

Pathway for Surgeons and Programs to Establish and Maintain a Successful Robot-Assisted Adult Cardiac Surgery Program

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Definition

Robotic cardiac surgery is defined as any cardiac operation that is performed either completely or in part using robot-assisted (ie, telemanipulation) technology. At present, for robot-assisted cardiac operations, the Food and Drug Administration (FDA) has approved only one device, the da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA).

Preamble

The da Vinci robotic surgical system was FDA approved for mitral valve surgery in 2002 after phase I and phase II investigative device exemption trials [1, 2]. In 2004, the system was FDA approved for coronary revascularization [3]. Since then, there has been slow adoption of this technology in cardiac surgery for many reasons, including (1) cost; (2) technical demands; (3) need for significant institutional resources (ie, dedicated operating room, nursing, anesthesia, and perfusion teams); and (4) more importantly, lack of proper training, and for robotic mitral surgery, the lack of prior experience in mitral valve repair and conventional minimally invasive techniques. That has resulted in only a few centers worldwide being able to establish successful and enduring da Vinci robotic cardiac surgical programs [4–14].

Cardiac surgeons receive appropriate training for conventional sternotomy-based cardiac surgical operations in

either residency or postgraduate programs; however, only a few education programs offer training specifically in minimally invasive cardiac surgery. Moreover, these programs generally do not provide training in robotic-assisted cardiac surgery. For surgeons to participate in this emerging field in a safe and efficacious manner, a new training paradigm has become necessary. Many surgeons desire more guidance from professional organizations when establishing robotic cardiac surgical programs.

The members of this writing group are experienced with robotic-assisted adult cardiac surgery procedures. Although we understand that there are several potential pathways to establish a successful adult robotic-assisted cardiac surgery program, this document presents a potential pathway and set of recommendations for both individual surgeons and surgical programs to begin or to participate in robotic-assisted adult cardiac surgery. By adhering to these criteria, cardiac surgeons can expect to follow minimum safety standards for implementation and independent conduct of robot-assisted cardiac surgical procedures. This document establishes criteria supported by The Society of Thoracic Surgeons (STS) and the American Association for Thoracic Surgery (AATS). It is well recognized that a coordinated surgical team, which includes cardiac anesthesiologists, cardiac surgeons, operating room assistants, nurses, and perfusionists, is critical to establish a successful robot-assisted cardiac surgical program.

Background

Currently, robot-assisted telemanipulation is used mainly for two cardiac surgical categories: (1) intracardiac operations (mitral valve, tricuspid valve, atrial septal defect, cardiac tumors, and atrial fibrillation); and (2) coronary revascularization. This document delineates the

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recommendations from a group of experienced robotic cardiac surgeons for cardiac surgery programs that want to perform these operations safely and independently.

Criteria

Robotic Cardiac Surgical Team Requirements

INSTITUTIONAL. To establish a successful robotic cardiac surgical program, there must be a strong hospital commitment, as well as commitment from all team members, including cardiac anesthesiologists, cardiologists, cardiac surgeons, perfusionists, and operating room personnel. Individual surgeons should start programs only if this type of full commitment is apparent. In addition, the team must have had substantial cardiac surgical experience as a unit. It cannot be overemphasized that transition from traditional sternotomy-based operations to a minimally invasive robotic-assisted platform requires an experienced and cohesive cardiac surgical team. Hospital administrators and physician leaders should be aware of the necessity of surgeon and team learning curves, which in some complex procedures can reach three digit numbers. Long operative times and technical difficulties, requiring conversion to sternotomy or thoracotomy, should be expected during the implementation phase.

INDIVIDUAL. A single cardiac surgeon should be designated to be the team leader. This person should coordinate the strategic action plan, when developing a robotic cardiac surgical program, as well as monitor program quality and safety. Initially, one main robot-assisted application (ie, an intracardiac procedure versus coronary revascularization) should be chosen based on the surgeon's current practice. Simultaneous introduction of different procedures can be more challenging; however, that can have synergistic effects for reducing the learning curve and can help maintain adequate robotic procedure volumes. Surgeons selecting an intracardiac platform should be experienced in mitral/tricuspid valve operations as well as other open-heart procedures. If coronary revascularization is selected as the initial pathway, the surgeon should have solid coronary revascularization experience, which may include off-pump techniques and, ideally, minithoracotomy coronary revascularization approaches. Larger case volumes of conventional cardiac operations best prepare surgeons and teams for the initiation of a robotic cardiac surgical program.

The anesthesia team must have significant experience with cardiac surgery patients who have comorbidities. They should have significant experience with intraoperative two-dimensional and, ideally, three-dimensional transesophageal echocardiography (TEE), especially for teams involved in robotic mitral valve surgery. In addition, the anesthesiologist should have expertise with single-lung ventilation, using double-lumen intubation and bronchial blockers. To gain maximal early experience, only one or two cardiac anesthesiologists should be involved in the first 20 robotic cardiac operations. It is best that the anesthesiologists or lead cardiac surgeon have prior experience in placing transjugular cannulas for cardiopulmonary

perfusion, retrograde coronary sinus cardioplegia administration, and intracardiac pressure monitoring.

If the program does not have anesthesiologists versed in intraoperative TEE, a dedicated cardiologist with experience in intraoperative imaging should perform TEE studies. It is critical that cardiac surgeons and cardiologists involved in the program define, and agree, which patients benefit most from robot-assisted cardiac operations. Ideally, these decisions should be made in the setting of a multidisciplinary team case conference. In addition, they must carefully monitor the intraoperative and postoperative quality outcomes. It is prudent to begin a robotic program by selecting low operative risk patients with simple pathology. That is extremely important and ensures physiologic reserves should learning curve cases become complicated, extensively long, or necessitate conversion to an alternate approach.

The perfusion team and the cardiac surgeon should select one or two perfusionists who will perform the first 20 operations or as many as the lead surgeon determines are necessary to maintain expertise. They should have prior experience in managing peripheral arteriovenous perfusion with vacuum-assisted or kinetic venous drainage.

A small core group of operating room personnel must be dedicated to participate in each of these procedures. Surgical technicians and nurses must become extremely familiar with the robotic system setup, deployment, and intraoperative organization. It is crucial to have a single person (ie, surgeon, physician assistant, or nurse assistant) selected to be the patient-side assistant for these early cases. Close synchrony between the patient-side assistant, surgeon, and scrub personnel is essential for maximizing temporal economy. Thus, at many experienced robotic centers, the same first assistant and scrub personnel perform every one or at least the vast majority of the robotic-assisted cardiac cases.

Owing to the complexity of these procedures, reviewing a preoperative checklist for availability and function of all devices is recommended. Completion of this checklist should be part of the "time-out" preoperative protocol.

Surgeon Experience Requirements

ROBOTIC INTRACARDIAC OPERATIONS. Surgeon expertise in performing both routine and high-risk cardiac procedures is essential. The surgeon should have completed an accredited cardiothoracic surgical training program in which the surgical management of valve disease is a focal point. Ideally, this surgeon either should be eligible or certified by the appropriate cardiac surgical board according to his or her practice location. However, we recommend that the lead surgeon must hold an appropriate certification (eg, board certification by the American Board of Thoracic Surgery or by the certifying institution at the country or region in which she or he practices cardiac surgery) to independently practice cardiac surgery.

The console surgeon should be facile in performing sternotomy-based and minimally invasive intracardiac surgical operations. We recommend that before initiating

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