Chapter XXVII: Critical Care Medicine and Management of Mass Radiation Casualties:

Joel S. Greenberger, M.D.[1], and Donald M. Yealy, M.D.[2]

[1]Dept. of Radiation Oncology, UPMC Hillman Cancer Center, Pittsburgh, PA

[2]Dept. of Emergency Medicine, University of Pittsburgh, Pittsburgh, PA

Since the terrorist attacks of 911, hospitals, emergency departments, and critical care units must consider and plan about handling mass casualties; this starts with how to triage injured patients, not only within one hospital, but among hospitals in a regional network. Other chapters in this textbook address the different scenarios of radiation terrorism including: clandestine dispersal of radioactive materials, dirty bomb in which radioisotopes are dispersed by a conventional explosive device, and emergency room and hospital radiation detector systems to prevent spread of radioisotopes throughout hospital and adjacent buildings.

This chapter detailswith clinical strategies and pathways used by emergency physicians at the entry point of injured patients to hospital systems, and how triage decisions are made.

Emergency physician training preparedness for a radiation terrorist event.

The level of awareness of emergency physicians and hospital personnel, and the tools to aid, improved over the past decade, aiding detection and management of patients who may have radioisotope exposure or repositories they bring into the hospital environment. Most emergency departments now have a Geiger counter or other radiation detection device. As part of routine training, often required by government or other regulatory bodies, most emergency physicians receive baseline training in how to isolate patients suspected or known to be contaminated with radioisotopes. The task gets complicated if part of a mass casualties event, like in a setting of a fission bomb detonation with large numbers of patients having blast injury, thermal burn, penetrating wounds, and traumatic brain injury complicating any concern for irradiation contamination.

The general preparedness of emergency physicians in triage follows basic principles. First, potential exposed patients are not brought inside the emergency department (ED) absent screening; often this is accomplished by assessment in the ambulance. Also, prehospital teams should communicate at the scene or en route with the medical command personable or the destination ED to share important basic information: Vital signs, oxygen saturation, neurological evaluation, and assessment of overall status and other injuries. On arrival, assessing patients outside in a designated area will help avoid contamination of the ED; initial decontamination can occur there if needed, and portable detection devices aid in assessing likely contamination. After that step, use standard ED triage procedures if no known radiation exposure. Decisions on whether to transfer patients immediately to an operating room facility, intensive care unit, or inpatient facility will allow the most number of patients to get the best care if a mass event occurred; a designated triage physician aids in designating which care destination based on assessment of degree of injury and requirements for care.

The “surge capacity” of an individual ED varies across different hospitals. Small community hospitals may exceed their capacity; if so, they must inform EMS oversight leaders to seek other destinations. Some larger urban hospital ED have observation or holding units nearby that can be expanded to structure triage. The lead physician doing triage at the ED again has the role of identifying the best match of patient need an immediate next care site, using all of the options.

There are usually multiple categories of patients, based on arrival mode and also based on acuity. Those that arrive by ambulance are often – not universally – more injured or exposed than those coming by private vehicle or public transportation, though much overlap exists. Patients who have radiation exposure and not displaying signs of other injuries require assessment of isotope contamination. At the intake site – again, often outside the ED - ask: Where were you in reference to the blast, approximate location? Do you have nausea or vomiting? Do you have any other injuries or complaints? If no obvious isotope exposure exists using a detector, treat the patient for any other injury or illness – often, reassurance is the next step as others arrive.

The "three by three" rule helps identify higher priority need patients – if a someone experienced a total body radiation dose of 3 Gy or higher (assuming this is known), or if a exposed patient has nausea or vomiting within 3 hours of the blast, a higher risk of the hematopoietic syndrome exists; this may develop into a drop in blood counts and require further assessment for administration of granulocyte stimulation factors or even bone marrow transplantation. Some patients with close proximity to the blast zone but no early symptoms still may develop delayed hematopoietic syndrome; they are not the highest priority (i.e., minutes) but require further assessment. The " walking well" are those may have no radioisotope contamination (Geiger counter survey or radiation detector survey) but are often frightened. Triage these individuals to a less intense management area.

Instructions for care providers

Many hospital ED plan and prepare for managing patients who may be contaminated with irradiation emitting isotopes, again often starting outside doors of the facility and in a designated area (1-3). Standard infection control procedures require ED personnel to use gown and glove precautions and, in the case of suspected airborne virus infections, face shields, masks, and head protection. These same precautions reduce the chance of the radioisotope spread from the patient's clothing to healthcare providers and will decrease the chances of inhalation of respirable particles containing radioisotopes. Once a radiation exposure event is clearly exists, be ready to remove all arriving patient clothing if they were near the site and transfer this contaminated material to specific holding areas. Wash the patient's skin and opposed surfaces to remove isotopes before any transfer inside or to the next area to lessen risk of downstream contamination. In rare settings where severe acuity exists - patients with significant thermal burn, penetrating wounds, or respiratory distress – these efforts should occur albeit they may be truncated – remember, staff safety is first, then patient care. The decontamination process usually occurs simultaneous with care in these latter situations. Existing protocols aid creating and training ED and hospital staff for these needs; two are :
https://www.remm.nlm.gov/ext_contamination.htm
https://emedicine.medscape.com/article/834126-overview

Transfer of patients to operating rooms and intensive care units.

Depending on the level of capability of each hospital, triage officers send patients to the next area for care, matching it to immediate needs and likely isotope exposure load. At the time of the emergency event, the hospital should delay elective procedures, keep existing inpatients isolated and removed from the management of the radiation casualties, and depart less ill existing patients (using non-ED outflow paths to avoid those entering the area for care) to optimize physical and staffing capacity. Operating rooms already in use become sites for "noncontaminated patient" care when the existing care is completed. It is key to identify operating rooms for the care of those with "potential radiation contaminated". For example, patients with radioisotope inhalation determined by radiation detector sensitivity can be moved after clothing is removal and skin wash, receiving care in this site for any conditions requiring surgery or more advanced assessment. In the case of those with penetrating wounds, shrapnel, or other explosive material in the body plus clear irradiation, use the same "contaminated operating room".

The intensive care units (ICU) can also serve as destination after initial assessment, usually for those not needing surgical intervention but with more prominent symptoms or with other injuries, esp. when the ED capacity is overwhelmed. Triage of patients to these beds depends on number of patients entering the ED, the severity of injury, and the judgement of the triage officer of overall care need (usually higher in this group). In extreme demand, even conventional hospital no-ICU wards become intensive care units if needed.

The distribution of nursing staff and mobilization of hospital personnel at all levels of training to participate in patient care follows the providers training and the patient demands at each site. While local policies vary, in general caregivers at all levels may participate in care of patients, depending on level of training. Medical students and nursing students may be conscripted to participate in dire settings, though this is extremely unlikely. Finally, hospitals usually have approaches to rapidly onboard professionals who volunteer – a path described in advance but with much more truncated requirements compared to usual entry to start care. These professionals can augment care in large scale events.

Administration of radiation countermeasures

Once a radiation terrorist event exists or is highly suspected, the Centers for Disease Control and Prevention (CDC, Atlanta, GA) and the Federal Emergency Management Association (FEMA) will mobilize delivery of "push-packs" of medications to be sent to an area of a disaster. Specific packs are designated for known or suspected radiation terrorism/contamination. Radiation counter-terrorism specific push-packs contain granulocyte-colony stimulating factor (G-CSF) and also other management tools including: Prussian blue (for Cesium contamination), Potassium Iodide (suspected of significant Radioiodine inhalation or ingestion), and broad spectrum antibiotics and anti-fungal agents (5-6). Push-packs also contain burn management pharmaceuticals, endotracheal tubes, intravenous fluids and administration tubing, and surgical equipment. Most hospitals, even cancer or trauma centers, rapidly exhaust their available supplies in large scale events.

Key to optimal large-scale event care is coordination and communication – between field team and hospital, and also amongst hospitals – this allows capacity use optimization and limits care gaps. After each hospital has exceeded its surge capacity, and all patients in the intake process have gone through the initial triage procedure, a team of physicians and surgeons should determine the next steps.

New approaches to manage irradiated patients exist, including those in later stages of progression of organ or organ system failure in the setting of a depleted immune response. Sepsis – a dysregulated immune response to infection – is newly redefined: Septic shock exists with infection and the need for both vasopressor support *after* fluids plus with an elevated blood lactate level; all other forms of infection with organ duress or failure are called sepsis. Early recognition, fluid and vasopressor support, and antibiotics are the key to improving outcomes. (7) Ringer's lactate solution in an initial dose of 30 cc/kg, followed by titration of more or vasopressor support based on the bedside assessment or hemodynamic assessment is a common initial approach, seeking restoration or maintenance of perfusion plus infection source control (antibiotics, broad targeting) inside 2-3 hours when possible. (8-9) New approaches to management of irradiated patients include recognition of the role of oxidized lipidomics (4) in both establishment of radiation dose sustained and approaches to delivery of countermeasures.

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