surgery on a radiation accident victim is no different than surgery on a nuclear medicine diagnostic or therapeutic patient or, in some cases, a radiation oncology brachytherapy patient. The surgeons involved will need to be monitored and will need to perform the surgical procedure without receiving excessive exposure or causing unnecessary contamination.

● Public relations. Public relations will need to be briefed so that they can effectively field questions from the news media, know who the key players are, and arrange for news briefings and prepare bulletins, if necessary.

● Telephone operators. The hospital telephone operators will need to know what is going on and who can take calls from the outside. A designated, informed individual to whom the operators can refer is essential.

Handling the radiation accident victim(s)

Once the patient(s) arrives, the health physicist will have additional responsibilities in regard to the medical radiation emergency plan:

Provide health physics guidance. The health physicist will need to be prepared to do whatever is necessary to assure that the medical radiation emergency plan is carried out effectively (Fig. 1), that the patient is appropriately evaluated (Toohey 2002) and decontaminated (Mettler 2001; Berger et al. 2003; NCRP 1979; NCRP 2001; AFFRI 1999), that staff are not overly exposed or contaminated and that the facility and hospital equipment are not excessively contaminated.

Assure monitoring, sampling, evaluation, decontamination and waste disposal

● Monitoring and surveying. This will include monitoring or surveying of the patient for contamination (Fig. 2), monitoring of staff exposures and surveying to verify they do not become contaminated or are appropriately decontaminated as necessary, surveying of any samples or items (such as clothing) taken from the patient, and surveying of anything brought from the medical radiation emergency room(s). A survey of the emergency department entryway to return the corridor to immediate routine traffic use after contaminated patient passage may be necessary.

● Sampling. This involves anything taken from the patient that might be useful in determining the contaminating radionuclides, level of contamination, resulting doses and effective medical care. Samples might include blood, urine, feces, nasal secretions, nasal swabs, swipes, shrapnel, excised tissue, irrigation fluids or the patient’s clothing.

● Vacating medical radiation emergency room. Once the event is over, the patient and hospital staff will need to be removed from the medical radiation emergency area so surveying, decontamination and re-

Figure 1. Transfer of patient to a decontamination tray on a clean litter.

Figure 2. Survey of patient in medical radiation emergency room.
turn of the area to routine use can be accomplished. If the room became contaminated, care will be required in removing the patient (Fig. 3) without spreading contamination outside the room. This is often accomplished by unrolling a clean floor covering into the room to the patient’s litter and transferring the patient to a clean litter. Likewise, staff will need to exit the room in a systematic manner to prevent spread of contamination. Step-off pads at the doorway and a container for collection of clothing, gloves and shoe covers plus appropriate surveying are necessary.

- **Return of radiation emergency room to routine use.** Once the patient and hospital staff have been removed from the room(s), surveying, decontamination, waste disposal and return to normal can commence.

- **Critique, upgrade, refine and retrain.** Each medical radiation emergency provides an opportunity for training, upgrading and refining of the medical radiation emergency plan. After things have calmed down, within a day or two, everyone involved should be assembled for a review and critique of the handling of the event. If there are problems, they can be corrected, if additional supplies or equipment are needed, they can be listed, if modifications of the written procedures are indicated, they can be accomplished. The critique will also provide the health physicist and emergency physician with an opportunity for positive feedback and reassurance for the staff.

**Large scale events**

For large scale events (NCRP 2001; AFFRI 1999; Donovan et al. 1983; Miller 1990; Miller 1994), such as from terrorist activities or the unlikely event of an accident at a nuclear facility, the traditional medical radiation emergency plan, usually designed to handle a limited number of contaminated individuals, would be inadequate. If there are massive numbers of contaminated individuals, then the hospital plan would be inadequate and large numbers of contaminated individuals arriving at a emergency department would threaten to contaminate the department and possibly lead to its shutdown. For such situations, alternative plans for rapid decontamination at an area remote from the emergency department would need to be implemented. Since 9/11, a great deal of thought has gone into how to accomplish decontamination of large numbers of contaminated, uninjured patients. Pop-up decontamination tents such as the one shown in Fig. 4 have become available.

In addition, many first responders and fire departments have developed plans to use the showering capabilities of fire trucks (Fig. 5) to effectively and quickly decontaminate large numbers of individuals contaminated with radioactive, biological, or chemical contaminants.

If the hospital is in a fallout zone

In the unlikely event that a hospital might be in a nuclear fallout zone, consideration will need to be given for protecting patients, staff, and visitors. In such an event, the health physicist will play a key role in providing guidance and controlling the situation.

**Initiate environmental monitoring.** Assessing a fallout or radioactive plume involves radiation measuring and possibly the evaluation of appropriate samples, including air, water, vegetation and fallout from surfaces.

**Controlling air handling systems.** Air intake systems should be turned off during plume passage.

**Prepare briefs for staff.** In a major radiological emergency, everyone is worried and everyone has questions. The health physicist needs to be attuned to these concerns and questions and be prepared to give briefings, in lay terms. The health physicist must also be prepared to provide briefings for emergency physicians and other decision makers, and may be asked to:

- Explain doses and other radiation related terminology in lay terms;
- Prepare for interaction with the media, staff and the public;
- Prepare written briefs for the media;
- Establish contacts with outside experts, e.g., REAC/TS (see Appendix B);

![Figure 3. Removal of patient from medical radiation emergency room.](image)

![Figure 4. Emergency decontamination tent.](image)
• Open lines of communications with assistance groups, e.g., Nuclear Regulatory Commission, State Bureau of Radiation Protection, Health Physics Society;

• Additional considerations (Miller 1986; Weidner et al. 1980) might include: (1) Setting up an on-call team (this could include health physics staff, nuclear medicine physicians, radiologists, medical physicists, dosimetrists, etc.); (2) Prepare lists of typical questions and appropriate answers; (3) Prepare information bulletins; (4) Establish “hot lines” manned by individuals briefed in advance.

**Advise administration.** In the event of such an occurrence, the health physicist will be called upon by administration to help interpret situations and design the best plan that will provide protection for patients, staff, visitors, and the facility.

**Move inward and downward.** In a fallout situation, considerable protection is provided by building materials. This protection can be maximized by moving everyone inward and downward.

**Plan for evacuation.** If an evacuation is ordered, the health physicist will need to advise on the safest way to accomplish the evacuation and provide monitoring outside the evacuation zone.

**Improvise as the need arises.** In a major situation there are many unexpected things that can arise that will require the health physicist to respond appropriately. Some examples might be:

• A need for additional survey meters or radiation detectors. This can be satisfied by rounding up all such meters at a facility. In addition to survey meters maintained in health physics, meters are required in nuclear medicine, radiation oncology and biomedical research labs. If the need arises, these can be brought to a designated location for use as appropriate.

• Establish monitoring for the public. This could include thyroid uptake counting using nuclear medicine equipment, urine bioassay using health physics equipment or whole body counting using appropriate and available equipment.

• Prepare for the aftermath. For the health physicist involved, a major radiological incident does not end when the situation is brought under control. Often, recovery, monitoring, corrective actions, evaluations, and epidemiologic studies will go on for years and even decades after the event.

**CONCLUSION**

Throughout the course of a medical radiation emergency, the health physicist assumes a host of responsibilities and must work to maintain a sense of order and calm among the numerous and varied staff attending to the emergency. In helping to prevent things from being overlooked, the health physicist must communicate frequently with the emergency department physician, the charge nurse, the incident commander, and others who play active roles in responding to such emergency situations.


APPENDIX A

Medical radiation emergency poster

APPENDIX B

Additional useful information

Outside assistance.

- Radiation Emergency Assistance Center/Training Site (REAC/TS), (865) 576–1005, url: www.orau.gov/reacts;
- Medical Radiobiology Advisory Team (MRAT) Armed Forces Radiobiology Research Institute (AFRRI), (301) 295–0530, url: www.afri.usuh.mil;

Helpful books, articles, and websites.

- Medical Management of Radiation Accidents; Gusev, Guskova, Mettlerr, 2001;
- Medical Effects of Ionizing Radiation—Mettler and Upton, 1995;
- The Medical Basis for Radiation-Accident Preparedness—REAC/TS Conference, 2002;
- National Council on Radiation Protection Reports Nos. 65 and 138;
- “Major Radiation Exposure—What to Expect and How to Respond,” Mettler and Voelz, New England J Medicine, 2002; 346: 1554–1561;
- www.acr.org—Disaster Preparedness for Radiology Professionals;

Procedures for Medical Emergencies Involving Radiation

1. Survey and record results.
2. Wrap or position patient to avoid spread of contamination.
3. Wash with soap and same all contaminated fluids in appropriately marked barrels.
4. Dry with clean uncontaminated towel. Do not make hair. If necessary hair may be cut, but do not rinse.
5. Re-examine and record.
6. If contamination persists, repeat above steps.

Disposition of Patient

Once the patient has been treated for both burns and contamination, transfer can be made to an appropriate area within the hospital. Collect all urine for 24 hours, and request monitoring of all contaminated areas.

Notification of Appropriate Agencies

1. Notify Nuclear Regulatory Commission.
2. Notify your state department of radiological control and health services.
3. Do not notify the newspapers or make any public statements relative to the situation until they have been directed to do so by the Radiation Safety Officer, Administrator and public health departments.

Waste Disposal

1. Collect contaminated water and put in labeled containers in plastic bags and appropriate disposal.
2. Put contaminated disposable supplies in plastic bags for disposal.
3. Keep contaminated equipment in the controlled area until decontaminated.

PERSONNEL EXPOSURE

1. All personnel working the control area will be properly equipped at the situation warrants.
2. Survey personnel when they leave the control area.
3. Personnel contamination will be handled in the same manner as described above.
4. Personnel will be shielded from further contamination as directed by the radiation safety officer and/or personnel. Only personnel who will again report to a control point for a final recorded survey.
5. Request all personnel to collect successive urine samples for analysis of radioactivity, if the situation warrants.
6. The radiation safety officer or designated personnel will remain at the hospital until surveyed around the appropriate area of contamination.

Types of Personal External Radiation Exposure

All apparel worn will be made to keep personnel exposure to less than one (1) rem.

Higher levels can be shown for lethargic situations.

Helpful contacts. Email: info@hps.org. Website: www.hps.org.

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