ORIGINAL ARTICLE

Radiologists: The Unsuspecting Subject Matter Experts

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Abstract

The social and political climates are changing rapidly in the United States and the world at large. The threat of a chemical, biologic, radiologic, and/or nuclear event is a rising concern to many. The current Ebola crisis has shed light on health care providers' preparedness for such an event. Radiologists, including radiation oncologists, nuclear medicine specialists, and all radiology subspecialists are considered "subject matter experts" in this area and are likely to be called upon in response to a radiation incident. Although others, such as radiation safety officers, provide important expertise, the clinical leadership will be the responsibility of physicians and other health care providers. However, many radiologists are unaware that they are considered subject matter experts who may be called on to assist, should their local hospital's emergency department need to take care of casualties from a radiation incident.

A mass-casualty situation with hundreds of patients would require the immediate assistance of all available medical providers. Radiologists are primed and positioned to take the lead in ensuring preparedness of their local hospital and community, through emergency planning for a radiologic incident, given their combined medical and radiation physics knowledge. Therefore, increasing the skills of radiologists first is the more prudent approach in such planning. This preparation can be done through understanding of the critical components of such scenarios: the threat, types of radiation incidents, contamination, detection, decontamination, and acute radiation syndrome and its treatment. Once the necessary knowledge supplementation has been completed, radiologists can participate in educating their fellow medical colleagues and health care staff, and assist in the radiation-related aspects of an "all hazards" emergency department response, decreasing "radiophobia" in the process.

Key Words: Acute radiation syndrome (ARS), physician's preparedness for radiation casualties, radiation injuries, radiation dispersal device (RDD), radiophobia, radiation incident or accident

J Am Coll Radiol 2015;12:745-753. © 2015 Published by Elsevier on behalf of American College of Radiology

INTRODUCTION

Radiation is all around us, both the naturally occurring kind, and that produced for the benefit of people through the practice of medicine. Nuclear medicine, radiation oncology, and other radiology subspecialties all depend on the physics of radiation, yet a palpable pulse of "radiophobia" remains in US society. We live in a time of uncertainty and unrest. The threat of a chemical, biologic, radiologic, and/or nuclear component of a terrorist attack is real. Although the chemical and biologic threats are discussed frequently, radiation and its effects remain a mystery to many.

Radiologists are often listed as would-be subject matter experts in the event of a radiologic incident or accident, yet many are unaware that they have this title, or how to respond should they be called upon in their community's time of need. Unfortunately, this is a dilemma for not only radiologists, but also the many specialists in the US medical arena, as many health care providers do not believe they know how to react in a mass-casualty situation involving radiation [1,2]. The recent Ebola crisis is shedding light on the preparedness of the medical community as a whole to respond to a chemical, biologic, radiologic, and/or nuclear event. Thus, radiologists have an inimitable opportunity to make a difference [3-6].

A mass-casualty incident with radiation is not the same as one without radiation. However, the basics required for responders are similar to those in an "all hazards" response.

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The views expressed are those of the authors and do not represent those of the Uniformed Services University of the Health Sciences or the US Department of Defense.

1546-1440/15/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2015.01.014

Critically important areas of physician knowledge are the basic radiation definitions, the types of signs and symptoms created by acute exposures, and how to triage, treat, and decontaminate patients [7]. The question remains [8-11]: How well prepared are our hospitals to handle mass casualties in the event of an attack involving a radiologic dispersal device (RDD/"dirty bomb") or other such radiologic incident? We no longer have the luxury of thinking that this type of disaster happens only outside US borders.

BACKGROUND

In the 40 years after the discovery of x-rays by Wilhelm Roentgen (1895), and of the naturally occurring radioactive source radium, by Madame Curie (1898) scientists worked toward making good use of radiation in medical areas. However, the capability behind the power of fission and fusion to unleash various ways to cause devastating explosions was soon discovered and used in wars and other nefarious activities. The poisoning of Alexander Litvinenko in 2006 was the first confirmed instance of lethal, polonium-210-induced acute radiation syndrome (ARS). Physicians noted that "Litvinenko's murder represents an ominous landmark: the beginning of an era of nuclear {radiological} terrorism" [12,13]. The risks and benefits of radiation in medicine, as well as in power sources, have come under scrutiny, as incidents and accidents involving radiation are occurring across the globe; and fear of the acute and long-term effects of radiation exposure continues to raise concerns.

Historical and Hypothetical Scenarios

Counterterrorism agencies model scenarios that are more likely to occur than others, for the purpose of helping to ensure response preparedness [6,14,15]. Examples of past incidents include, but are not limited to, the following: nuclear bombs; improvised nuclear devices (INDs); nuclear power plant incidents; radiologic exposure devices and/or hidden sources; RDDs; and lost or stolen sources. Each of these is discussed in this section.

Nuclear bombs. Nuclear bombs are either uranium-235- or plutonium-239-based devices designed to destroy large areas using 1 weapon, as opposed to carpet bombing with multiple conventional bombs. Examples of nuclear bombs include the 2 weapons the United States dropped on Japan to force an unconditional surrender. On August 6, 1945, a US B-29 bomber dropped a gun-type nuclear weapon with a uranium-235 core on Hiroshima; 3 days later, it dropped an implosion-type nuclear weapon with a plutonium-239 core on Nagasaki, causing over 100,000 deaths instantly [16]. In the months afterward, approximately 100,000 more people died as a result of a combination of radiation dose, burns, and shrapnel.

Improvised nuclear devices. An IND is a device designed to produce a nuclear explosion, at full or partial yield. An IND exposes people to a high-level external radiation dose, trauma, inhalation of radioactive materials, particulate contamination, and ingestion of radioactive materials in the food chain [15,17-20]. No incident involving an IND has ever occurred, but considering the widespread devastation possible with use of such a device, considerable resources are used to ensure that such an event does not happen. In response to concerns about an IND detonation, the US Federal Emergency Management Agency and Department of Homeland Security completed a report of what is termed an illustrative IND scenario [14], ". . . to provide needed context to a broad and complex discussion, this report relates key planning and response considerations to an illustrative (hypothetical) 10-kT IND detonation in downtown Washington, DC. . .." The damage zones to this hypothetical scenario in Washington, DC can be seen in Figure 1.

Nuclear power plant incident. If nuclear power plants cannot cool their core effectively, a meltdown is possible. The most recent example of a nuclear power plant incident is the Fukushima Daiichi Nuclear Power Plant accident [21]. On March 11, 2011, the Great East Japan Earthquake led to a tsunami that caused almost 16,000 deaths, and damaged the diesel backup generators at that power plant. The loss of backup power caused a meltdown of 3 of the plant's 6 nuclear reactors, which led to the release of radioactive materials into the region and the Pacific Ocean [21,22]. Although the meltdown caused no deaths, the radiologic contamination evacuation zone extended >20 km (~12.4 miles) from Fukushima [21]. Although some of the evacuation orders are being lifted, it is unclear when all those affected by the power plant accident may return to their homes.

Radiologic exposure devices and/or hidden sources. A radiologic exposure device is radioactive material in a sealed source, or within a container, intended to expose people in the vicinity of the device to a high-level external radiation dose. Some materials used in military equipment and supplies contain radioactive components that, if improperly handled, could function as such a device [16,19]. Industrial radiography sources constitute the most prevalent of these devices in the