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For decades, magnetic resonance imaging (MRI) suite layout has been a one-step process for design professionals, largely consisting of copying and pasting the MRI vendor's template into the floor plan.

The equipment was long considered too complex, too specialized and too expensive to entrust the supporting design

between standard design and clinical practice has been cited as one of the contributing factors to a dramatically increasing rate of accidents that jeopardizes the safety of both patients and clinical caregivers.

The American College of Radiology (ACR) published a document in 2002 titled the "White Paper on MR Safety,"

suites. Under this principle, a person must successfully complete sequential levels of screening before they are cleared to proceed from areas with zero risks from MRI magnetic fields toward the magnet itself.

As with the previous publications, the current guidance document provides a conceptual floor plan that illustrates one potential layout achieving the four-zone objectives. It is important to note, however, that this layout is meant to be illustrative and the provided floor plan is in no way to be viewed as a sanctioned prototype or template for a safe or compliant suite.

With so many factors in the MRI suite involved in patient safety, canned prototypes and copy-and-paste design solutions will invariably present safety and operational conflicts with one or more of a number of factors, including technical siting requirements, patient throughput expectations, clinical staffing, patient acuity, clinical applications and interventional care as well as others.

It is for this reason that the "MR Facility Safety Design Guidelines," which is part of the ACR guidance document, offers a breakdown of the most frequently utilized programmatic elements in MRI and structures them in a narrative sequence so that design solutions unique to the needs of an imaging provider can be developed.

Understanding the process

All of this is intended to shed light on the operational process for the design professional. The country is littered with examples of technically sufficient and code-compliant MRI suites that, because of layout and design, impede operational effectiveness and compromise the safety of patients and staff. Without a better understanding of patient flow and the management of care in the MRI suite, architects and engineers are doomed to repeat the mistakes of the last 20 years.

SAFETY FIRST

'MR Facility Design Guidelines'
takes planners through the process



by Tobias Gilk

to architects. In fact, this shifting of responsibility away from the design professional has been so complete that there have been no building codes or standardized design practices promulgated for MRI suites.

The result of this disconnect between crucial elements of facility design and applicable codes and standards has been a widening gap between what MRI suites were designed to do and what they're expected to accomplish today.

Surgical connection

Often designed with only diagnostic examinations and ambulatory patients in mind, many MRI suites are now routinely used for minimally invasive interventional applications and are treating patients of increasing acuity. The gap be-

which addressed a number of operational and clinical aspects of patient safety and proposed a basic organizational layout for an MRI suite. However, it was written primarily as a policy manual and not design guidance, and it explicitly stated that the principles were based on existing MRI facilities. In an update to the document in 2004, minor concessions were added to issues of MRI suite planning and design

This year, however, a wholly rewritten document, retitled the "ACR Guidance Document for Safe MR Practices: 2007," has been dramatically expanded to offer a new standard for the design of MRI suites. Consistent with the preceding issues of the 2007 guidance document, the ACR reaffirms the application of the four-zone principle in laying out MRI

The following elements provide a basis for this understanding:

- Clinical screening.** Following the progress of the patient as he or she enters the MRI suite, one of the first functional elements is the screening of the patient. Sometimes this has been initiated with a pre-screening telephone call, but frequently it begins with a questionnaire for the patient to fill out regarding their medical history. After the questionnaire is filled out, it must be reviewed with the patient and a trained MRI staff member. Because of the potentially sensitive nature of these conversations and the importance of full disclosure, Health Insurance Portability and Accountability Act (HIPAA) issues are of significant importance in suite planning and design.

- Physical screening.** Following a successful clinical screen for metal fragments, contrast agent sensitivities and contraindicated implants, the patient must then undergo a physical screening to assure that he or she does not have ferromagnetic materials on their person that could become threats in proximity to the MR scanner. Iron-containing materials are so ubiquitous that it takes effort to rule out ferrous materials in clothing, jewelry, accessories—even cosmetics and tattoo inks. Many facilities ask patients to remove their street clothes and change into gowns or scrubs. Others carefully screen MRI patients and their clothing prior to admitting them into areas near the scanner.

- Ferromagnetic detection.** While the ACR MR Safety Committee strongly rebukes the use of conventional airport-style metal detectors for patient screening, the committee is now specifically recommending the use of specially developed ferromagnetic detectors for use in screening persons entering the MRI suite. Designs for new or updated facilities should address the operational and minimal siting requirements for these new devices.

- Multi-modal imaging suites.** Because of the concerns about co-mingled patients, the new guidance document offers warnings to facilities where post-



The ACR guidance document calls for provisions for clinical and physical screening of all persons in the MRI suite.



New ferromagnetic detectors can identify and localize potential threats.



MRI suites should be provided with access controls to keep unscreened or untrained persons away from the hazards.

screened MRI patients share holding or sub-wait areas with patients for other modalities. These mixed-patient holding areas present the opportunity for introduction of ferromagnetic materials and, depending upon the layout, also increase the opportunity for un-

screened individuals to enter into the magnet room.

- Access controls.** To prevent the unscreened person or object from entering the higher-risk areas of the MRI suite, the guidance document also outlines where access controls should be placed and how systems should be specified to minimize the likelihood of unauthorized entry by persons or equipment. Magnetic swipe cards, one of the most common access control devices used in contemporary hospitals, are often erased when brought close to the scanner and, as a result, are problematic when used to secure MRI suite access.

- Situational awareness.** Despite the presence of screening protocols and locked doors, the single greatest asset in minimizing risks in the MRI suite is effectively trained staff and their ability to monitor activities within and approaching the MRI scanner. Too often these staff members are sequestered in black-box control rooms without the ability to see or hear those approaching the door to the magnet room. The guidance document provides design considerations for the technologist's field of view to reinforce the safety elements with staff oversight.

- Clinical care.** As the clinical uses of MRI change so, too, should the physical facilities provided to support patient care. The guidance document identifies areas of clinical practice that should be investigated before designs for a suite are developed. These include questioning the use of medical gases and anesthesia, areas for induction and recovery of sedated patients, areas for exam and contrast preparation, interventional applications within the MRI suite and infection control practices suggested for each of these. The design responses to

each of these issues can be substantially different among different facilities, but the inquiry into the design needs of each should be equally thorough.

- Cryogenics.** A number of accidents involving the escape of superconducting-enabling cryogenics, referred to as a

DOWNLOADING A /FREE COPY/ OF THE MR GUIDELINES

The new American College of Radiology's "ACR Guidance Document for Safe MR Practices: 2007" is available for free download in .pdf format from the American College of Radiology at www.acr.org/mr_safety.

Though the "MR Facility Safety Design Guidelines" (which is Appendix 2 within the guidance document) provides valuable input in design criteria for patient safety in the magnetic resonance imaging (MRI) suite, there are many aspects of MRI facility design that are beyond the scope of the ACR publication.

It is still left to the facility and design professional to address technical siting criteria, operational issues and financial considerations.—T.G.

There are a myriad of other design considerations in the MRI suite beyond patient safety, including operational efficiency, technical performance of the equipment, unique life-cycle costing issues, building systems integration, future expansion limitations and equipment upgrades. However, safety should be an inviolate principle and the most fundamental of design services.

The new ACR guidance document has become a *de facto* clinical standard of care for safety in the MRI suite. The "MR Facility Safety Design Guidelines" within the document should likewise become the MRI suite designer's standard of practice for safety. ■

"quench," have pointed out the potential hazards of cryogenic liquids and the facility design elements that can help mitigate these risks. Improper design and maintenance of site-installed cryogen venting, exhaust and pressure-relief systems can jeopardize not only the safety of patients and staff, but also the MRI equipment itself. The guidance document offers information to reduce these risks.

Safer MRI facilities

The guidance document clearly directs design professionals to actively engage MRI clients in developing safer facilities. While providing appropriate clinical care is the responsibility of the hospital staff, building an environment that supports the delivery of that care is the responsibility of the design professional. This responsibility too often has not been met in the design of MRI facilities.

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