

Radiation Protection and Procedures in the OR



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JULIE A CHAFFINS, R.T.(R)(CT)

The field of surgery has advanced considerably during the past decade. New and innovative surgical techniques have emerged, many involving the use of diagnostic and therapeutic radiology procedures. Although these benefit patients, adequate radiation protection for the operating room staff is still an issue. This article provides information on diagnostic and therapeutic imaging exams performed in the operating room and discusses occupational radiation hazards for operating room staff, as well as the measures that must be taken to ensure radiation safety.

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After completing this article, readers should be able to:

- Discuss the increased use of fluoroscopy in the operating room.
- Explain the risk of radiation exposure to staff in the operating room.
- Understand radiation physics and safety, including units of exposure, rules, regulations and guidelines.
- Explain how to protect staff during imaging procedures in the operating room.
- Discuss specific diagnostic and therapeutic imaging procedures performed in the operating room.
- Identify new trends in radiologic and surgical procedures in the operating room.

All radiologic technologists should be familiar with the name Wilhelm Conrad Roentgen — the man who discovered the basic properties of x-rays in 1895.¹ This discovery, coupled with Henry Becquerel's discovery of radioactivity in 1896, began the science of radiation. However, these discoveries came at a high price.²

Shortly after Roentgen first announced his discovery, frequent and persistent reports of injuries began appearing. Many early radiation injuries to patients occurred primarily because of the long exposure times required for good diagnostic images. At first, injuries such as skin and eye irritations were not attributed to x-rays because of the latent period before symptoms started. Soon, however, experimenters connected skin burns, which looked like sunburns, to x-ray exposure.

An American physicist, Elihu Thomson, was so interested in these reports that he deliberately exposed the little finger of his left hand to x-rays at half-hour increments for several days. The resulting pain, swelling, stiffness, erythema and blistering of the skin convinced many of the danger of x-rays; however, others denied Thomson's

claims, attributing the symptoms to the intentional abuse of radiation.³

In 1898, Thomas Edison developed the fluoroscope. However, Edison abandoned his research less than a decade after his good friend and assistant Clarence Dally died from a severe x-ray burn and radiation-induced cancer in 1904. Dally's death was noted as the first x-ray fatality in the United States.³ In the following years, it was discovered that radiologists were developing blood disorders such as aplastic anemia and leukemia at much higher rates than the general public. Consequently, radiation protection devices such as lead aprons and gloves were developed.³ Eventually, most of the scientific and medical community came to believe that exposure to x-rays could harm patients, and efforts were made to limit dose. Exposure time, beam filtration and collimation were reduced, as was the use of intensifying screens and higher x-ray voltages.

In 1913, the German Roentgen Society began the first organized effort at radiation protection by adopting a resolution to protect workers from x-ray exposure. Two years later the British Roentgen Society implemented similar standards. In 1921, a group of British physicians

organized a radiation protection committee and created more specific guidelines for protecting health care workers from radiation. The United States adopted similar standards in 1922.

In 1928, the Second International Congress of Radiology was established to provide information and radiation protection recommendations to physicians, x-ray technologists and other health care workers.¹ By the 1930s, more organizations established guidelines to oversee radiation protection. In 1959, the Federal Radiation Council was established to advise the U.S. president on radiologic issues and to provide guidance to all federal agencies and states regarding radiation issues.

Congress created the Environmental Protection Agency in 1970, and the Radiation Protection Division became responsible for setting standards and guidelines to protect the public and environment from undue radiation exposure. Subsequently, organizations that used ionizing radiation were required to comply with these standards.²

Today, radiation protection for both patients and staff is emphasized. The National Council on Radiation Protection and Measurements (NCRP) recommends limiting radiation dose for both radiation workers and the general public; the goal is to minimize potential harm for anyone exposed to man-made radiation.³

Radiology has grown by leaps and bounds since the early 1900s, and new technologies and modalities have been developed in recent decades. Diagnostic ultrasound debuted in the 1960s, positron emission tomography (PET) and computed tomography (CT) were developed in the 1970s and magnetic resonance (MR) imaging appeared in the 1980s.³

Fluoroscopy has been an important part of radiology since the early 20th century. Once primarily used for gastrointestinal work, fluoroscopy now is employed for interventional procedures and in the operating room.⁴ In addition, fluoroscopy is being combined with CT for more accurate placement of needles and catheters, thus reducing procedure times. As a result, the number of prolonged fluoroscopic procedures has increased dramatically over the past decade. Two reasons for this are managed health care's push for minimally invasive procedures and improvements in technology. Fluoroscopic interventions like coronary angioplasties are sometimes the only treatment available to save a patient's life.^{5,6}

In addition, other fluoroscopic interventional procedures, such as neuroembolizations and transjugular intrahepatic portosystemic shunts (TIPS), and pain-management procedures are becoming more common.⁴

The use of fluoroscopy during orthopedic surgical procedures also has grown tremendously. In a busy trauma hospital, the operating room staff may be exposed to high levels of radiation because of the frequency of orthopedic procedures, especially procedures such as intramedullary nail fixations of the hip and pedicle screw insertions in the spine.^{5,6} Vertebroplasty and kyphoplasty are relatively new procedures and require both anteroposterior (AP) and lateral real-time imaging of the involved vertebra. This requires 2 C-arm units, with increased radiation exposure to the patient and staff.⁷

Fluoroscopically guided invasive procedures, both diagnostic and therapeutic, have become accepted clinical practice. These procedures are performed by a wide variety of specialists and may provide advantages over other therapies, with better patient outcomes as the result. However, major health risks are associated with long exposure times and high dose rates. One of these risks is injury to the skin at the exposure site. Such injuries are reported to the U.S. Food and Drug Administration (FDA), and in 1994 the FDA issued an advisory to health care facilities warning of the potential for radiation-induced burns to patients. According to this report, a number of invasive procedures can cause skin injury, even when the fluoroscopic time is an hour or less at the normal dose rate (see Box 1). The problem with this type of injury is that its onset is delayed and the extent of the injury might not be evident until weeks after the procedure.⁶

Risk of Radiation Exposure in the OR

Patients

Fluoroscopic procedures, particularly interventional procedures, can cause the patient to receive high doses of radiation. This dose depends on the type of procedure, the time involved, the equipment, patient size and a variety of other factors. Safe patient exposure relies mainly on receptor entrance and skin entrance exposure rate management, as well as clinical monitoring of patient doses.⁴

The Radiation Control for Health and Safety Act was passed in 1968 to protect the public from the hazards of radiation. The intention was to reduce the public's exposure to unnecessary radiation from electronics, such as microwave ovens and color televisions. This legislation also included diagnostic imaging equipment. Furthermore, it established the Center for Devices and Radiological Health (CDRH). This bureau conducts an ongoing radiation control program and establishes standards for the manufacturing of radiologic equipment.