MEET THE CHALLENGE: AORTIC CENTER STRATEGIC PLANNING, INVESTMENTS, AND TACTICS

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The development of a comprehensive aortic center should start with a thorough planning process that first collects information. Both a market analysis and institutional analysis that identifies strengths, weaknesses, and opportunities are a good starting point, informing an aortic center's vision and steering its direction before making capital requests and team investments. It is important to know the characteristics of your market—patient demographics as well as referrer demographics to understand established referral patterns. This understanding can serve to guide institution-specific strategies to establish or renew existing relationships with primary care physicians and to offer aortic screening to the community.[1] It is important to be aware of all long-term clinics in the area and the transport flow among them, including which facilities care for acute aortic syndrome, for example. A market analysis should reveal epidemiologic trends of aortic disease in the targeted population, the degree of awareness and diagnosis of aortic conditions, and estimates of patients who would benefit from the expertise of the aortic center.

Performing an institutional inventory and assessment can help an institution anticipate barriers, clarify community and peer perceptions, and seize opportunities for building collaborative teams internally and externally. SWOT analysis can be useful because it asks important questions that are self-reflective of the institution and its allies and can be used to identify strengths and weaknesses internally, many of which can point to both internal and external opportunities and threats (Figure 1). All institutions have system and team challenges and recognizing them is critical to doing the important work of patient care.

A SWOT analysis can be especially useful in exploring human factors in any health care organization.

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Unfortunately, medical errors can and do occur,[2,3] the majority of which occur in high-intensity care areas, such as in surgery and intensive care.[4] Medical errors may be the result of mistakes at the team and individual level. For instance, a 2015 study reported that medical errors were associated with nursing staff bullying.[5] There are a variety of technologic innovations to reduce errors that are system- or provider-based electronic or human process measures. Radiofrequency identification tagging has emerged as a method to monitor patient location,[6-8] and automatic drug devices and handoff programs have been used to combat errors in drug and transfusion delivery.[9,10] However, barriers exist that prevent these same innovations from being adopted.[11] Human factors should therefore be anticipated and planned for in the process of developing a comprehensive aortic center, and these system or team weaknesses can be identified in a SWOT analysis.

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tic center consists of stakeholders representing multiple disciplines, it is important to meet with all stakeholders in the SWOT process, which could perhaps be arranged at opportune times, such as protocol and order set review or in individual or group interviews.[12] Traditional SWOT analyses can benefit from integrating stakeholder expectations with current or projected institutional resources needed to meet those expectations.[13] This can open the door to planning an aortic center in a deeper, more meaningful way, answering questions like: "What are stakeholder expectations for an aortic center?" "Can the organization deploy resources (people, finances, capabilities) to meet these stakeholder expectations? Can it be sustainable?" "What factors influence expectations and resources?"

COLLABORATION: PATIENTS, TEAMS, AND SYSTEMS

Collaboration enables individuals to work together to achieve a shared goal. One key type of collaboration is the interaction of a health care team member with a patient and his or her family, a relationship all others are based on in the health system. Patient buy-in is critical since patients perceive risk differently, each interpreting words like "high" or "low" risk differently given that they bring their own insight, education, values, and inclinations to every interaction.[14] The aortic team's interaction with the patient should always be based on respect and cultural sensitivity,[15] engaging the patient to encourage his or her active participation, and should transcend perceived professional hierarchies and boundaries.[16]

Respectful interaction can help avoid antagonistic interactions that could escalate to a liability.[17] The communication of risk should not be overgeneralized or glossed over, but instead tactfully geared toward the values and needs of the individual patient. Patients may be uninformed, confused, and/or conflicted on which procedure to choose and the weighing of benefits and harms. A 2014 systematic review reported "high-quality evidence" that decision aids (vs usual care) can be helpful in assuaging this decisional conflict when patients face treatment or screening.[18] Thus, it is critical to be receptive to patients and listen, understand with empathy, educate persuasively, and pres-

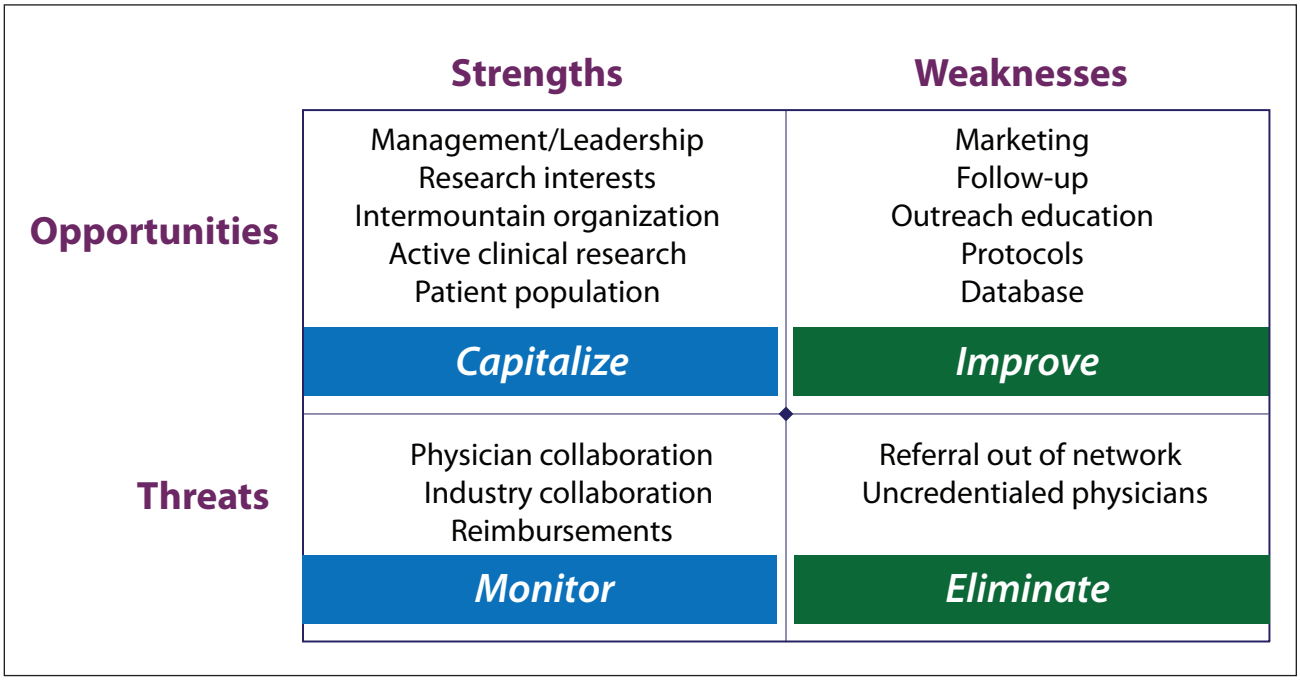

Figure 1. Sample SWOT analysis for a developing aortic center. This analysis highlights areas of opportunity to capitalize on existing strengths and monitor external threats to the hospital system's business model, while improving upon known weaknesses and eliminating threats where possible.

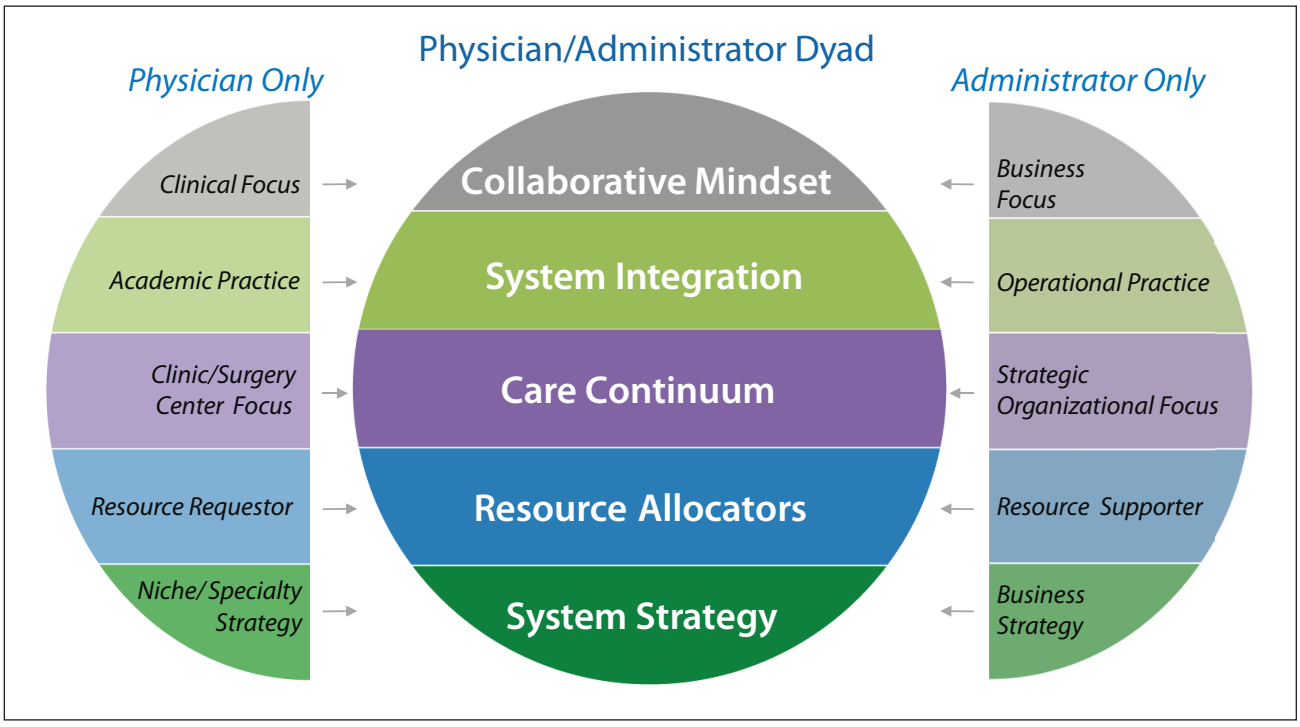

Figure 2. The physician-administrator dyad—collaboration based on core strengths.

ent decision aids to reinforce patients with confidence. Teaching institutions developing an aortic program should also be prepared in this regard to patient interaction. Although patients generally have favorable perceptions of teaching hospitals and usually welcome interaction with surgical residents and fellows, all patients still need to be oriented to the aortic team and informed by the aortic team to maintain confidence and trust.[19]

Collaboration may be inter- and intraorganizational in nature. One example of interorganizational (system-level) collaboration is the experience of a consortium of several hospitals in northern Ohio that collaborated with two large hospital systems and local emergency medical services.[20] They adopted a trauma protocol and 2 years later compared mortality rates with those from 2 years before the policy was implemented. Mortality was reduced as much as 40%. Another example of either intra- or interorganizational collaboration is the linking of redundant electronic medical record (EMR) systems among partnering organizations to pool data resources and backup systems to prevent data loss, which can allow health services to continue in case of unplanned shutdowns.[21]

One of the most important intraorganizational interactions is that of the physician and administrator. Physicians have a responsibility to understand the mind-set of administrators, who are typically data and goal driven, business and strategically oriented, driven by the system's strategic direction, and who may not initially be aware or convinced of the clinical benefits of what they may consider a niche program. Administrators likewise have a responsibility to understand the role and goals of the physician, including their clinical, surgical, and academic/research expertise, as well as their resource needs. The confluence of strengths and focus between these two roles is illustrated as a dyad schema of leadership (Figure 2), in which common goals of a collaborative mind-set, system integration, continuum of care, and appropriate resource allocation are achieved for the benefit of advancing the aortic program's vision to support the health system's strategy. This dyad-based leadership should be established as early as possible in aortic center development to (1) identify needs specific to the aortic center vision (ie, reviewing its current and future state via SWOT, consider patient impact and clinical benefits, and identify operational efficiencies); (2) determine the planning/design team (ie, using a multidisciplinary approach by identifying team members and aligning to strategy with operational resources and throughout implementation process); and (3) actually plan the aortic center with the creation of a business proposal, a financial pro forma, and to map the care delivery model.

The multispecialty team is one of the most critical components of a comprehensive aortic center. In addition to surgical expertise in both cardiac and vascular surgery, other clinical specialists such as cardiologists, radiologists,

and geneticists are important to a successful center. Each specialty provides a clinical perspective and service that allows the center to manage and treat the most complex patients. Successful aortic centers must foster opportunities for this multispecialty team to collaborate and manage as a team.

Regardless of whether multiple organizations are involved, multidisciplinary meetings can be very helpful to get buy-in from all stakeholders and reach agreement on key questions, guide best practices, and make recommendations. However, attendance to multidisciplinary meetings focusing on integration of care has been notoriously underfinanced in chronic care models.[12] These meetings should be a higher organization priority, since they can provide a structured, organized forum for sharing important perspectives of roles from each department, present cases and examples highlighting unmet clinical needs, and the critical sharing of ideas and perspectives to advance an aortic center.

Meetings should take place frequently to adapt to the working needs of all represented stakeholders, and a clear agenda should be prepared, but allow for open discussion. Other discussions may include refining logistics; mobilizing the team and team assignments; health technology requirements, including data entry expectations; procedure and room preparation and equipment requirements; guided treatment decisions; and other resource-related questions. Important team members may include physicians (radiology, surgery, cardiology, interventional), ancillary staff (physician extenders, schedulers, coordinators), research personnel (who help orchestrate potential trial candidates), fellows, residents, and students—any professional who has a role and stake in the outcome of improving patient care.

BARRIERS TO COLLABORATION

There are known barriers to collaborative team interaction, particularly in the context of a rapidly evolving patient system centered on the patient medical home. A 2013 systematic review of 44 studies reported barriers to interprofessional collaboration. Although team members may buy into the need to collaborate to improve patient care, this is not enough to produce effective collaboration. Significant barriers were reported across studies, including challenges to roles and definitions, undermining team building and professional training, breaches in confidentiality, and inadequate information sharing and willingness to take responsibility.[16] Several barriers to the adoption of surgical quality programs were reported in a 2015 article by key members of a multidisciplinary perioperative care team (n = 55; 19 general surgeons, 18 anesthesiologists, 18 nurses). The majority of the team reported that while they supported the Enhanced Recovery after Surgery (ERAS) program at several University of Toronto-affiliated hospitals,[22] there were several barriers to optimal team function, including: (1) a lack of manpower, (2) suboptimal team interaction, (3) disagreement with the program's goals, by what may be characterized by an "old-school" recalcitrance or resistance to change, and (4) patient factors. The authors suggested that barriers could be anticipated proactively by better clarifying best practices and supporting guidelines, clarifying protocols and order sets, and improving team and patient education.[22]

The need for highly skilled aortic operators has increased dramatically over the past 2 decades as endovascular techniques and devices have been increasingly used and preferred in a number of clinical scenarios and pathologies. Acquiring skills should be a priority for all physicians, not just residents and fellows.

Although patient satisfaction is an important qualitative metric for any aortic center, the importance of employee work satisfaction may not be as appreciated as a factor in the total equation of care quality. Work satisfaction is the result of dynamic interpersonal and interdisciplinary interactions every day an employee comes to work. There may be several barriers along these lines that affect work satisfaction and, perhaps to some degree, work effectiveness. A 2012 survey of surgeons (n = 32) in Canada identified barriers to and facilitators of surgeon work satisfaction.[23] Primary barriers reported were lack of access to resources and a perceived disconnect with hospital administrators regarding practice priorities that hampered patient care.

On the other hand, positive, supportive aspects of work satisfaction were also reported. The greatest source of surgeon satisfaction was the effective and timely resolution of patient problems. Another important source of career satisfaction came from professional interaction with colleagues and patients who were supportive of their role. Work satisfaction may therefore impact the delivery of high-quality patient care, with key barriers being lack of professional engagement or being "out of touch" with patients and colleagues. Turnover may also potentially disrupt the formation of a well-functioning care team, the continuum of patient care, and the institution's advancement toward its goals.

TABLE 1. TEN CONSIDERATIONS IN HYBRID SUITE DEVELOPMENT AND MANAGEMENT

Consideration	Factors to Evaluate, Choose, or Implement
Create an environment of care	• The physical space: functional relationship to adjacent surroundings, including the preoperative and postoperative/postanesthesia unit, other ORs, waste disposal and restrooms, and storage • Equipment: Diagnostic, procedural, and safety equipment; electrical support and backup; and information technology integration • Personnel: Trained and knowledgeable in technologies and procedures
Design logically	• Locate suite in area contiguous to both OR and interventional suites for improved access in case of complicating events • Locate away from noise and artifact generating • Temperature, humidity, air-exchange requirements • Larger room size to accommodate for access and movement of the patient and multidisciplinary personnel • Lighting capabilities • Imaging: 10-ft floor-to-ceiling height to accommodate imaging equipment; decide on floor- or ceiling-mounted imaging
Retrofit an existing OR	• 1,000 sq ft and 1,200 sq ft needed • Design separate control room to minimize unnecessary radiation • Increase wall lead lining from 0.5 mm (standard in ORs) to 2 mm to 3 mm, depending on state regulation
Decide on equipment/instruments	• Determine if equipment systems should be floor-mounted or ceiling-mounted (eg, most hybrid OR suite planners opt for mounted fluoroscopy systems over mobile fluoroscopy) • Bed considerations include manual operation or controller only if cord is damaged or malfunctions; does fluoroscopy/angiography require mobile or stationary bed?; Rails or arm board-capable bed for open surgical conversion?
Build a hybrid OR team	• Knowledge and expertise in vascular surgery, interventional radiology, and cardiology (all personnel, including nursing and medical personnel, internists, and generalists) • All members to agree to multidisciplinary approach to standard operating procedures • Staffing requires cross-training of skills needed from both surgery and interventional radiology • Continuing education and annual competencies should address standards of care, organizational and regulatory changes, and new technologies; quality management program needed
Select an anesthetic agent	• General vs regional anesthesia
Emphasize the preoperative assessment	• Preoperative assessment to anticipate complications (eg, renal dysfunction, allergies to contrast media, thrombolytic agent use)
Emphasize the perioperative nurse's role in procedural care	• RN circulator responsible to assess, plan, implement, and evaluate patient care; surgical counting, including instruments and monitoring contrast used
Adhere to guidelines for radiation protection	• Avoid pulsing by using multiple still images • Refer to last image (last image hold) • Confine x-ray beam to smallest area (collimation)
Identify financial considerations	• Anticipate startup costs; first-year estimates typically show a loss • Cost for retrofitting existing OR • Cost justification dependent upon patient population, estimated volume • Cost of fixed vs mobile systems; fixed system cost may be clinically justified if other specialties require it • Cost of sterility maintenance

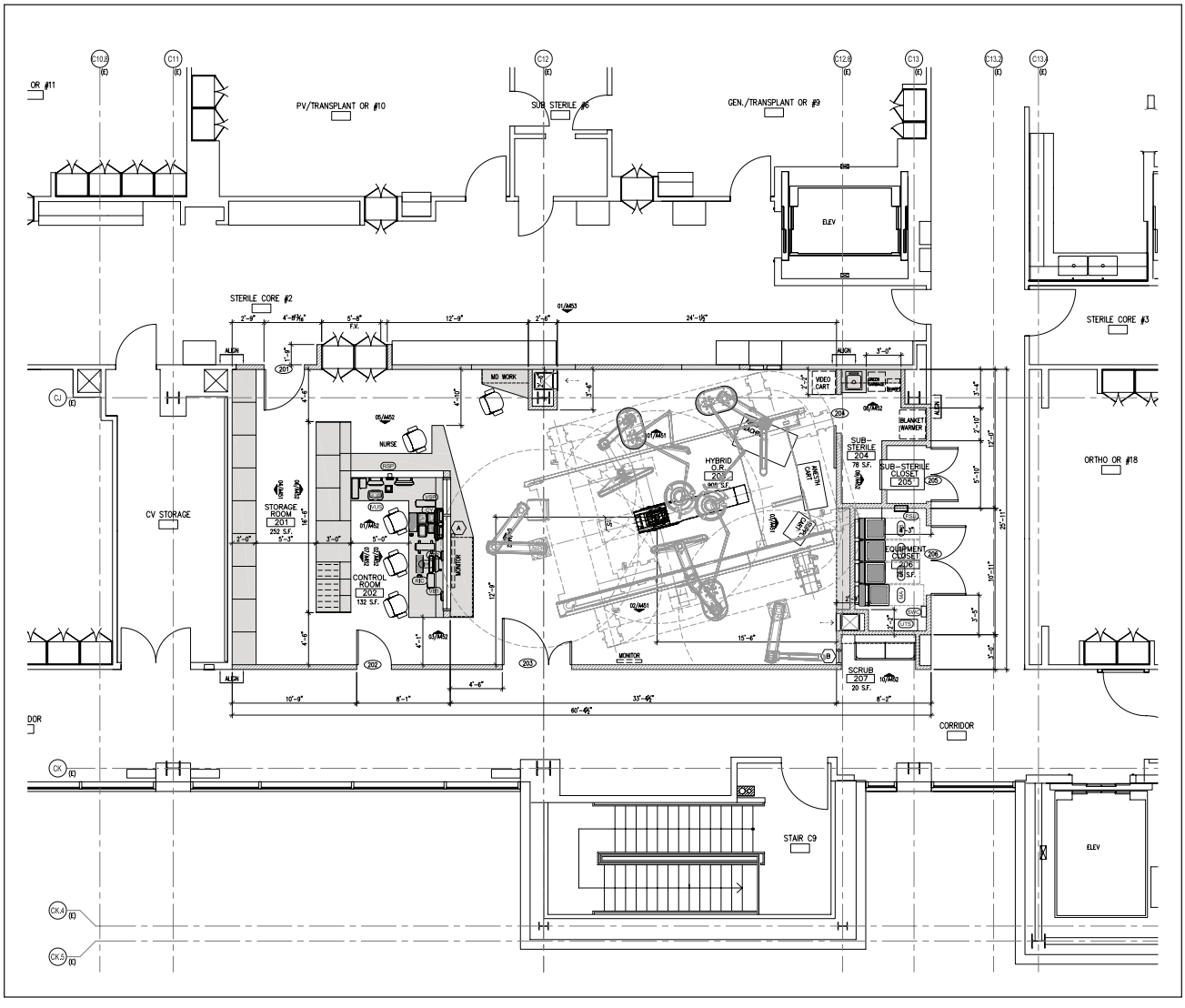

Figure 3. Floor plans of Intermountain Healthcare's dedicated endovascular/OR hybrid suite (Intermountain Medical Center, Murray, Utah). Construction began February 21, 2015, and scheduled completion is mid-August 2015. The blueprint shows the retrofit conversion of two OR spaces creating a single, longer workspace. Diagonal configuration of the patient bed was a creative solution given this suite's spatial dimensions, accommodating all necessary equipment while optimizing flow of personnel and patient traffic. Retrofit construction included increased shielding reinforcement and integration of load-bearing structural elements. This blueprint also highlights the suite's adjacent proximity to other ORs (general/transplant, top), the separate control room for procedure monitoring (left interior), storage (left of control room), and the location of the sub-sterile and equipment closets (right).

Good communication practices among health care professionals can address or even prempt these issues. These practices include open, bidirectional communication, in which colleagues and patients clearly understand roles in the delivery of care privacy laws. Raising colleague and patient awareness of current or potential problems allows those problems to be resolved openly, collaboratively, and inclusively—as long as participants are pursuing and/or inventing "options for mutual gain."[24] A leader can champion these facilitating factors to counteract barriers, such as uncertainty of roles and fragmented or interrupted team communication, ultimately preventing disagreements and tension.[25]

Identifying organizational weaknesses at the interpersonal level can be difficult, particularly when addressing interpersonal skirmishes or breakdowns. Identifying areas where health care professionals—whether they are physicians, nurses, or administrators—can improve their job effective-

TABLE 2. LIST OF PROCEDURES PERFORMED IN HYBRID OPERATING ROOM[28]

- Endovascular abdominal aneurysm repair
- Endovascular thoracic aneurysm repair
- Hybrid arch reconstruction
- Transfemoral aortic valve replacement
- Transsubclavian aortic valve replacement
- Transapical aortic valve replacement
- Endovascular mitral valve repair
- Transpulmonary valve replacement
- Transapical neochord replacement for mitral valve repair
- Hybrid Maze procedure
- Atrial septal defect with septal occluder
- Ventricular septal defect with septal occluder
- Endovascular repair of coarctation of the thoracic aorta
- Hybrid coronary revascularization with coronary angiogram
- Atrial fibrillation/flutter ablation
- Carotid artery stenting/carotid endarterectomy
- Peripheral vascular stenting
- CABG procedures
- Minimal invasive aortic valve/mitral valve procedures
- Hybrid therapies for congenital heart diseases
- Pacemaker/automatic implantable cardioverter defibrillator implantation
- Neurovascular interventions
- Interventional bronchoscopy
- Endoleak coiling
- Diagnostic angiography
- Intravascular ultrasound

ness and competency of care may be just as challenging. Finding the "teachable moment" is one potential strategy for both managers and employees and can appeal to each professional's commitment to self-education. A 2014 survey reported that when 74 licensed clinical instructors were asked about teachable moments,[26] two distinctive types were provided: flexible and inflexible. Recognizing these moments and whether or not intervention would yield a positive outcome may be an instructive organizational tact.

SURGICAL SIMULATION TRAINING FOR PHYSICIANS AND THE TEAM

The need for highly skilled aortic operators has increased dramatically over the past 2 decades as endovascular techniques and devices have been increasingly used and preferred in a number of clinical scenarios and pathologies. Acquiring skills should be a priority for all physicians, not just residents and fellows. But continuing education can be challenging, as it may require time away from work and involve complicated logistics of setting up on-site proctorship visits. Fortunately, a number of simulators are available that can help in the initial steps of developing procedure competency before performing a live procedure.

Simulators can approach realistic surgical conditions in a safe way without impact on a patient. They keep the focus of the activity on the learner, and simulations can be repeated as many times as necessary to achieve competency. They can be useful for centers and training programs to provide feedback allowing trainers to objectively assess trainee surgical skills and competence. Simulators can record metrics to be monitored over repeated sessions. Amount of contrast, number of devices selected, and duration of procedure and other recorded measures allows trainees to set goals for improvement in repeated tests and become proficient in multiple surgical scenarios.

Simulations can also be very effective for teams training to work together more efficiently. It has been posited that procedure simulators may in the future be used for board examination and certification and as part of the physician credentialing process.[27] Specialty boards require a number of cases to be performed every year. If a physician is up for recredentialing and has five cases fewer than what is required, perhaps the remainder could be satisfied with simulator tests.

Industry has played an important role in the development of simulators, based on the need to facilitate training for their own devices. For example, Medtronic's program simulates several of its products for endovascular aneurysm repair (EVAR), thoracic endovascular aneurysm repair (TEVAR), or peripheral vascular applications. Medtronic's simulation program uses the Compass™ (Compass is a trademark of MSC) and Simbionix Module systems, both of which have been featured at international conferences. These systems are also transportable to institutions for training. Residents and fellows can enter the program and debrief individually or as a team with their attending physician. Learning is progressive, and repeated simulations can yield dramatic reductions in duration of cases.

RESOURCE INVESTMENT FOR THE LONG TERM

The Hybrid Suite as a Dedicated Endovascular Environment

The hybrid operating room (OR) suite concept—the combination of an angiography suite and a traditional OR with high-field imaging and anesthetic support—has gained traction in recent years as a model of innovation.

The concept of a fully automated med pod is still the musings of science fiction, but the idea of consolidating modern surgical techniques into one centralized interventional arena has become a reality. Although these types of operating suites have been used for several years, they are only now coming into more mainstream use as they are increasingly viewed as a necessary component of an aortic center rather than a mere luxury. An aortic center should strive to provide all available diagnostic and treatment options for each patient in an efficient and dedicated manner, and constructing a hybrid suite is a significant step to achieving that goal. There are several considerations in planning for and implementing a hybrid suite (Table 1). A hybrid OR retrofit project currently underway at Intermountain Medical Center (Murray, Utah) highlights several aspects of these planning elements to bring to fruition a creative hybrid suite solution specific to the facility's needs by combining two conventional OR suites (Figure 3).

A significant advantage of hybrid suites is that they can combine several aspects of multidisciplinary interventional care in a single operating theater, allowing both traditional open surgery and minimally invasive endovascular procedures on the same patient and at the same time and place, minimizing lost time and reducing risk of other complications like infections. They can be equipped to more efficiently treat a number of vascular conditions including blunt thoracic aortic injury, aneurysm rupture, infrarenal aortic aneurysms, thoracic aortic aneurysms, type A and B thoracic aortic dissections, iliac aneurysms, and other peripheral pathologies. Multiple procedures can take place in the suite with greater efficiency than in separate specialized OR suites. This "OR of the future"[28] can accommodate a wide range of procedures (Table 2). CABG can also be performed. Institutions with hybrid suites can attract clinical studies because new procedures are preferentially performed there, such as percutaneous heart valve replacement, carotid artery stenting, and lower extremity revascularization.

Cost can range from $1.2 million to $5 million depending on the capabilities and technologies installed.[28] A less expensive suite could be installed, but this may limit some capabilities or future software/hardware upgrades and additions. The construction of hybrid suites requires shielding of doors and walls and a control room. Having all or most interventional tools in a single operating theater may have significant advantages in health outcomes, including shortened procedure times, less use of nuclear imaging radiation, faster recovery times, reduced time in the intensive care unit, and shorter hospital stays.[28-31] The accurate visualization of pathology is one of the required tools to navigate vessels, great and small. The ability to recognize and landmark anatomic challenges is the key to guiding stents, catheters, and guidewires to prevent or minimize complications. The full range of imaging needed to support minimally invasive vascular techniques can be integrated into a hybrid operating theater: radiography, angiography, computed tomography (CT), and magnetic resonance imaging. CT fusion capability may also allow for decreased radiation exposure and need for contrast in complex aortic cases. Same-room imaging studies decreases the need for in-hospital transport, which presents additional risks due to the time needed to transport and risk of infection exposure. All of these advantages may lead to improved outcomes and lower costs per case.

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In 2009, Field and colleagues suggested that a hybrid suite's most meaningful advantage may be in the confluence of interdisciplinary efforts.[29] Highly specialized expertise can be found not only under the same roof, but in the same room where physicians can collaborate to direct benefits to patients. Hybrid suites are also suitable for emergency procedures in tandem with multidisciplinary cardiology, radiology, and surgical teams. The hybrid suite may therefore act as one of the centerpieces of collaboration for an aortic center, with all team members aligned for the patient's best interest. ■

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