In the interest of improved patient outcomes, increased workflow efficiency, and implementation of cutting-edge technology, The Prince Charles Hospital in Brisbane, Australia has embraced the benefits of a Siemens hybrid catheterization lab for cardiovascular procedures.

By Tim Thwaites

The Hybrid Cath Lab: A Revolution in Cardiac Care
What happens when a closed operation suddenly becomes open – when a catheter perforates an important blood vessel, for instance, and a routine procedure suddenly becomes life threatening? It’s a potential problem associated with the increasing sophistication of transcatheter procedures, and it’s often brought up by the cardiologists, surgeons and radiographers at The Prince Charles Hospital in Brisbane, Australia – because they have faced it.

“One of the recommendations that came out of our safety committee was that we must get into a hybrid lab as soon as it becomes available,” says Darren Walters, M.D., Director of Cardiology at the Prince Charles. “If you have to move people in the middle of an emergency from a catheterization lab to a main operating theater up three floors, it’s an enormous logistical undertaking, and it puts the patient at risk.” The hybrid room – an integration of cath lab and operating theater – takes a significant amount of risk out of such an emergency by enabling an instant switch from a percutaneous procedure to surgery. The fact that this was used in Brisbane as an argument for the operation of a hybrid room shows how far the technology has come in less than a decade. Even though the concept is still novel, its potential benefits are so apparent already that expense is now just one factor among many to be addressed in the business case and the decision to go ahead. And certainly for a large public hospital, such as the Prince Charles, it was probably not the most important. “If you’re a major teaching hospital and a cardiovascular center of excellence, then you really are not going to be able to continue to provide the highest levels of care if you don’t have these sorts of facilities,” Walters says. “It’s not so much about an instant return on dollars and cents, as about placing yourself strategically so that you can be
involved in the development of cutting-edge techniques that ultimately improve patient outcomes.”

**The Need for Integration and Coordination**

Moving a catheter laboratory inside an operating theater is no easy matter. It creates a complex environment in which each piece of technology has to be carefully integrated. How can adequate high-end imaging be provided, for instance, without getting in the way of surgical lights and ventilation? What sort of surgical table do you install to service the needs of both open and closed surgery? What sort of space is required for surgical teams sometimes amounting to ten or more people?

When the equipment for anesthesia is added, how do you ensure that lights, monitors, tubes, movable X-ray equipment, lead plate protection and people do not get in each other’s way?

The hybrid room that Siemens built for The Prince Charles Hospital is large, above 80 square meters. It is fitted with an operating table, above which is a ceiling-mounted track running lengthwise. Along this track a Siemens Artis zee ceiling-mounted C-arm system can be moved in and out to provide sophisticated imaging during procedures. Around the operating environment are groups of surgical lights and monitors attached to arms extending from the ceiling that can be moved into any position manually. And there are also mobile stations for standard connections to medical gases and suction.

**New Procedures Demand New Equipment**

The budget for the whole hybrid unit was almost 3 times the budget for a classic interventional cath lab. “It’s not just the imaging technology, it’s all the additional equipment – the hemodynamic monitoring, the refit of the room, the upgrade of the audiovisual capability – there’s quite a bit of money involved,” says Walters.

“The business case flagged the move to increasing endovascular treatment of conditions that had previously been managed with open surgery, conditions for which neither the existing catheter labs nor the operating theater were an ideal environment,” he adds. “When catheter labs and OR theaters were designed, these new procedures did not even exist. For the cath lab, the issues include factors such as available space, sterility and access to OR theater facilities. In the operating theater, on the other hand, there’s no access to acceptable imaging, and there’s an increasing need for catheter-based technologies.”

Walters continues, “In looking forward, it is very clear that procedures are becoming less invasive and that imaging is becoming increasingly critical to the interventions. All sorts of endovascular work, from cardiac surgery to cardiothoracic surgery, such as aortic stent grafts, and to vascular surgical procedures, as well as percutaneous aortic valve replacement, insertion of biventricular pacemakers, removal of chronically implanted devices – all of these are areas in which you really require a hybrid environment.”

Walters believes that one area this has opened up – the development of percutaneous valve replacement – is the next great step forward in interventional cardiology after coronary stenting. It is a significant component of a revolution in cardiac care. “If you don’t have these sorts of facilities, you really cannot be involved in the clinical trials of these technologies,” he says, “and it’s going to make it very difficult for you to implement these techniques into routine practice.”

Such techniques are opening the way to heart valve replacement for elderly patients in Australia who are at high risk from open surgery. In fact, at Prince Charles, only 15 percent of patients referred for percutaneous aortic valve replacements were deemed ultimately eligible for open surgery. But a further 40 percent were able to go on and have the replacement done using catheter-based techniques.

These particular patients suffer from conditions that lead to a relatively rapid death if not treated quickly, Walters says. And the early trial figures show that with percutaneous intervention, they have shorter hospital stays and significantly less morbidity and mortality.

Those in this group who undergo open surgery often take more than six months to recover, he says, and even then can still be at relatively high risk of dying.

**Dosage Reduction in Valve Replacement Surgeries**

There are also new operations that could not easily take place in any other environment but the hybrid room. Although access for most percutaneous heart valve replacements is through the femoral artery, in some people – small, elderly women for example – that blood vessel is too small to use for access. For patients such as these, the operation can only be done by means of sub-clavian or transapical approach. The latter requires about a 5-centimeter surgical incision on the side of the chest, thus demanding a hybrid operating room in addition to catheterization. If undertaken in a standard operating room, where there would be no fixed imaging equipment, the catheter part of the operation would have to be undertaken using a mobile X-ray unit, which would involve relatively high doses of radiation and poor image quality. For such interventions, the Artis zee imaging systems, with their dose reduction programs, reduce the dose of X-rays significantly. It may be able to reduce dose in other ways too, as Prince Charles radiographer Jim Crowhurst is beginning to find out. The flexible C-arm on the Siemens Artis zee allows X-ray images to be taken from up to 290 degrees around a patient’s body. And using Siemens syngo DynaCT software, three-dimensional images can be constructed. Crowhurst and Walters have found such images useful for a critical part of the aortic valve replacement operation – profiling the aorta to determine the right angle at which
to align the new valve. The 3D image produced using syngo DynaCT is easily good enough to use as an overlay on a real-time 2D roadmap image to determine the best angle for deployment of the valve. And this has some significant advantages, as the clinical researchers argue in the abstract of a paper they are submitting for publication. It can all be done while the patient is on the operating table, so that he or she does not have to move between image acquisition and valve implantation. Interestingly, the 3D profiling of the aorta turns out to be more accurate with the live syngo DynaCT Cardiac 3D data than on previously acquired CT scan images to determine the correct projection angles. Not only does this help in placing the valve more precisely, but the image can also be constructed with fewer X-ray shots, so a smaller volume of contrast agent can be used, thus additionally reducing the risk to the patient. Traditional pre-operation CT scans may even be waived in some cases, according to Walters.

The acquisition of increasing expertise and the ability to conduct research at the cutting edge means that the hybrid room at the Prince Charles will begin to attract even more skilled medical professionals to Brisbane. “I think that once this technology starts to become more widely disseminated, we can play a teaching role,” says Walters. “You have to have the skill set to do these procedures. Before this facility became available, there was only myself and maybe one other doctor in Queensland who were regularly treating aortic valves percutaneously – in the catheter lab using balloon valvuloplasty. Over time, as hybrid room procedures become routine, you’ll get more people coming back here who’ve been trained in these techniques. And the hybrid room also allows our people to go elsewhere to get training. Because if you want to go to the top medical centers in the world, you can’t come from some tin shack.”

“If you’re a highly specialized center, a cardiovascular center of excellence, then you really are not going to be able to continue to provide the highest levels of care if you don’t have these sorts of facilities.”

Darren Walters, M.D., Director of Cardiology at The Prince Charles Hospital, Brisbane, Australia
Learning to Manage the Learning Curve

Walters freely admits that learning to operate in the hybrid room is still a work in progress – a delicate ballet of equipment and people. “We’ve had to work through the inevitable glitches that can be both technical and workforce-related. Bringing surgery and anesthetics and cardiology together for the first time, there’s a certain amount of sorting out to do. Initially it can be hard, because you’ve got people from different backgrounds, different cultures, not used to working together. The teams take a little while to storm and form, and to work out who’s who in the zoo. But if you can get through that, you start to deliver the benefits that teamwork and collaboration can bring.” Clear role definition is critical, he says, determining who is in charge of what and where, for instance, where the theater nurses’ responsibilities begin and end. Having a disaster plan is very important. “Rather than learn by experience, you really need to role play and try to anticipate. That’s what we’ve done.”

Around the world, colleagues told Walters of several places where hybrid rooms had been established but were underutilized. “They’ve encountered these sorts of issues and retreated back to their own environment. It has been a failed experiment for them, and I think it may be that perhaps they don’t have the right approach toward developing a collaborative, team-based effort. You’ve got to know where people will stand, who’s going to move what. That’s part of the whole role play.”

Collaborative Planning Pays Off

Careful planning extends to each procedure. Setting up the room for a day’s work, deploying the C-arm, monitors, lights and all the other equipment, can involve considerable discussion beforehand between radiographers, theater staff, cardiac surgeons, cardiologists and anesthetists, so that all moves like clockwork during surgery.

Even before the hybrid room at the Prince Charles began operating in June 2009, staff from every discipline in the hospital, along with the companies supplying the equipment, were deeply involved in the decision-making, design and planning process. “There were up to 30 people sitting around the table consulting with Siemens,” says Crowhurst. It was an iterative process with designs being drawn up, submitted, considered, modified and brought back time and again. In fact, after the decision to go ahead, the whole process of designing and constructing the room took about six months.

Siemens is one of only a couple of high-end providers of such technology, Walters points out, “And there’s a yawning gap to the rest.” The company was selected on a whole range of criteria because of its total package, including cost, he says, but particularly because of the high level of its image quality, its reliability, the fact that it had a proven track record, and, just as important, Siemens product support. Also, two catheter laboratories built only a year before the hybrid room at the The Prince Charles Hospital are equipped
with a Siemens Artis zee biplane imaging system, so the hospital had already had experience working with the company.

One aspect of the planning stage is to ensure that the equipment supplied fits the future purpose of the hybrid room. At The Prince Charles Hospital, that involved flexibility – since the room is also being used for vascular surgery as well as cardiac and coronary procedures. Because of the room’s dual nature, the planning group decided to specify a larger, 30 x 40-centimeter flat detector on the Artis zee imaging system, instead of the 20 x 20-centimeter typically used in coronary interventions. It was partly a compromise, Walters explains: “A big detector allows you to cover larger organ systems, so if you are doing thoracic endovascular stenting work, for instance, a large detector will work well for you. But if you are doing very small coronary work, you do lose a degree of sharpness. It’s quite a subtle difference.”

Although The Prince Charles Hospital deliberately started slowly, the hospital is rapidly working towards full utilization of the hybrid room as vascular surgery comes on line. “I think it takes at least a good six months to get it right,” Walters says. It also takes persistence. But at The Prince Charles doctors, nurses and radiographers have resisted going back to how they worked in the past, because they see the hybrid room clearly as the way of the future.

Tim Thwaites is a veteran freelance science writer, editor, university teacher and broadcaster based in Melbourne, Australia. As a founding member of Australian Science Communicators, he was national president from 2007-2009, acting as co-chair of the program committee for the 5th World Conference of Science Journalists in Melbourne in 2007 and convening the ASC National Conference in February 2010. Tim currently works for Science in Public, a science communication company based in Melbourne.

Contact
anne-eloise.cournut@siemens.com