SPRINGER LINK
Find a journal Publish with us Track your research Search Cart
Home > International Journal > Volume 10 > Issue 1
International Journal volume 10 Issue 1, 2021
Article | International Journal | Long-reference work entry
Designing Rooms for Image-Guided Therapy
J. Bender[1], J. Lang & M. Kleinke
Using reference work entry | First Online: 26 July 2021
28 Accesses

Abstract

Most live-saving decisions have been remarkable advances in imaging and procedural guidance technology. Enhancements in computing, sensors, and data processing now allow many imaging modalities to produce information that can be displayed, transmitted, and utilized real time. This has allowed the immediate use of imaging modalities to guide surgery and other interventions. Image-guided therapy (IGT) has evolved into a specialty that uses diagnostic imaging, surgery, anesthesia, and interventional radiology tool techniques and evolved lately. Independently in the past, procedural rooms were generally designed with a single discipline in mind. We are now asked to construct procedural work environments which support multidisciplinary work flow and most navigated therapeutic procedures. In these new image-enhanced working environments, the collection, processing, and display of information is rapidly evolving. Accompanying these changes in the workflow are increased demands on the physical space, equipment, and staff to accommodate these new diagnostic and therapeutic technologies. This chapter discusses the design of these rooms. The goal in interventional IGT design is to produce functional spaces that are safe and efficient and that have the capacity to support the evolution of new technologies and equipment with minimal corrective changes.

Keywords

Information display | Lighting | Regulations

Access provided by SpringerReference Community
Download reference work entry PDF

Introduction

Operating rooms, diagnostic radiology facilities, and interventional radiology suites each have their common and unique elements. As imaging equipment and image processing becomes to speed it allow real-time use of images for navigation and monitoring, and with increasing frequency, these rooms are being combined into multidisciplinary image-enhanced procedure spaces. These rooms have a demand for complex, unique logistics and workflow. [1, 2, 3, 4, 5] The facilities designer is now confronted with technical design and operational challenges not anticipated in single discipline rooms. An understanding of the components of room design is particularly important now for clinicians, to allow them to effectively participate in the design process and to make the best use of these new technologies. In order to produce a safe and efficient hybrid interventional radiology facility, the architect and the design team, including the physicians, must have an understanding of regulations as well as the facility issues. Other doctors, engineers of new technology, and facilities designers collaborate and pool their resources, the result is an optimally functioning facility. [6] The purpose of this chapter is to provide a brief overview of the design process. The technology must have enough a better grasp of facilities issues to collaborate in the design of these experimental facilities. In this chapter, the main considerations in designing the interventional room will be discussed.

Overview of the Interventional Center

The basic functional space and spaces for an interventional suite have three major components:

1. *Patient preparation, holding, and recovery areas*: A well-designed preparation and recovery area is essential for efficient flow of patients, and is important for the high turnover reality of modern interventional practice. Such areas require space for reception, seating, interview and consult rooms, exam rooms, dressing rooms, holding areas, and PACU beds (Fig. 1). When well designed, this area also provides support for communications to alleviate anxieties of families and patients.
2. *Procedure rooms*: Designed of procedure rooms must also account for acute stress (Fig. 2), clean supply, storage, control rooms, and observation space for staff. Additional space must be provided for diagnostic equipment, infrastructure, and storage space for portable or mobile equipment not always in use or fixed in the procedure room.
3. *Support areas*: These areas include staff offices, clean and soiled work rooms, instrument cleaning and processing, clean and sterile supply storage and delivery, sterile handling and cleaning, locker and changing rooms for staff, and patient lockers.

Fig. 1
Operating room (from cath lab) and suite. This area provides for scrub sinks, storage area for essential and emergency equipment, as well as quiet work area for the clinician to provide(s) to the procedure room. (Photograph courtesy of the Bartlettman Photography)
Full size image ↗

Fig. 2
Operating room (from cath lab) and suite. This area provides for scrub sinks, storage area for essential and emergency equipment, as well as quiet work area for the clinician to provide(s) to the procedure room. (Photograph courtesy of the Bartlettman Photography)
Full size image ↗

In this chapter, remarks will be restricted mainly to the procedure rooms. For discussion of the other two areas, the reader is referred to standard texts on these subjects.

Regulatory Issues and Guidelines

Procedure room requirements are distinct within surgical suites, endoscopy areas, and radiology departments. There are common elements for cleanliness and ease of the patients and support of staff. These are governed by the Facilities Guidelines Institute and published as "Guidelines for Design and Construction of Health Care Facilities" [7]. The set of guidelines, which sets minimum standards for hospitals, has been adopted by most states. In the United States, these guidelines are used by the Centers for Medicare and Medicaid Services. Their construction used to be guided by different standards depending on the invasiveness of the procedure, the equipment needs, and the level of anesthesia and the support required for the procedure. Now, each facility has been set to a common standard for operating rooms or operating room environments for all invasive procedures with the major design differences being the size of the room, the equipment, and the support for the anesthesia and monitoring related to the procedure and type of anesthesia used. The time required to complete the procedure and recover the patient affect infrastructure of the facility, such as emergency power requirements. Generally, in the design of these facilities we work to support a patient with minimal disruption to their normal sleep cycle processes, medical flows, and unavoidable interruptions. The goal is to design the facility to adapt to flexibility of staffing requirements and efficiency in training and education.

Work environment of the current year. The size and optimal location of the procedure rooms is generally determined by the level of care to be provided. The levels of care are defined by the American College of Surgeons in the ASC "Guidelines" 2015 edition [8] as follows:

Class A: Provides for minor surgical procedures performed under topical, local, or regional anesthesia without pre-operative sedation. Excluded are intravenous, spinal, and epidural routes; these methods are appropriate for Class B and Class C facilities.

Class B: Provides for minor or major surgical procedures performed in conjunction with oral, parenteral, or intravenous sedation or under analgesic or dissociative drugs.

Class C: Provides for major surgical procedures that require general or regional block anesthesia and support of vital body functions.

The level of care also affects infrastructure and utility requirements and will be discussed in a separate section.

In 2018 ESG Guidelines revised the Class designation and adopted a descriptive approach. Instead of using the terms minor and major, the guidelines now use the terms "invasive" to describe the types of procedures, the amount of staff, and the equipment required. The updated guidelines include maintaining minimum square for the sterile field, circulation pathway, immediate equipment in zones, and an anesthesia work zone. Minimums are still included with Operating Rooms at a minimum of 400 ft² and 600 ft² when designed for the purposes of image-guided surgery or procedures.

Size of Rooms: Operating rooms generally start with a minimum floor area of 400 ft² (Fig. 3a) for modern minimum standards and are regularly built at 500 ft² or more to accommodate additional personnel and equipment for procedures (Fig. 3b and c). Diagnostic rooms start at 300 ft² and go as large as 500 ft² for modalities such as MRI (Fig. 3d).

Typical size and designs of procedure rooms. Panel a illustrates a typical operating room for conventional surgery of approximately 400 ft². Panel b illustrates a typical room for the performance of approximately 500 ft². Panel c illustrates a modern imaging procedure room of approximately 500 ft²
Full size image ↗

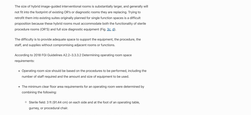


Fig. 4
Typical fluoroscopy (left) general operating room. This photograph illustrates lighting improvements with ceiling mounted LED lights. The ceiling mounted equipment boom provides a clear pathway for the surgeon. The center of the room for balance surgery is free so the can see clear. (Photograph courtesy of Duke Bartlettman Photography)
Full size image ↗

Fig. 5
MEDICAT provides room. This photograph illustrates the challenges of transitioning the patient chair. Large room alternating equipment is involved. Note the anesthesia boom in the middle of photo. Also, the ceiling mounted equipment boom is in the middle of the room. Also, the patient chair is "pulled" around the operator. (Photograph courtesy of Duke Bartlettman Photography)
Full size image ↗

The size of hybrid image-guided interventional rooms is substantially larger, and generally will not fit into the footprint of existing OR's or diagnostic rooms they are replacing. Trying to retrofit them into existing suites originally planned for single function spaces is difficult. The preoperative because these hybrid rooms must accommodate both the functionality of sterile operative rooms (OR's) and full size diagnostic equipment (Fig. 3c, d).

The difficulty is to provide adequate space to support the equipment, the procedure, the staff, and supplies without compromising adjacent rooms or functions.

According to 2018 FGI Guidelines A-2.1-3.3.2 Determining operating room square requirements:

- Operating room size should be based on the procedures to be performed, including the number of staff required and the amount and size of equipment to be used.
- The minimum clear floor area requirements for an operating room were determined by combining the following:
  - Sterile field: 3-ft (914 mm) on each side and 7-ft (2.13 m) in the operative setting, gurney, or procedural chair.
  - Circulation pathway: 2-ft (610 mm) on both sides and 7-ft (2.130 m) at the foot of the sterile field.
  - Movable equipment zone: 2-ft 6-in. (762 mm) on the sides and 5-ft at the foot of the circulation pathway.
  - Anesthesia work zone: 360 ft² (4.90 m²) at the head of the operating table, gurney, or procedural chair.
- The sterile field includes the OR table (measuring 2 × 7 ft or 610 mm × 2.13 m), a 3-foot (914 mm) clearance in each side to accommodate personnel and instrument patient access, and a 5-foot (915 mm) clearance at the foot for personnel.
- The circulation pathway includes space for two people to meet and pass each other without touching either non-sterile surfaces (e.g., walls, people, or equipment) or one-way traffic around equipment and personnel. The circulation pathway is a minimum of 2 feet wide. The circulation pathway on all four sides is provided space for personnel to set up a sterile field prior to the procedure, assist with safe patient evacuation using a stretcher in cases of an emergency, pass between the back table and the wall during the procedure, and pass at the head of the patient without interfering with care being provided. The circulation pathway at the foot of the table is 5 feet (915 mm) to allow access at the head of the table, such as for anesthesia. The circulation pathway is not to be used for setting up sedation of the patient (7 ft (610 mm) at the top of that circle can be used as part of the circulation pathway.)
- The movable equipment zone includes 2 ft 6 in. (762 mm) on each side and 2 ft (610 mm) on the foot of the table to accommodate the minimum equipment for surgical procedure.

Basic Considerations in Design

The precedents for the design of major global interventional facilities are interventional radiology rooms, the integrated image-guided therapeutic laboratory (IGTL), and the first generation hybrid and intraoperative CRs built for special purposes and specific procedures. The integrated OR provides a good starting model for thinking about image guidance in that it provides the multidisciplinary environment and the multiple image-enhanced modalities and controlling the environment as it affects the treatment. There is a well-developed information management system for the creation of visual images and their display at the bedside for the use of the surgeon. The protocols and controls are understood by the staff and have generally been developed to support the process and needs of each individual institution. Although the IGTL provides a multidisciplinary environment for the performance of IGT, the facilities designer is challenged the new imaging equipment to be added to the existing environment, how it works and how its information is produced and used in the treatment of the patients.

The image-guided therapists discussed in other chapters of this book can be ranked into interventional radiologists for the purposes of room planning and process design. Most therapists under consideration are mobile and involve minimale equipment and instruments that move from room to room and are specific to the imaging and guidance systems. Rooms for these therapists need to be flexible, designed with sufficient work spaces, storage, and power and data connections to accommodate the equipment and instruments and be easily configured. These involve modeled therapists, such as these procedures in through otherwise, and are usually integrated into imaging modalities such as CT, PET, or MR systems. however, these systems must also be designed to support the minimale when they use.

The greatest challenge in design is that due in large part to the new and developmental nature of image guided procedures rooms and the small market for equipment, there is a lack of equipment and systems designed and manufactured to support these uses. Thus, design of novel guidance procedures usually involves large bulky diagnostic equipment that has been adapted to support the procedure. Unfortunately, this equipment is not ergonomic and usually has been a designed for interventional radiology procedures that may require the use of a single system or Cath lab. Other modalities will require a room-based system to provide most guidance information to the physician.

Lighting

Lighting consists of two major elements: the fixtures and the controls. Both are necessary to get the system to function correctly and support the procedures to be performed. As a rule, controls and specially fixtures like OR lights should be consistent from room to room within a facility in order to prevent staff fatigue and errors and to allow for ease of maintenance (Fig. 4).

The two most important characteristics of lighting are brightness (lux) and color temperature. Typically, the light sources used now are LED because they have long life, are easily controlled and dimmed, and have very consistent color from lamp to lamp. They are also the most efficient and have the most flexibility in color temperature.

Lux requirements, (and color temperature) are for illuminating setup, cleaning, and equipment service. Functions that require additional bright light throughout the room. A common design for the lights is a room to have the ability to be dimmed and controlled in small, localized zones for lighting of specific tasks in the room during a procedure. When all the lights are switched on at high intensity, unless, general lighting of the room is required, the intensity of the light will be too bright for the patient and staff. Therefore, the lighting system should have brightness without flicker in order with This will enable support of the image guided interventional procedures where the information displayed on video screens is at lower light levels. Covering the room lights reduces glare and helps with lightening the image and reduce reflection from the video displays.

In all procedures and surgeries there are staff circulating about the room. Thus, a consistent low level of lighting across the entire room is necessary to allow for this travel without accidents. Beyond this there is the need for large lighting of certain areas to permit the operation of equipment to be compact tasks, to operate equipment, or to prepare patients for the procedure. Lighting for these tasks is provided by the OR lights. These systems support these functions using ceiling and lighting that is brighter than the room lighting. Revolving ceiling mounted task lights should have controls that allow them to be turned on and off as needed by the person working in areas such as the anesthesiologists, technical support areas, case carts, nurses managing notes, or imaging personnel operating control consoles. [9, 10]

For lighting of the procedure area itself, the controls should be not only adjustable but also programmable so that the usual setups or operating modes of the room can be preset. This allows a quick transition between lighting programs and provides a consistent work environment from room to room, and from day to day. This programming should include the lighting for the equipment, the room, and the procedure. Lighting for the equipment and equipment should also be configured or emergency power to allow the procedure to continue without interruption even in the event of a power outage. The lighting and controls should also be designed to function through the transition between power sources and function identically on normal or emergency power. [11, 12]

For novel interventional environments such as those with MRI, the electrical and lighting considerations are even more complex. Filtered, dimmable LED lighting systems for illumination of the work environment within the high magnets. Nerf are used. Fiberoptic switching networks and RF shielded direct fiberoptic find monitors for MRI images are necessary.

Sterile Work Environment

The design standard for clean room environments requires a laminar flow air supply and a pressure differential to keep the room free of airborne particles. [13, 14, 15, 16, 17, 18] This system is based on a special air supply diffuser mounted in the ceiling that supplies air in a non-aspirating curtain that falls vertically toward the floor until it is past the table (Fig. 5). The curtain is then drawn horizontally now from the field to the return grills in the corners of the room. To be effective, the diffusers must form a closed ring and extend 2 ft beyond the table in all directions. The air must be supplied at a velocity of 90 feet per minute (fpm) which is large quantity of air. Care must be taken in the design of this system to control air velocity and thereby to reduce noise. The white noise produced by an air supply system not properly sized or balanced can mask speech. Therefore, the design of the room must include task lighting, room mounted displays, and other equipment must be considered with design equipment the planned working positions to provide convenient access to the utility connections and sight lines to the displays.

Other design challenges have to do with the control of equipment and process heat loads. To the extent possible these should be isolated from the procedure spaces is especially important for the operation of the laminar flow system. Equipment should be located outside of the procedure rooms. In both the equipment and the procedure spaces the designer needs to be aware that the equipment heat loads vary dramatically over time. The imaging systems idle at low power when not in use but produce large heat outputs during imaging. The heat profiles are incoherent from room to room so the cooling for the controls must be by dedicated room, not groups of adjacent rooms.

Imaging and Image Processing

The diagnostic images in the principal output from the radiology equipment such as an MR system, CT, PET, or C-arm. The image is displayed on a monitor or projected on a screen for the surgeon to display and scrolling of the image information to aid in guidance and consultations. The simplest way to do this is with a dedicated display chart provided by the equipment manufacturer that is not routed or switched in the room. The dedicated chart provides the radiology staff with a single visual reference point or "line of image" for calibration and comparison of all of the displays and images requested during a procedure.

The image storage and picture archiving (PACS) system serves a dual role in interventional suites. It is the system that brings the diagnostic information already collected and

Visual Information Management

The information necessary to guide a case needs to be displayed at the bedside and at multiple other locations in the room so that all of the staff is aware of what was going on and where in the procedure they were at the moment (Fig. 5). Ideally, there should be a large display visible to all in the room with essential data relevant to all personnel (such a "Mail of Merit" display), and smaller displays at the bedside and at the surgeon's workstation (such as a "brief" display, as well as the data such as ongoing vital signs. This system uses data streams to systems at the hospital and displays it in a standard format for the staff to use in monitoring the patient and organizing their schedule and workflow (Fig. 6).

Fig. 5

Angiography/CT procedure room. The different displays nestled in an around image-guided interventional equipment provide information to the staff. Ceiling-mounted displays provide a 180-degree panoramic view of the procedure and vital signs. Auto-lights also will be used by the surgeon because of the audible cues of therapeutic intervals. (Photograph courtesy of Arthur Bertelsman Photography)

Full size image >

The first and near-free images to be displayed in the modern interventional environment include not only radiologic images but also images from cathlog, operative light microhelel, and laparoscopic camera. This mentions much support display of almost every video format. There is also the need to provide remote viewing access for visiting physicians and students, which can be optimized by displaying the working images at strategic points in the room and providing a duplicate image stream to a PACS workstation. Ceiling-mounted displays, such as those on auto-displays is much shorter than the distance from which one watches television images. Keeping the working distances consistent from eye to hand and eye to display and maintaining a uniform light level from display to working field and from display to surgeon is important in reducing fatigue and eyestrain caused by refocusing or adjusting to different illumination as one works.

Visual Technology and Infrastructure for Advanced Image-Guided Interventional and Surgical Suites

With the exponential increase in imaging device complexity, the complexity of image guidance/navigation technologies, and the requirements for distributed collaborative clinical care, there is need for advanced production/processing room designs and that associated infrastructure to support.

Image-guided interventional procedure rooms and operating rooms have constantly evolved from their early beginnings the audiovisual distribution systems to today's systems advanced remote control routing, streaming, and data-driven clinical systems. DVR, PACS, etc. RFIDIP image guidance/navigation, physiological monitoring, pathology, and many other clinical information systems have been integrated into these state of the art procedure room systems. Fused multi-modality imaging data sets, near-electronic rendering, and enhanced navigation planning have become required technologies for many treatments.

3D-extended reality technologies and tools are to integrated into image guidance therapies and surgeries. VR anticoagulant experiment/training, virtual reality, and haptics. With the advent of 5G technology, remote control of medical devices and robots, remote telemedicine has tele-telemry images and video can be achieved. With the recent announcement of Cisco's Intelligent conferencing solution, remote 3-D holographic imaging will soon become an commercial technology for remote case viewing and telementoring.

These next-generation spaces require advanced light performance (court lamb) AIR, and collaborative, evidence-based protocols, infrastructure and technical requirements have become considerably more complicated.

Software defined virtual networks (SDN) and "Zero Trust" architecture to route network traffic provide that confidence that high performance network interview systems. Creating mini-stage cameras and secondary communication rooms may become the new standard.

Today and in the future, there is an emphasis on IoT and IoMT initiatives. It is very important to build surgical/interventional spaces with infrastructure that will integrate edge data collection devices. These sensors and systems will allow the acquisition of many different types of use medical treatment and imaging devices for data acquisition in the cloud.

Some of the edge-to-cloud analytics and deep learning capabilities are now building into surgical and interventional spaces will allow modeling clinical and operational workflows to optimize and reduce costs and errors. Examples could be how multidisciplinary surgical/interventional teams work together or the efficiency of treatment and services.

In summary, the most important technology design considerations for image-guided interventional and surgical spaces is to provide the infrastructure to accommodate the new technologies and modalities. We are moving from Healthcare Information Technology to Health Data Technology.

Image Displays

Resolutions of image displays have been improving rapidly. 8K HD video displays have become standard — a substantial upgrade in image quality over the previous PC display standards used in integrated ORs. Video and other working images are migrating to this standard. Displays with 4K, 8K, and higher resolutions are being used to provide more detail and regards the these image guidance tools for display of the pre-procedure and intra-procedure images. Even with glasses, these systems will be useful for virtual reality viewing. Imaging and even better cross-co-registration software is perfected. 3-D displays not requiring glasses are also available, and their implementation is only awaiting further improvements in resolution and decrease in cost.

Design in placement of displays depends mainly on data needed to provide working information at the location from which the display would be viewed. Boom-mounted displays are usually smaller than wall-mounted displays but should be the same resolution and aspect ratio (Fig. 4). Boom-mounted displays are usually positioned directly overhead and adjacent to the surgeon's workstation with the displays and controls positioned in the sterile field of the video system. This allows for equipment to travel from room to room. The use of a standard signal in the switching systems also makes it easy to route images and controls to different systems and display them consistently throughout the facility.

Composite procedures are those that include multiple imaging modalities simultaneously to accomplish something that one specialist could not do alone. Examples include the use of catheters or laparoscopic to manipulate and protect an adjacent structure to enhance tumor ablation. Other examples include combined endoscopic ultrasound and CT guidance to navigate through the lung to reach a lesion, and combined laparoscopic and ultrasound. The composite patient safety people in the procedure room and operating room and digital displays in the field to display images and information for each of the simultaneous processes.

Because most imaging equipment was developed as diagnostic equipment, the specifications of room sizes and configurations necessary to house much of the imaging hardware is not well defined and not optimal for interventional rooms. Even the weight of equipment has to be issue when equipment is isolated and the work area is arranged to support sterile instruments and a sterile field. This creates a planning and functional bending that the equipment vendors should be pressured to address. The cables currently connecting many video wireless equipment to the wall plates are a source of contamination and a tripping hazard in the sterile field. These line standing based cables will likely be replaced in the future to allow control of equipment information and images while maintaining sterility.

Equipment Noise and Acoustics

Acoustics in sterile environments are compromised by need for washable and wet cleanable hard surfaces that generally reflect and amplify sound. Noise from systems and equipment in the room, and from the HVAC system, can be a distraction to the surgeon and make it difficult to communicate over a voice, since the ability to discern and control sound with flexibility and esthetics is limited. Walls between rooms and doors to corridors need to be substantial to attenuate sound transmission between rooms and corridors. Acoustic and vibration construction details are required in the walls of rooms containing noise- producing equipment such as MRI, where patient cuts can produce noise at 80 Db (subway train volume) so that staff in adjacent rooms is not disturbed.

Acoustic panels and acoustically engineered ventilation protection of require continuity and chosen which conflicts with the requirements for the distribution of and access to the utilities and equipment. Acoustic panels are also difficult to keep sterile and cleanable. Acoustic panels where the ceiling is isolated in the center where it can be installed only in construction and inspection. Then the individual rooms and their ceiling and piping could be installed in the rooms. These line standing based walls will enhance sound attenuation between rooms. In the future it is expected this will enhance our ability to work in the rooms and update systems and equipment even more at a time without disturbing procedures in adjacent rooms.

Challenge of Large Equipment and Nomadic Equipment

Several workflow challenges in the design and operation of image-guided environments that are not well addressed by current standards and practices are the movement of equipment through large immobile imaging equipment. Unlike traditional surgery where the operative field is generally placed in the middle of the room and personnel as well as therapeutic equipment are brought to the field, in interventional environments the operative field is usually fixed to space and is rarely in the center of the room. The patient and therapeutic field are fixed in the imaging equipment, and the staff and equipment must move around the imaging to accomplish procedures therapies in a time-efficient but safe manner. Depending on the procedures, patients may be fixed in or head out of the imaging equipment, and the patient cut access of the staff to move as well. This must be taken into account when displacements in a environment where the staff is tethered at both ends since their equipment has connections to both the patient and the utilities. In some rooms there are multiple locations where anesthesia utilities support must be provided to support the variety of procedures performed.

The increased volume of the working fields including fixed equipment having several optical and electrical connections to the patient and the need for multiple imaging modalities has created a challenge. Once the optimal location for the anesthesia set up for a case has been determined, issues relating to cable and tubing management around and to the patient and at the movement of the patient to the imaging device can be a hazard. Ceiling-mounted utility boxes minimize the cable and tubing clutter in the sterile field and provide a flexible and adjustable connection to both the patient and the utilities. In some rooms there are multiple locations where anesthesia utilities support must be provided to support the variety of procedures performed.

The increased volume of the working fields including fixed equipment having several optical and electrical connections to the patient and the need for multiple imaging modalities has created a challenge. Once the optimal location for the anesthesia set up for a case has been determined, issues relating to cable and tubing management around and to the patient and at the movement of the patient to the imaging device can be a hazard. Ceiling-mounted utility boxes minimize the cable and tubing clutter in the sterile field and provide a flexible and adjustable connection to both the patient and the utilities. In some rooms there are multiple locations where anesthesia utilities support must be provided to support the variety of procedures performed.

The increased volume of the working fields including fixed equipment having several optical and electrical connections to the patient and the need for multiple imaging modalities has created a challenge. Once the optimal location for the anesthesia set up for a case has been determined, issues relating to cable and tubing management around and to the patient and at the movement of the patient to the imaging device can be a hazard. Ceiling-mounted utility boxes minimize the cable and tubing clutter in the sterile field and provide a flexible and adjustable connection to both the patient and the utilities. In some rooms there are multiple locations where anesthesia utilities support must be provided to support the variety of procedures performed.

The Patient Experience

The quality of the patient experience or "hospitality" component of the hospital is a significant consideration in the design of the image-guided interventional and surgical environments. Lately, there is an expectation of quality personal care. A well planned treatment room environment that is more efficient allows both experienced-care to be fulfilled, and produces better, more consistent outcomes.

Where a patient is to recover after a procedure is a very important consideration in patient flow. It has been shown that fewer transfers between stretchers/ceiling and beds make the patient more comfortable and reduces complications caused by movement. During the entire treatment day, the patients should be treated with dignity and respect and the ability to be accompanied by a family member or friend. They should be able to talk with staff and family members without being overheard by others in the room. Patient satisfaction is reflected in evolving standards that now call for private rooms and closed consultation and interview rooms [2]. Patients' expectations for the care of their clothing and belongings, separate space for dressing in private and preparing oneself to leave the hospital and personal care items, such as a mirror to check one's appearance and a chair to sit while getting dressed as well as adequate space for someone to assist them if there are limits, must be reflected in the design.

PACU/recovery is the place where patients spend the majority of their conscious time in the interventional suite. Ideally, these spaces should be designed as private rooms with valid privacy curtains. This will allow for the patient to be accompanied by family and friends and need to talk with them and the staff responsible for their care. These conversations require privacy and patients recovering from anesthesia require quiet and isolation from the other patients and their families. Nonsuch a room will need an appropriate area to be cared for in private.

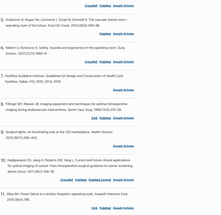
Other Adjacencies Necessary to Support This Work

A plan for immediate interaction with pathology is essential for any modern interventional suite. There is the need for expedited delivery of received specimens. In designing rooms control flow, there should be a separate entrance for receiving specimen and distribution and reporting of results in real time to the interventionist room is required [3], [4].

Central sterile supply and instrument processing facilities need to be located so that materials can be delivered from and produces rooms only by cart or elevator. It is not acceptable to use carts or "push in times" ordering and delivery must be planned to meet the needs of supplies and instruments for procedures. Regularly needed equipment or equipment needed in an emergency (such as specialty angiographic catheters) should be placed in close proximity to the procedure [5].

Planning room placement and sharing of control rooms for rooms where similar procedures are performed will enhance efficiency and minimize personnel and scrubbing costs. This will also allow for sharing of high cost mobile equipment and other specialized items. Intra-procedural consultations can then also be facilitated in difficult cases (Fig. 7).

Fig. 7



A remote control room. The entire procedure room for mobile three-dimensional, Multi-axis cone beam CT is controlled from this room. The operator can see the patient through the lead-lined window, anesthesiologists, and medical physicists. Sharing of a remote control room between two or more procedure rooms can reduce personnel and equipment requirements. In designing remote control rooms, the operator should be able to see the patient and the procedure room through the adjacent procedure room. (Photograph courtesy of Arthur Bertelsman Photography)

Full size image >

Equally important are quiet workspaces away from the procedure room for charting post-processing images and data, and for discussions and phone calls. These areas make it possible to complete these administrative and social tasks that accompany our daily work without the acoustic challenges in the procedure room (Fig. 8).

Conclusion

The development of image-guided operating rooms began with laparoscopic/MIS and interventional radiology suites. As technologies began more expensive, and sophisticated imaging equipment became standard in the interventional environment, simple procedure rooms evolved into interventional suites, and now multidisciplinary interventional suites. Because of the high cost of the construction operation and maintenance of these rooms, they must be designed to be flexible and adaptable to the future. Because of the complexity of procedures, and image-guided interventional ORs are also designed to accommodate pediatrics and outpatients. Uniform standards and equipment should be selected and workflow, room controls and charting information systems standardized to support collaboration between the specialties and to provide support for the application of new and developing therapies. For efficiency and further cost reduction, groups have started to design rooms and equipment that would allow a number of patients being treated in adjacent rooms to be transported to a common area for recovery and observation. This would allow the anesthesiologist to be in a best position in one area to help to cross-development of mobile, high resolution, imaging equipment that will travel between and service a number of procedures simultaneously. Both models would move away from the current one-room one-procedure model of intra-procedural imaging to a low-costly many-rooms one-machine model.

References

1. Kapadia J. Hybrid cardiovascular suite: the operating room of the future. J Card Surg. 2010;25(6):724–8.

Google Scholar Crossref Search Google Scholar

2. Sikirica CJ, Nelson MM, Zoeteweij C J. The creation of the optimal dedicated endovascular suite. Eur J Vasc Endovasc Surg. 2004;28(2):168–174.

Google Scholar Crossref Search Google Scholar

3. Bonnell J, Vassiliadelis T, Wong M, Jakob H, Erber R, Forest E, et al. How to build a cath lab operating room. Heart Surg Forum. 2007;10(4):E344–E349.

Google Scholar Crossref Search Google Scholar

4. Hallett D, Wild S. Planning a cardiovascular hybrid operating room: the technical point of view. Heart Surg Forum. 2009;12(3):E135–20.

Google Scholar Crossref Search Google Scholar

5. Hualtomolo N, Rogan DE, Lombardo J, Zinab M, Schmidt S. The vascular hybrid room—operating room of the future. Acta Clin Croat. 2010;49(3):289–295.

Google Scholar Crossref Search Google Scholar

6. Hatem U, Kornczyk S. Safety, hazards and ergonomics in the operating room. Surg Endosc. 2007;21(7):1065–9.

Google Scholar Crossref Search Google Scholar

7. Facilities Guideline Institute. Guidelines for Design and Construction of Health Care Facilities. Dallas FGI; 2010, 2014, 2016.

Google Scholar

8. Ettinger HF, Weaver JB. Imaging equipment and techniques for optimal therapeutic imaging during endovascular interventions. Semin Vasc Surg. 1999;12(4):310–316.

Link Publisher Google Scholar

9. Surgical lights. An illuminating look at the LED marketplace. Health Devices. 2010;39(7):390–402.

Google Scholar

10. Vasilyevskyi OS, Jung H, Rhiem DR, Yang L. Current and future clinical applications for optical imaging of cancer: from intraoperative surgical guidance to cancer screening. Semin Oncol. 2011;38(1):109–118.

Crossref Publisher Pubmed Central Google Scholar

11. Wiley RH. Power failure in a tertiary hospital's operating suite. Anaesth Intensive Care. 2010;38(4):785.

Link Publisher Google Scholar

12. Wolfson JA, Nawal RK. Electrical power failure in the operating rooms a neglected topic in anesthesia safety. Anesth Analg. 2010;110(6):1705–21.

Crossref Publisher Google Scholar

13. Dalainin CJ, Venkatasupiah J, Wentworth AL, Parks WB, Hayes RG, Thyne SM. Electrical power failure in a population of operand-sterile operating room rooms. J Bone Joint Surg Am. 2008;90(5):1027–9.

Crossref Publisher Google Scholar

14. Lemke HU, Berliner L. PACS for surgery and interventional radiology: features of a therapy imaging and model management system (TIMMS). Int J Medic Inform. 2011;80(2):99–113.

Crossref Google Scholar

15. Kranzfelder M, Schneider A, Gillen S, Feussner H. New technologies for information retrieval to achieve situational awareness and higher patient safety in the surgical operating room: the MRI institutional approach and review of the literature. Surg Endosc. 2011;25(3):696–705.

Crossref Publisher Pubmed Google Scholar

16. Sebat J, Marcario A. Can anesthesia information management systems improve quality in the surgical suite? Curr Opin Anaesthesiol. 2008;21(2):128–31.

Crossref Publisher Pubmed Google Scholar

17. Gerrit AR, Sandberg WS. Sharing the operating room and perioperative systems of the future: innovating for improved communication. Curr Opin Anaesthesiol. 2010;23(6):765–71.

Crossref Publisher Pubmed Google Scholar

18. Tamura Y, Marwil R, Popescu C, Orizio S, Ferro Y, Bianco C, et al. Design and implementation of a web-based system for intraoperative consultation. World J Surg. 2006;30(3):448–54.

Crossref Publisher Google Scholar

Download references ↓

Author information

Authors and Affiliations

Jeffrey Berman Architect, New York, NY, USA

J. Berman

Department of Surgery, City of Hope Medical Center, Duarte, CA, USA

T. Ting

D'Arcy Masonc Design Associates, Hariparua, CA, USA

R. Masonc

Corresponding author

Correspondence to J. Berman.

Editor information

Editors and Affiliations

Department of Surgery and Radiology Memorial Sloan-Kettering Cancer Center, New York, NY, USA

Yuman Fong

Diagnostic Radiology, Room H-110, Memorial Sloan-Kettering Cancer Center, New York, NY, USA

Anna Cooley

Department of Radiology, Beth Israel Deaconess Medical Center, Boston, MA, USA

Hiroaki Ohnari

City Of Hope National Medical Center, Duarte, CA, USA

Jonathan Kaufman

Department of Surgery, Carolinas Medical Center, Charlotte, NC, USA

David A. Iannitti

Department of Radiology, Cape Cod Hospital, Hyannis, MA, USA

Damian G. Duquay

Section Editor Information

Cape Cod Hospital Radiology, Cape Cod Hospital, Hyannis, MA, USA

Damian G. Duquay MD

Rights and permissions

Reprints and permissions

Copyright information

© 2023 Springer Nature Switzerland AG

About this entry

Check for updates

Cite this entry

Berman, J., Fong, Y., Moores, B. (2023). Designing Rooms for Image-Guided Therapy. In: Fong, Y., Covey, A., Ahmed, M., Kessler, J., Iannitti, D.A., Dupuy, D.E. (eds) Interventional Oncology. Springer, Cham. https://doi.org/10.1007/978-3-030-51192-0_14-1

Download citation

.RIS .ENW .BIB

DOI	Received	Accepted
https://doi.org/10.1007/978-3-030-51192-0_14-1	22 December 2021	13 December 2022
Published	**Publisher Name**	**Print ISBN**
26 July 2023	Springer, Cham	978-3-030-51192-0
Online ISBN	**eBook Packages**	
978-3-030-51192-0	Springer Reference Medicine Reference Module Medicine	

Publish with us

Policies and ethics

Discover content

Journals A-Z

Books A-Z

Publish with us

Publish your research

Open access publishing

Products and services

Our products

Librarians

Societies

Partners and advertisers

Our imprints

Springer

Nature Portfolio

BMC

Palgrave Macmillan

Apress

Your privacy choices/Manage cookies Your US state privacy rights Accessibility statement Terms and conditions Privacy policy Help and support

68.132.136.232

SpringerReference Community (3000481153)

SPRINGER NATURE
© 2023 Springer Nature