Building a Modern Endovascular Suite

One hospital's experience provides the guidelines for the planning, designing, and construction of a state-of-the-art endovascular suite in an operating room theater.

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When our vascular fellows finish their 2-year training, they typically will not consider a job at an institution without an endovascular suite or the promise of the hospital to build them one. The importance of endovascular therapy for patients with vascular disease is not news to anyone who is a regular reader of *Endovascular Today*. What is more controversial, however, is how the procedures are performed and in what environment. Interventionists will argue that a fixed fluoroscopy unit, either ceiling or floor mounted, in a catheterization lab or interventional suite environment, provides the best imaging and patient care. Some surgeons specializing in endovascular therapy will argue that the flexibility of a portable fluoroscopy unit is perfectly adequate for most cases and, in fact, has certain advantages for hybrid procedures.

Our Division of Vascular Surgery lived the entire evolution of endovascular therapy, beginning with portable units, progressing to the cardiology catheterization laboratory, and finally being able to design our first endovascular suite in an operating room environment approximately 7 years ago. That unit served us well and was one of the first of its kind in the US. As our division grew and broadened, we added experience in interventional radiology suites, all the time continuing our experience with portable units in the main operating room and utilizing our endovascular suite.

When our university merged with a busy private hospital, our division expanded once again. We subsequently had the opportunity to design a new, state-of-the-art endovascular suite nearly a decade after designing the first. Obviously, technology had advanced, and many of the problems that we experienced with our first room would be addressed with this second design. Even more important, however, was the experience we learned while performing procedures in these multiple settings—especially the cardiac catheterization lab. The mentality in this specialized setting is much different from a standard operating room. Anyone who has performed procedures in a catheterization lab is always amazed at how efficient the staff is with scheduling and patient flow. This often allows for 10 or 15 procedures to be completed per day in a single room. It was this procedure-oriented mentality that our division wanted to incorporate in the design of its endovascular suite but within the operating room theater. This article reviews our experience in the planning, designing, fundraising, staffing, and ultimate construction and outfitting of a modern endovascular suite located in an operating room environment.

Figure 1. Our first endovascular suite.

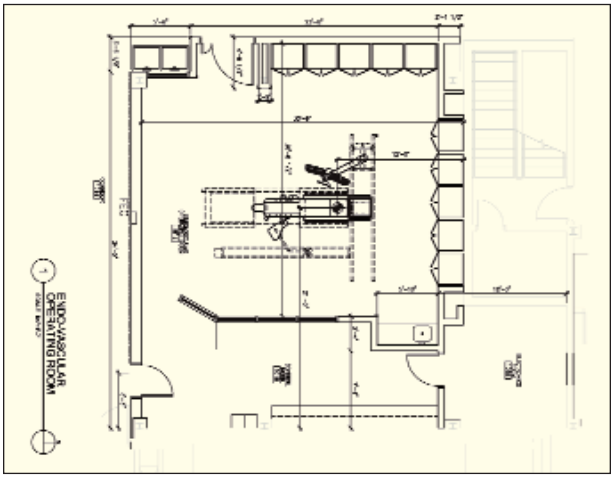

Figure 2. New endovascular suite design.

THE FIRST ATTEMPT

Our first endovascular suite was truly state of the art when it opened in 2001 (Figure 1). A fixed ceiling-mounted unit with a 16-inch image intensifier and an approximately 650-square-foot room served us well for nearly a decade. All types of procedures were and continue to be performed in this environment. However, there were frustrations that arose over the years, and in retrospect, there were many things that we would have done differently. For example, the overall room size is too small for modern endovascular procedures. Once a back table, scrub tech, x-ray technologist, anesthesiologist, circulating nurse, vascular surgeon, fellow, resident, or medical student all enter the room, it is clear that this footprint is not adequate. A room size of 850 square feet, with a control room of approximately 200 square feet, seems more reasonable.

At that time, only CRT-type monitors were available (as opposed to the flat panel technology available today). Unfortunately, with two or three monitors located on a boom, this total weight of nearly 300 lbs is extremely bulky and difficult to maneuver. Moreover, surgical lights to be used for open procedures were unfortunately placed too far from the table and never could be positioned directly overhead. This remained a frustration throughout the years and proved difficult to correct because of the structure of the roof, the immobility of the fluoroscopy unit supports, and the maximum length that could be put on each supporting arm. In addition, the original concept of the fluoroscopy unit was for it to have the mobility to be positioned against the wall and completely out of the way when the room might be needed for a rare totally open operation. This degree of mobility was never fully available. We were determined to correct these flaws in the new room.

In addition, our experience in the cardiac catheterization lab allowed us to understand that patient prep, stretcher availability, proximity of the prep area to the endovascular suite, and minimizing turnover time between cases are all extremely important to overall room efficiency. Our overriding goal was to take this level of catheterization lab efficiency and place it in an operating room environment. Although this was much easier in the design portion of the project, convincing the operating room staff that this really is a "procedure room" and not an "operating room" would prove to be much more challenging.

THE BEGINNING

One of the first and most important strategic moves in building an endovascular suite is to build a successful

Sample Endovascular Proforma

	Current*		Projected FY 07**		FY08***		FY09****	
	Part A	Part B	Part A	Part B	Part A	Part B	Part A	Part B
Inpatient Surgeries								
Hospital Employed Physicians	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Other Physicians	XXX		XXX		XXX		XXX	
Outpatient Surgeries	XXX		XXX		XXX		XXX	
Hospital Employed Physicians	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Other Physicians	XXX							
Vascular Laboratory Diagnostics	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Net Patient Service Revenue	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Endovascular Suite								
Salaries - Additional Staff				XXX		XXX		XXX
Fringe (22%)				XXX		XXX		XXX
Nonmedical Supplies				XXX		XXX		XXX
Maintenance & Repairs	XXX		XXX					
Outside Training	XXX		XXX					
Other	XXX		XXX					
Subtotal - Operating Expense	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Net Income before Capital	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Depreciation & Amortization				-		-		-
Net Income before Overhead	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Overhead	-		-		-		-	
($XXXX for input, $XXX for output)								
Net Income/Loss	-	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Combined Income/Loss	XXX		XXX		XXX		XXX	

Notes:

* - 11 endo cases/week for 42 weeks ** - 17 cases/week for 42 weeks *** - 21 cases/week for 42 weeks **** - 23 cases/week for 42 weeks

Figure 3. The financial pro forma.

Figure 4. The control room.

vascular program. This not only involves open vascular surgery but endovascular procedures, as well. It involves building relationships with other surrounding general and vascular surgeons to strengthen referral patterns, and it frequently involves community outreach and building an awareness of vascular disease. Perhaps most importantly, it involves the support of the hospital administration; the project will not be successful without this. The Chief Executive Officer, Chief Operating Officer, and Vice Presidents involved in the vascular program are critical elements. Often, before the hospital administration leaders will commit to the major funding required for an endovascular suite, they will want to see firm commitment to endovascular procedures either performed in the operating room with portable equipment or in existing interventional or catheterization lab environments.

THE CONCEPT

One must begin with a concept or vision of what the program will become. For example, what type of interventional room do you want? What kind of staffing will be necessary in this room? Do you want around-the-clock coverage? Will the room be used strictly as an interventional room, or do you want the ability to perform hybrid and open cases, as well? What type of preprocedure prep area and patient flow are required? Finally, what type of postprocedure recovery area is necessary?

The most important question when considering the design of the room is, "What do you want to accomplish with the new endovascular suite?" In our case, we wanted the ability to bring a patient with a symptomatic aneurysm directly to the endovascular suite, perform a quick CT, immediately decide if the patient is an open or endovascular candidate, and have the ability to do either procedure in that same room. Thus, our new room would need to be located in the operating room environment, have full open surgical capabilities, and full anesthesia support; our system would also need to have the ability to perform a CT.

In addition, after years of performing procedures standing within several feet of a portable C-arm unit, we now wanted the ability, in most cases, to stand in the protected control room during acquisition runs. Other decisions, such as a fixed, always-on intravascular ultrasound (IVUS) unit attached to the table (with the controlling computer located in the control room), lighting, and space-saving built-in cabinets, allowed for the entire concept to come together (Figure 2).

TRAVEL

A key part of any conceptual design is to visit other cities and other institutions that have done what you are trying to do. Listen to what works best for them and what they would have done differently. Pay careful attention to their room design and layout, what type of storage space they have, whether the floor-mounted or ceiling-mounted units work best for them, how they handle the patient flow and anesthesia services, what their control room looks like, if they have enough room, the type of inventory control and storage they have, or if they use barcodes or infrared technology.

Storage capabilities are especially important. Often, with budgetary cuts and restrictions, minimal personnel will be in the room, and therefore, you do not want people having to leave the room to get a catheter or other device not located in the room. Cabinets with glass fronts that allow the nurses to look inside and quickly locate catheters and wires are particularly useful. In addition, catheters and balloons designed to hang and be pulled out for quick retrieval are important. Install as many cabinets as the room can hold; you will fill them. Inventory control and reporting are sometimes overlooked but can play a critical role in the room's efficiency. These rooms are heavily inventory driven, and reordering and restocking used wires, catheters, balloons and stents, are critical. Barcoding or infrared inventory control are modern solutions to such a problem. In institutions that perform an extensive amount of endovascular grafting, storage and security are especially important. These devices are extremely expensive and usually should be kept in a secure environment. A specific area or room outside the endovascular suite is probably appropriate for storage of these components. Preplanning of any endograft procedure plays a critical part, and therefore, the possible components are usually well known before the procedure and can be pulled from the storage area and placed in the endovascular suite.

THE PRO FORMA

The hospital administration will likely ask you for a pro forma, which will include what you will need to open such a room, what are the construction and start-up costs, what types of procedures will be performed, and what is the estimated income and expenses. Being as complete as possible with this equipment list and pro forma will help your administration support their position to the hospital board. On the equipment list, include everything that will be needed in the room: the table, monitors, IVUS, anesthesia machine, cabinetry, overhead lighting, fluid warmers, furniture, computers, instrument trays, shelving, and the lead aprons (Table 1). Do not forget to take into account any additional staff that might be necessary, including salaries and fringe benefits, as well as any outside training that might be required; also take into account estimated maintenance and repairs of the equipment. Typically, what is shown in the pro forma is a 3-year plan of projected combined income and loss. Rooms such as this will normally have a loss within the first year, quickly becoming profitable in the second and third years. You will be asked to estimate how many cases can be done in the room and how many additional cases this room will generate. One must consider that with a room of this design and with the increased efficiency and decreased turnover time, many additional daily cases will be performed when compared to a typical operating room environment.

Figure 5. Glass fronts on the cabinets allow items to be quickly located without searching (A). Pull-out hangers allow the circulator to find the correct catheter easily (B).

Figure 6. The surgical lights.

You will be asked to estimate the staff that will be needed to run such a room. This will usually vary depending on each individual environment. However, the typical basics would be a circulating nurse, a conscious sedation nurse, an operating room or scrub technician, and an x-ray technologist or two to run the fluoroscopy equipment. Do not forget to include a nurse manager or a service line coordinator if you think the projected program growth supports it. In addition, if prep or postprocedure areas are being incorporated, include those personnel, as well as a scheduler. Include an estimate of salary and benefits for the projected 3-year plan. Obviously, all of this must add up to a net gain for the hospital, or the administration will not be interested in your project. The hospital will usually accept a first year in the red knowing that the program will need "ramp-up time" (Figure 3).

THE ROOM DESIGN

It is key for you to stay involved throughout the entire project. You must attend every meeting possible and keep on top of every detail. It is your room, and no one will benefit more than you when there is a well-designed, efficient, and patient-friendly room to perform your procedures. One of the first meetings that you will be involved in is a planning meeting with architects to not only design the room but to also plan for the location. As mentioned previously, our preference was in the operating room environment. The next important decision will be to pick the fluoroscopy system. This will critically influence the room design. Whether one decides on the floor-mounted or ceiling-mounted system, make sure that the architectural team is familiar with the difference and the square footage required for each system. Ceiling height is a crucial dimension for both floor-mounted and ceiling-mounted fluoroscopy units and will often dictate the location of your room.

During the design, pay particular attention to the control room (Figure 4), storage space, and built-in cabinetry (Figure 5), as well as any future plans for additional endovascular suites where a common location might be possible. If an additional endovascular suite is planned, make sure the location of this room anticipates the future locations of the second room.

Typically, the manufacturers of several fluoroscopy systems are brought in to give a demonstration to the design team. Listen carefully to their presentation and ask numerous questions. Focus on the advantages of their system compared to others. Bring them back a second or even third time before making a final decision. During the site visits to other institutions, you can ask what they like about their individual systems. Pay particular attention to

the table design. Is the table capable of holding a patient in the Trendelenburg position? Reverse Trendelenburg? Does it bank to the left and right, and can it be swiveled out of the way? Can rails be placed on the sides to accommodate self-retaining retractors, such as the Omni Tract (Omni Tract Surgical, St. Paul, MN)?

The room lights deserve special mention. Typically, there are two types of lights that are necessary in such a room. First, there are the major surgical (operating) lights used for any open surgical exposure (Figure 6). Critical features of this type of lighting involve the ability to reach completely across the operating room table, as well as head heights and collision paths. Computerized designs from the manufacturer often can predict the range of such lights and where they should be anchored to the ceiling (Figure 7). Many lights have the ability to have a small (endoscopy) light on the opposite side, as well as special features, such as closed circuit camera and video capabilities.

Generalized room lighting can be incandescent or fluorescent. Pay particular attention to the capability to dim these lights (often automatically) during fluoroscopy. Bright white lights will often cause glare when trying to view the monitors, and orange, yellow, or green lighting can be used to prevent such glare (Figure 8).

One of the most complex and often confusing facets of the endovascular suite design is the interface of the multiple technologies necessary in such a room. Will the fluoroscopy unit interface with the physiologic system necessary to monitor the patient's blood pressure and heart

TABLE 1. ENDO SUITE MINIMUM EQUIPMENT REQUIREMENTS

Device	Manufacturer	Quantity
Cart, resuscitation	The Harloff Company, Inc. (Colorado Springs, CO)	1
Defibrillator	Physio-Control, Inc., a division of Medtronic, Inc. (Redmond, WA)	1
Glove and apron rack, multi-apron	GE Healthcare (Wauwatosa, WI)	1
Illuminator, 1 X 4	GE Healthcare	1
IVUS	Volcano Corporation (Rancho Cordova, CA)	1
Anesthesia machines	Dräger Medical, Inc. (Telford, PA)	1
Cart, anesthesia	Blue Bell Bio-Medical (Van Wert, OH)	1
Curtain, laser block	Kentek Corporation (Pittsfield, NH)	1
Flowmeter, air	Ohmeda Medical, a division of GE Healthcare (Madison, WI)	4
Flowmeter, 02	Ohmeda Medical	3
Illuminator, 2 over 2	GE Healthcare	1
Imaging, angio system	Siemens Medical Solutions USA, Inc. (Malvern, PA)	1
Infusion system/injector	ACIST Medical Systems (Eden Prairie, MN)	1
Lights, dual-head surgical, inclu. camera	Berchtold Corporation (Charleston, SC)	2
Med gas boom	Berchtold Corporation	1
Ceiling column	Berchtold Corporation	1
Monitor arm w/keyboard tray	Ergotron Americas (St. Paul, MN)	1
Patient monitor	Dräger Medical, Inc.	1
Refrigerator, undercounter	Jewett Inc. (Buffalo, NY)	1
Regulator, continuous suction	Ohmeda Medical	5
Regulator, suction	Ohmeda Medical	1
Warmer, fluid	Covidien (Hazelwood, MO)	1
Waste receptacle, Big Brute w/wheels	Rubbermaid (Atlanta, GA)	1
Stools		5
Computers		3
Linen hampers		2
Prep table		2
Instruments tray		1
Misc. furniture, shelving, lockers		
Lead aprons/vest		4
Site-Rite ultrasound	Bard Access Systems, Inc. (Salt Lake City, UT)	1
Stretchers	Stryker Corporation (Kalamazoo, MI)	3
Sensis	Siemens Medical Solutions USA, Inc.	1

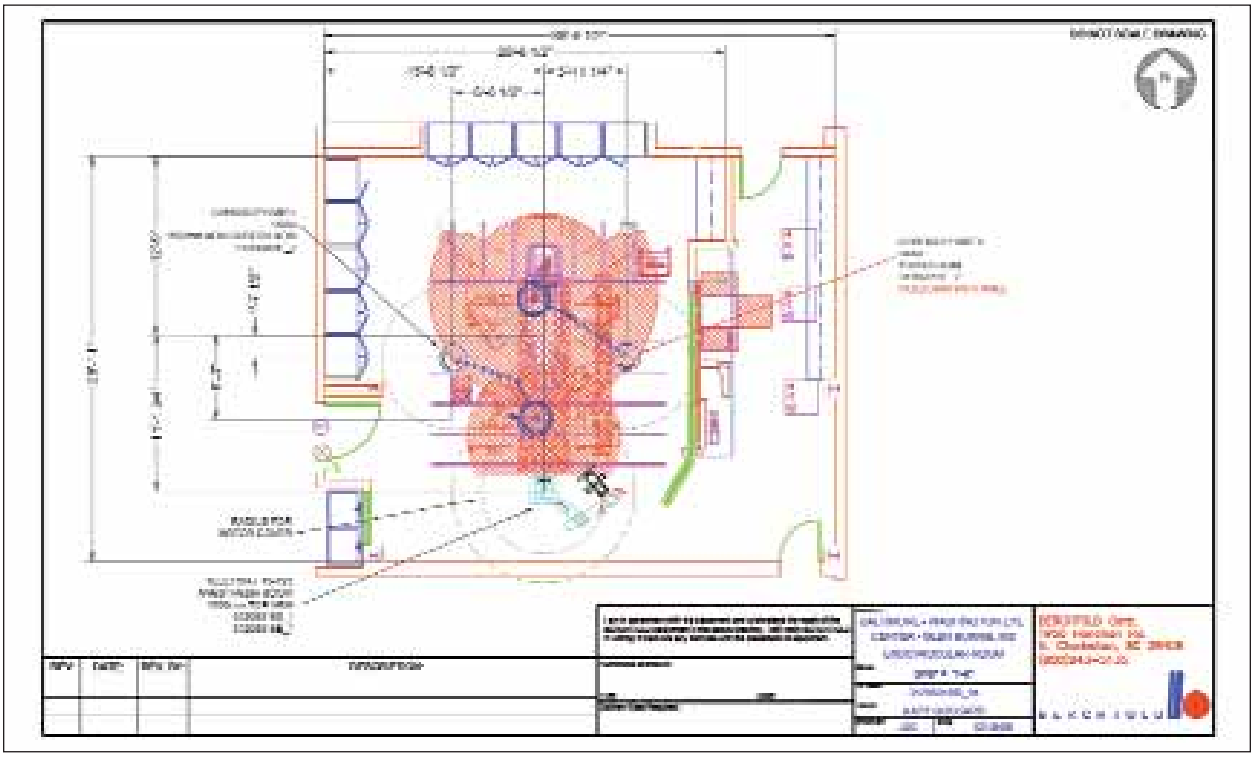

Figure 7. The computerized light clearances.

rate? How about the interface with any IVUS, PACS (picture archiving and communication systems), or hospital information system? These systems will rarely "talk" to each other, and an interface will be necessary (Figure 9). Do not forget to include your local IT group, as well as the IT experts from all the various instrument manufacturers, in your meetings. One of the most important facets for the successful completion of the entire project is your relationship with the general contractor. Ultimately, he will be building what you want, and a close personal relationship with daily visits is mandatory. By seeing the progress each day, you will pick up things that can often be corrected during the construction, such as the wrong location for x-ray view boxes or the proper location for electrical outlets, telephone, and computer hookups (Figure 10).

STAFFING YOUR NEW ROOM

The staffing of the modern endovascular suite is perhaps the most important aspect of the functioning of the

Figure 8. The green lights prevent glare off of the monitors.

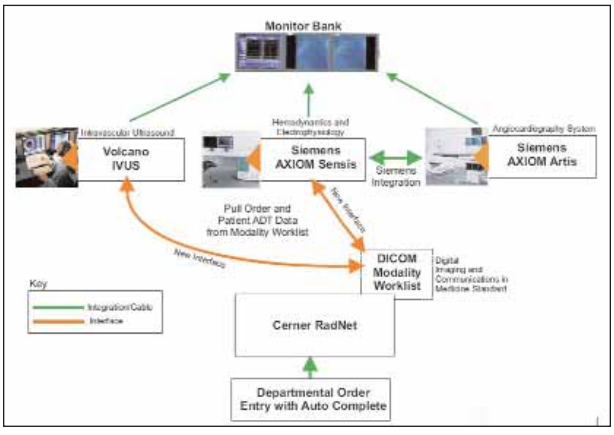

Figure 9. Your IT department will need to design interfaces to allow all of the systems to communicate with each other.

Figure 10. Inspecting the room each day as it develops will help you with any changes along the way.

Figure 11. The completed project.

room. The room can have the most beautiful design with the most modern equipment, but if it functions inefficiently, everyone will be frustrated. Because of limitations, our first endovascular suite in a major university setting was staffed with general operating room personnel. Although very knowledgeable in general surgical principles and sterile technique, there was little understanding of endovascular techniques and the efficiency of a procedure-oriented room. In addition, anesthesia services, including an anesthesiologist and anesthesia resident, were required on every case. These factors significantly diminished the overall room efficiency. Turnover times of 60 to 120 minutes were commonplace. This type of inefficiency is frustrating for surgeons and patients alike. Moreover, patients undergoing endovascular procedures do not need to be included in the preoperative workup that is typically performed in the ambulatory prep areas before major open surgery. This proved to be yet another stumbling block to increased efficiency.

Our second endovascular suite was designed with a new concept. Again using the model of a catheterization lab in the operating room environment, a separate ambulatory prep area specifically for the endovascular patients was included in the design. In addition, a dedicated staff, well versed in endovascular techniques, was critical to the plan. The model of a zero turnover-time room was constantly reinforced with the personnel. The concept of patients walking from the prep area directly into the endovascular suite eliminated the need for a stretcher and being taken to the room. Many patients walked into the hospital and walked into the prep area, so without any sedation and simply an IV, they should be able to walk back and get on the endovascular suite table. A stretcher waiting area, capable of holding patient transport stretchers, was designed to be just outside the endovascular suite door, eliminating the need to constantly search for stretchers to transport patients from the endovascular suite. These concepts combined will increase the efficiency of the new procedure-oriented endovascular suite.

Pay particular attention to selecting the right staff, making sure they are happy and share your vision. Getting a jacket for all vascular team members goes a long way to showing your commitment to the staff.

THE FINISHED PRODUCT

Planning an endovascular suite is not easy. It is time consuming and can be frustrating.

Construction alone often takes 6 to 12 months, and the planning process begins years before. Our entire project from concept to the first case took nearly 3 years. But, once you have performed your first case and have seen the entire project come together, it will be worth it. You and your staff will benefit from the new environment, with its modern equipment and increased space. Your hospital administration will appreciate the increased efficiency and quality of care. You will be amazed at the imaging that is possible with modern technology, and most importantly, your patients will certainly appreciate the efficiency and convenience of having their procedures performed in your new endovascular suite (Figure 11). ■

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