

From the ground up: building a minimally invasive aortic valve surgery program

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Minimally invasive aortic valve replacement (MIAVR) is associated with numerous advantages including improved patient satisfaction, cosmesis, decreased transfusion requirements, and cost-effectiveness. Despite these advantages, little information exists on how to build a MIAVR program from the ground up. The steps to build a MIAVR program include compiling a multi-disciplinary team composed of surgeons, cardiologists, anesthesiologists, perfusionists, operating room (OR) technicians, and nurses. Once assembled, this team can then approach hospital administrators to present a cost-benefit analysis of MIAVR, emphasizing the importance of reduced resource utilization in the long-term to offset the initial financial investment that will be required. With hospital approval, training can commence to provide surgeons and other staff with the necessary knowledge and skills in MIAVR procedures and outcomes. Marketing and advertising of the program through the use of social media, educational conferences, grand rounds, and printed media will attract the initial patients. A dedicated website for the program can function as a “virtual lobby” for patients wanting to learn more. Initially, conservative selection criteria of cases that qualify for MIAVR will set the program up for success by avoiding complex co-morbidities and surgical techniques. During the learning curve phase of the program, patient safety should be a priority.

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Introduction

“If you build it, he will come”.

This phrase, from the movie *Field of Dreams*, is mysteriously spoken one day as a humble farmer, played by Kevin Costner, walks through his cornfields. At first, he is confused what the voice is referring to, but eventually decides that he is being guided to build a baseball diamond on his farm, which had been struggling financially. Despite objection from others around him, he proceeds with his plans and eventually builds a baseball field that attracts some very unusual players, and along with them, the revenue that his family needs to survive.

This sentiment might seem appropriate for a Hollywood movie, but it can also be applied to the building of a

minimally invasive aortic valve replacement (MIAVR) program. That is to say, if we build it, patients will come. While the goal of this article is not to describe the advantages of MIAVR, it is worthwhile to keep in mind several key evidenced-based findings when considering the creation of a MIAVR program. MIAVR, first described in the mid-to-late 1990s, differs from conventional heart valve repair in that by avoiding median sternotomy and instead using either a thoracotomy or hemi-sternotomy incision, cosmesis improves, transfusion requirements decrease, patients are more satisfied, fewer analgesics are needed, and cost is reduced (1). In addition to these advantages, MIAVR has also been reported to shorten hospital stay and decrease recovery times while maintaining a comparable mortality rate to conventional heart valve repair (2). Minimally

invasive surgery techniques have become a standard of care in other fields and will likely remain an evolving area of cardiothoracic surgery. The aim of this article is to outline the steps involved in creating a MIAVR program from the ground up, a feat that requires a collaborative effort between several key members of a committed team.

Step one: compile the team

While patients will ultimately drive business in MIAVR programs, it is a collaborative team that will sustain it. A dedicated multidisciplinary MIAVR team also fosters creativity, collaboration, and allows members to learn each other's languages. The team should include at least one or two surgeons, cardiologists, perfusionists, operating room (OR) technicians, nurses, and anesthesiologists. It is extremely important to select a first assistant who will be involved in all of the initial cases. The assistant needs to carefully coordinate all of his/her moves with the primary surgeon, especially knot tying. Each of these team members plays a crucial and unique role in ensuring the success of the program and optimizing patient outcomes. While surgeons who are specially trained in MIAVR techniques will lead the team, close communication with the cardiologist is necessary to provide monitoring of post-surgical complications and continued surveillance of the patient. A multidisciplinary valve clinic should be considered as a valuable asset to a MIAVR program, involving participation from both the surgeon and cardiologist. Perfusionists need to be skilled in various techniques and equipment specialized for minimally invasive surgery, including vacuum assisted venous drainage, appropriate selection and knowledge of peripheral cannulas, and facility in dealing with potential cardiopulmonary bypass complications. In addition, alternative myocardial protection strategies should be considered. The efficiency of the procedure in the OR relies on OR technicians who are familiar with unique minimally invasive instruments, set up, and procedural steps. Anesthesiologists are also crucial to the team, and should be skilled with transesophageal echocardiography, not only to evaluate heart function and the aortic valve, but also in obtaining critical views necessary for the procedure, including bi-caval, long-axis aortic root, coronary sinus and short-axis of the descending aorta. Some centers may elect to utilize either an endoballoon or retrograde coronary sinus catheter (neck lines) and an anesthesiologist's knowledge and procedural expertise is critical. Finally, nurses both in the OR and on the floors, provide direct patient care pre- and post-surgery and should

be familiar with the MIAVR technique, postoperative care, and management of potential complications. A well-coordinated team will parallel the effectiveness of the program. A head camera or thoracoscope will also allow the entire team to visualize the surgery through the limited access approach and will facilitate the conduct of the operation.

Step two: obtain administrative/hospital support

After a comprehensive and dedicated MIAVR team is assembled, the next step is to obtain administrative support. It is important for the success of the program that the hospital is supportive and willing to invest financially. This will require a meeting between the members of the clinical team and administrators, during which a cost-benefit analysis of instituting a MIAVR program can be discussed. It should be emphasized to hospital administrators that a MIAVR program represents a long-term investment with significant front-end costs that will ultimately pay its dividends. A recent study conducted at Columbia University in New York showed decreased direct costs of MIAVR compared with traditional sternotomy, particular in the areas of cardiac imaging, laboratory tests, boarding and nursing, and radiology expenses (3). In addition, the authors found that fewer patients in the minimally invasive procedure group required nursing care upon discharge, and fewer were readmitted at one year. The cost savings plus the numerous advantages to patients who qualify for MIAVR will likely lead to increased revenue for the hospital.

Discussions regarding risk management will also be important in this step. Beginning any new program like this will carry with it a learning curve with increased risk before proficiency is achieved. A clear and detailed plan outlining predicted risks with a strategy to manage them will go a long way in allaying any concerns risk management may have, and will also show the level of preparedness and commitment of the team to the program.

Before revenue and long-term cost-effectiveness can be realized, the correct surgical instruments need to be purchased as part of the initial investment. MIAVR cannot be performed with conventional valve surgery instruments and trying to do so will ultimately lead to failure. It is important to obtain the appropriate ergonomic tools to operate through small incisions and space. It is therefore critically important that the hospital support the purchase of MIAVR specific equipment and single, long shafted instruments.

Hospital administrators will also need to consider the cost of marketing an MIAVR program as well as supporting educational training programs for the team members. A portion of this funding may come in the form of industry grants, which can help offset the initial financial investment.

Step three: obtain training

For any surgeon performing minimally invasive heart valve repair, the necessary prerequisite is to be fully comfortable with traditional open valve surgery. The minimally invasive techniques will not make you a better valve surgeon. It is possible that unforeseen complications will necessitate the conversion to a median sternotomy. Being prepared for this outcome requires a high level of communication among all members of the team. MIAVR, especially in the initial phase, will require longer operating times and some authors have suggested and agreed upon a timeline, which is usually earlier, for the conversion to median sternotomy to avoid poor patient outcomes (4).

There is a learning curve for minimally invasive procedures and surgeons will benefit from taking instructional courses offered by the American Association of Thoracic Surgery, the Society of Thoracic Surgeons, European Association for Cardiothoracic Surgery and/or other organizations. In addition, subspecialty training can be sought as an advanced dedicated fellowship in a high volume center, with young surgeons particularly benefiting from an additional year of training in MIAVR techniques. Intimate mentorship is imperative for those not pursuing fellowship training. The mentor provides valuable feedback and can be a resource for the surgeon to touch base with from time to time. As stated above, industry sponsored grants may provide the funding necessary for this extra training.

While on-the-job mentored training is essential, virtual reality simulation training affords endless practice opportunities in a “permission to fail” environment. Skills can be refined through correction of errors without adversely affecting patient care. Virtual reality training has been demonstrated to effectively reduce operating time and improve performance of surgical residents in cholecystectomy (5,6), with an increasing awareness of its utility in the role of cardiothoracic surgery (7). Different simulators are available for commercial purchase and can be invaluable during the initial learning stage. The surgeon should consider using minimally invasive instruments on sternotomy cases in order to develop this very important skill set. In addition, if a peripheral platform for cannulation

is chosen, one should initially consider practicing this technique on sternotomy cases as well.

Step four: market and advertise

Once a multidisciplinary team has been organized, hospital approval obtained, and training acquired, the next step is to find a soapbox to market the MIAVR program. Marketing should not be construed as self-promotion, but moreover as an opportunity to inform and educate consumers and society about new technologies to facilitate informed decisions. A multi-pronged approach is ideal, encompassing both digital and printed media as well as education conferences to other physicians and the public. Facebook, Twitter, Google+, LinkedIn and other sites are invaluable and inexpensive marketing tools. The program can be introduced to existing followers, with direct links to a dedicated website for the MIAVR program which will function as a “virtual lobby” for prospective patients. Printed media in the form of brochures and newspaper advertisements should also be invested in order to reach individuals not utilizing social media. Marketing to allied healthcare workers and physicians can be achieved by presenting grand rounds, speaking at valve conferences, and other networking activities. Without marketing, one can have an incredible product but no one will know.

Step five: operate

The final step in building a MIAVR program from the ground up is to begin operating with patient safety as the ultimate goal. The first cases will be inherently difficult and it is a good idea to have them proctored by an experienced surgeon. The devil is in the detail and an experienced proctor can pick up on subtle nuances that ultimately define the case. While the exact number of cases needed to develop proficiency will vary, one study found that between 75 and 125 cases was needed per surgeon to overcome the learning curve in minimally invasive mitral valve surgery (8). Prior to the case, the surgeon should mentally review key steps of the procedure, but equally important, the surgeon should rehearse critical steps with the entire team. Creating a surgical checklist is also important to make sure steps are not missed.

Patients should have appropriate disclosure of primacy and be aware that they will be among the first cases of the new program. Patients should be reassured however that an experienced surgeon will proctor the case and if exposure is

difficult or complications arise with the minimally invasive technique, the team is ready to convert to a conventional valve repair. Success in this early stage will require the ideal patients to be chosen for the procedure. Patients to avoid are those who are relatively sick, obese, short statured, diagnosed with aortic incompetence, in need of complex repairs, concomitant valve disease or who are otherwise high-risk. The size of the incision can be modest in the beginning to facilitate exposure and gain confidence with a goal of creating 5-6 cm incisions as the program matures.

In general, it can be predicted that initial poor surgical outcomes will be attributed to either the learning curve phase of the program or poor patient selection. Minimizing the learning curve and optimizing patient selection will go a long way to ensuring the success of a MIAVR program. At first, a conservative schedule of one case per day will be sufficient as the team familiarizes itself with the procedure and management of these patients. Documentation of progress through the use of pictures and videos will provide an objective assessment that can then be shared with patients and referrers.

Conclusions

Building a successful MIAVR program from the ground up is possible with the right blueprint. By assembling an integrated, multi-disciplinary team as the foundation, hospital administrative support can be sought with a focus on the cost-benefit analysis and long-term financial revenue. Various training options are available for surgeons from mentorship to advanced fellowship, both of which can also include virtual reality simulators to practice skills in a low-stress setting. Marketing and advertising will draw in the patients while also educating community providers on the availability of the program. Close communication between surgeons and referring cardiologists will be essential in ensuring the success of the program. And finally, operating to minimize the learning curve while maximize patient outcome will ease what can be a rough initial transition. These are the steps to building a successful MIAVR

program—“*once it is built, the patients will come*”.

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