OR of the Future

by Amanda Hankel

In minimally invasive surgery, technology, in a way, replaces surgeons' eyes, allowing them to see inside a patient despite only making tiny incisions. For some surgical specialties, this technology takes the form of a camera. For others, such as vascular and cardiovascular surgery, less invasive approaches have created a unique need for high-end angiographic imaging, fostering a new concept known as the hybrid OR.

According to Jay Ticer, CMRP, Senior Associate in the Applied Solutions Group at ECRI Institute, the advanced imaging found in a hybrid OR has its roots in the cardiac catheterization laboratory (cath lab) of the hospital – traditionally the domain of interventional cardiologists. In the mid-to-late '90s, vascular and cardiovascular surgeons began exploring minimally invasive approaches to procedures such as vessel repair. These procedures required the presence of fixed-base, high-end imaging equipment typically housed in the cath lab.

Clinicians soon realized the cath lab is not the best environment for these procedures, Ticer says. It is not built to OR sterility standards nor does it contain the staff necessary if a procedure needs to convert to open surgery.

As David Eustace, Business Development Manager at MAQUET, Inc., explains, today, if a patient is diagnosed in the cath lab with a condition that requires surgery, they must be transferred to the OR located elsewhere in the hospital or scheduled for surgery at a later time. Such inefficiencies can have cost and safety implications.

"Often, hospitals had an OR on standby in case of a crisis, so it wasn't generating any revenue," says Jim Norris, Senior Manager of Market Development at STERIS. "They had the room empty and a staff standing by just in case, which was very expensive. Plus, when an aneurysm bursts or a catheterization fails, they need to treat it immediately."

To reduce the complications associated with these minimally invasive procedures, a room was built to merge the fixed, high-end imaging capabilities of the cath lab with the sterility standards of a professional OR – a hybrid OR. It provides an operating room where a patient can undergo both open surgery and an interventional procedure. The presence of fluoroscopic imaging allows a multidisciplinary team of surgical and interventional clinicians to provide care to patients. As Eustace states, the room's design allows it to be easily adapted for multidisciplinary surgeries, helping to reduce patient risk and improve return-on-investment (ROI) for the hospital.

According to Sudhir Kulkarni, Director of the Hybrid OR Segment in the Angiography division at Siemens, the idea of the hybrid suite started with vascular surgery in the '90s with fixed angiography systems, but installations have increased rapidly in the past three to five years in the United States as the room's use has broadened to other specialties – particularly to cardiac surgery. According to Hanneke Naus, Business Development Manager, Philips Healthcare, BU Interventional X-Ray, new procedures such as trans-catheter valve replacement, which is currently in FDA trials, is driving this need. "These are true hybrid procedures," she says, "where advanced imaging techniques in a sterile room are necessary."

Currently, the main specialties using the hybrid OR are vascular and cardiovascular surgery, followed by neurosurgery. Trauma, pediatric, orthopedic and spine surgeons can also use the rooms' imaging capabilities. Statistics show that hybrid OR construction will only continue to increase. According to Norris, the hybrid OR is the "heart room of the future." A recent survey shows sixty percent of hospitals in the United States are either in the planning or thinking stage for a hybrid OR. Another recent study predicts approximately 75 percent of cardiovascular surgeons will be working in a hybrid suite in the next three to five years.

The 'hybrid' in a hybrid OR

While mobile c-arms have been wheeled in and out of traditional ORs for imaging for years, hybrid ORs require fixed imaging systems to ensure high-definition imaging for these closed procedures. It stems from the idea that in minimally invasive surgery, "the less you cut, the more you want to see," Kulkarni says. To allow surgeons to see all they need to during a minimally invasive procedure in a hybrid OR, the imaging system must be powerful enough to provide penetration and resolution that is superior to mobile systems or other forms of surgical imaging. The generators on mobile c-arms are simply too small to provide this power.

The hybrid OR merges the fixed, high-end imaging capabilities of the cath lab with the sterility of a professional OR.

"They're between 15 and 25 kilowatts," Kulkarni says, "which means that the x-rays they generate are not high-powered enough for penetration as well as resolution. You need high-powered x-ray in a hybrid suite, so the generator must be very big in terms of size, meaning it can't be mobile."

According Naus, the fixed systems also contain software to create 3D extrapolations from the 2D x-ray images that are taken.

"Instead of surgeons opening patients up and seeing what they're doing, they now go inside and look at monitors," Naus says. "They need excellent image quality – as good as can be – in 2D and with advanced visualization techniques. For example, pre-acquired CTA or MRA images can be re-used for roadmapping or to create a new soft tissue image in just a few minutes."

Furthermore, the imaging modalities in a hybrid suite can vary depend-

ing on procedure. The three most common types are:

- Angiography (X-Ray). Ticer mentions angiography can involve contrast studies performed using radiographic-fluoroscopic (R/F) systems. Other experts say R/F and angiography are considered separate systems.
- X-ray computed tomography (CT).
- Magnetic resonance imaging (MR).

Angiography imaging is commonly used for vascular procedures. Meanwhile, Ticer says, "If you are doing a tumor resection for neurosurgery, a MR/CT room will be better in terms of functions."

Kulkarni says the procedures being performed in the room will also drive whether a hospital chooses a single-plane or a bi-plane system. Single-plane systems are most often required for cardiovascular surgery, while bi-plane systems – providing the ability to view two planes simultaneously – are needed for pediatric and neurosurgery cases. Hospitals can also choose between ceiling-mounted and floor-mounted systems. Newer imaging technology, Kulkarni mentions, could even expand the use of hybrid ORs to other specialties, including general surgery.

A puzzle with 1,000 pieces

While the largest component of a hybrid OR is the imaging system, how everything else is organized around it is equally as important.

"You want it organized in such a way that you can do traditional, open OR procedures but you can also do newer techniques using catheters without disturbing the workflow," Naus says. "It's like a big puzzle with 1,000 pieces. All the key stakeholders have to help to make it a good end result."

For hospitals looking to install a hybrid OR, the experts advise taking these key steps to begin planning.

1. Consider space and budget. Norris says a hybrid OR needs at least 725, but optimally 800 to 1,100, square feet to be built well. In terms of budget, a room's cost largely depends on the imaging system. Hybrid ORs with an angiography system can cost $3 to $5 million, while a room with MRI could be $7 to $10 million. Hybrid CT rooms range around $2 million.

2. Start vendor selection early. "Vendor selection is important early on because the vendors providing equipment for the room need to start aligning," Naus says. "There is so much going on, typically in the ceiling. It's important that these vendors start talking and designing the room together."

To begin, hospitals must make purchasing decisions for the imaging system and the major pieces of equipment in the room, including booms, lights, tables and OR integration. Eustace says, many of these products are available with adapted features to suit the unique needs of the hybrid OR.

3. Engage key stakeholders. According to Norris, 18 to 20 people are often involved in the planning at hospitals for a hybrid OR. While it can vary project-to-project, key stakeholders often include:

- Surgeons: cardiothoracic, vascular, other specialities using the room
- Interventionists, such as interventional cardiologist and radiologists
- Anesthesiologists
- Nursing
- Facility planning
- Hospital administrators/management
- Architects
- Vendors for imaging and supporting equipment.

Failing to get all stakeholders communicating on the room's design can lead to big issues later in the project, Ticer warns.

"The c-arm has a particular way of moving, so you must plot out what happens if the procedure needs to convert to an open procedure," he says. "There are a lot of moving parts. If you get the room built and somebody says, 'But wait, we need to have this here,' it's basically too late."

The cost and design of a hybrid OR depends on the imaging technology chosen for the room.

Another piece in engaging all of the stakeholders, Ticer says, is to be prepared for the politics of competing services.

"For example, carotid stenting, which has historically been done by cath lab cardiology clinicians, can be done in a hybrid OR by a vascular surgeon or a cardiac surgeon," Ticer explains. "So, all of a sudden, several physician groups are competing for the same pool of patients, and that can cause some real problems."

The reality of a hybrid room, though, is that it involves a hybrid team, Naus says. The team is a combination of cath lab and surgical staff, often as large as 17 or 18 members. As Norris points out, it's a broadened knowledge-base, not a replacement of one staff for another. All clinicians need cross training so they can work together to use the technology.

From this teamwork, the benefits for everyone in a hybrid room can outweigh the complexities. Patients benefit because of the room's ability to provide minimally invasive solutions, which usually results in a quicker recovery and less blood loss. In case of a crisis in an interventional procedure, the hybrid OR allows staff to convert to an open procedure without taking the risks and time of moving the patient to a different room.

Physicians can provide better treatment planning and minimally invasive care in a hybrid OR. Their procedure times are often shorter and the availability of technology is a benefit to their procedural advancement.

For hospitals, the benefits lie in the ROI associated with increased room utilization and throughput, as well as surgeon recruitment and retention. Bottom line benefits can be harder to justify during the planning, but are often realized once the room is built and utilized to its full potential. Ticer adds the room can become a recruiting tool for physicians looking for the opportunity to work with leading-edge technology and a retention tool to keep the best surgeons at a facility.

In the end, it all comes back to communication to ensure the room is built to provide positive results for all using it now and in the future, Ticer says. It is the room of the future for heart and vascular surgery, and from the looks of it, for other surgical specialties as well.

This is part one of a three-part series on the hybrid OR. Stay tuned for an E-Zine exploring the pieces of equipment found in a hybrid OR. In the March issue of Surgical Products, hear from hospitals who have built, or are in the midst of building, a hybrid OR. SP