34 Development of a Robotic Prostatectomy Program

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Presently, one of every eight radical prostactectomies performed in the United States is being done laparoscopically utilizing the da Vinci® Surgical System (Intuitive Surgical, Sunnyvale, CA). More than 115 hospitals in America use the da Vinci robot to perform radical prostatectomy. Continued data collection and technical refinements are needed to address controversial issues such as positive margin rates, continence rates, and impotence. Patients are requesting minimally invasive approaches to surgery, and an increasing number of hospitals and surgeons are adopting surgical robotic techniques.

Establishment of a robotic urology program requires a number of vital elements combined with patience and persistence. A roadmap to success seems to be emerging, which begins with the development of a qualified team of surgeons, nurses, and operating room (OR) administrators. The hospital must be diligent in developing financial goals, setting performance criteria, and developing efficient fiscal collection strategies. Hospital administrators must be prepared to renegotiate nearly all of their managed care contracts to avoid significant financial loss. Finally, the success or failure for both surgeon and hospital will hinge upon the development and maintenance of a high-volume stream, in order to develop clinical proficiency and to compensate for the decreased profit margin. This inevitably involves marketing within the local and regional community.

Many of the obstacles to the development of a robotic urology program do not exist in centers where robotic cardiac surgery is already practiced. The profit margin is considerable for cardiac and thoracic robotic surgery, which includes cardiac bypass, valve surgery, and thoracic interventions. Consequently, in this situation, the hospital can afford to work with the smaller profit margins associated with robotic urologic cases. Proficiency and profitability can be reached with a stand-alone robotic prostatectomy program, without a concurrent thoracic program. We share our experience in the development of a successful program in robotic urologic surgery.

HOSPITAL CONSIDERATIONS

To initiate a robotics program, the hospital must initially invest the cost of the machine, which is currently priced at $1,200,000. A service contract must also be negotiated, which may cost as much as $100,000 per year. To justify such an expenditure, the hospital must be able to envision cash flow generated not only from the increased prostatectomy market share but also from additional hospital admissions and surgeries indirectly generated by the presence of a robotics program.

The prestige and visibility that a robotics program creates are intangible assets. Patients are attracted by the minimally invasive nature of robotic surgery, even though definitive evidence of superiority of postoperative continence, impotence, and cancer control is yet to be proven. It is the public perception that any hospital with surgeons who perform robotic surgery must also be technically advanced in other areas. The requisite marketing of a robotics program can be costly, including expensive advertisements via television commercials and sophisticated press releases. The introduction of robotic surgery into a region or community is indeed newsworthy.

As a robotic urologic program is developed, both hospital and surgeons must be sensitive to its impact on the local urologic community. The consequent shift in market share may incur resentment. Forging relationships with community urologists may minimize such an effect. This is accomplished by educating these physicians, and returning the patients back to their primary urologist for long-term follow-up care. Efforts may also include incorporating the original referring urologist as part of the surgical team.

CHOOSING AN OPERATIVE TEAM

The da Vinci Surgical System simplifies laparoscopic surgery and shortens the time to perform certain laparoscopic tasks.[1,2] The development of a robotics program in urology requires at least one surgeon (preferably two) with extensive laparoscopic experience. Optimally, these surgeons should be interchangeable and neither can be laparoscopically naïve. The surgical team must have excellent communication during the procedure and must respect each other's opinions as their operative technique evolves. Publications have reported that surgeons with limited laparoscopic experience may develop proficiency with laparoscopic prostatectomy using the robot, as long as they are initially collaborating with a skilled laparoscopic surgeon.[3,4] These same reports stress the need for the surgeons to be highly experienced in performing open radical prostatectomy and that the assistants be "moderately advanced" in their laparoscopic skills.[3,5,6] In our opinion, there is no other operation where the skill of the assisting surgeon is so closely associated with the successful completion of the operation. Further, we believe that the skill of the assistant is perhaps the most important determinant of operative time, blood loss, and conversion rate. Finally, we have found that surgeons participating in the program must be prepared to sacrifice monetary productivity during its early stages.

The surgical team needs significant support from the OR administrator in the form of OR block time, the training of nursing and scrub personnel, and the purchase of specialized equipment. Continuity of nursing staff is crucial, and their position as an integral part of the team needs to be recognized by the administrators. Nursing staff should accompany the physicians to the remote training courses and must be willing to work beyond their normal working hours during the initial cases to avoid the insertion of inexperienced nursing staff before case completion. It is also important to have the same anesthesiologist in order to establish specific anesthetic management issues (including steep Trendelenburg positioning, increased airway pressures, and minimizing over hydration) and thereby shorten operative times. All members of the team must learn and work together to reach a common goal.

■ TECHNIQUE

We strongly recommend active "live" mentoring by an experienced robotic surgeon for the first three to four prostatectomy cases. The team's operative technique will continue to improve and may require 40 or more cases to achieve proficiency. Several reports of the operative technique for robotic prostatectomy have been published.[7–11] The role of the assistant has also been described.[5]

Our operative technique is as follows. On the day prior to surgery, the patient undergoes a mechanical and antibiotic bowel preparation. We have not set a waist size or weight limit for our patients and have successfully operated on patients as heavy as 315 pounds. Extra-long ports will be required for such cases. A previous transurethral resection of the prostate (TURP) or a large middle lobe has not served as exclusion criteria for our series. In the OR, the patient is positioned on a beanbag, with the legs carefully placed in stirrups. Both arms are wrapped with egg crate foam in order to prevent transient upper extremity neuropathy. The knees, shoulders, and chest are padded. After tucking both arms and deflating the beanbag, the patient's upper body is secured to the table with an entire roll of tape applied in a crisscrossed pattern. Maximum Trendelenburg positioning is then achieved. After prepping and draping, an end-to-end anastomosis sizer is passed into the rectum in order to aid visualization during rectal dissection. An 18 French Foley catheter is also placed (Figures 34-1 and 34-2).

We place a total of five ports as described by Ahlering et al.[8] Our da Vinci robot is equipped with a fourth arm so that the left lateral port is an additional 8 French da Vinci port (Figure 34-3). We only utilize one bedside assistant, located on the patient's right side. Contrary to other published reports, we have not found that the handedness of the assistant is an important factor in choosing the laterality of assistant positioning. The primary role of the assistant is to keep the operative field clear of smoke and blood.

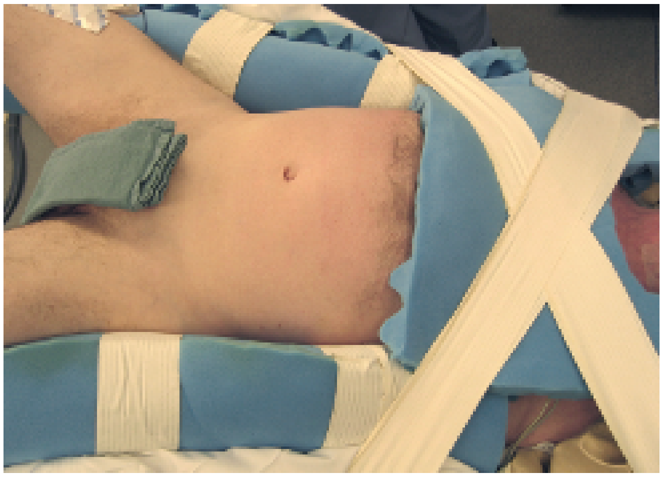

FIGURE 34-1. Positioning of the patient. Both arms are padded and tucked. The knees, shoulders and chest are also padded. The beanbag is deflated, and the patient's upper body is secured to the table with an entire roll of tape applied in a crisscrossed pattern. This allows the patient to be moved into a steep Trendelenburg position.

FIGURE 34-2. A mid-sized end-to-end anastomotic (EEA) sizer is placed into the patient's rectum for easy identification of the anterior rectal wall during the course of the dissection of the prostate.

A thorough knowledge of the operative steps is mandatory for the assistant, who must apply appropriate countertraction. The assistant's skill is particularly important during posterior bladder neck transection, seminal structure dissection, and rectal mobilization.

The case is started with a zero-degree scope without changing the camera lens. We find this angle of visualization adequate for all steps of the operation, and, by keeping the same lens throughout the case, we have reduced the need for repeated camera cleaning and defogging in the course of the procedure. We perform the prostatectomy via an intraperitoneal approach, with standard triangular takedown of the bladder and mobilization of the space of Retzius. Wide peritoneal dissection to the level of the vas deferens aids in visualization. The endopelvic fascia is opened bilaterally, from the bladder neck to beyond the apex. An extensive amount of apical dissection can be performed at this stage. This optimizes the precise placement of the dorsal vein suture and helps with the later mobilization of the neurovascular bundle and transection of the urethra. A large portion of the nerve-sparing procedure can be initiated during this step of the operation.

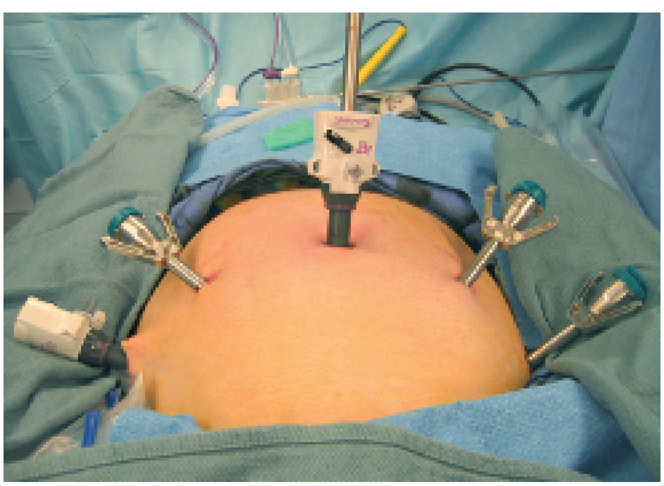

FIGURE 34-3. Port placement prior to the docking of the robot.

The dorsal vein is ligated with an absorbable figure of eight suture. A second suture is placed over the proximal prostate, just distal to the bladder neck. This is used for upward retraction during bladder neck dissection and will be held by the fourth robotic arm. For our first 20 cases, a third suture was placed in the bladder neck to aid in visualization of the bladder neck. We found this unnecessary, as we developed expertise with the procedure.

The transition between the bladder neck and the prostate is identified by the termination of bladder fat anteriorly and laterally. Using this landmark, the bladder neck is taken down following an inverted 'V' pattern in order to avoid cutting into the base of the prostate. Most of the posterior bladder neck dissection is performed with the urinary catheter in place. This serves to maintain a circular shape of the posterior bladder neck. The catheter is then held anteriorly by the fourth arm, and the posterior bladder neck is dissected. The seminal structures are ligated with Heme-O-Lock clips (Weck Closure Systems, Research Triangle Park, NC), and the tips of the seminal vesicles are typically left behind so as to avoid nerve injury. Electrocautery is minimized during the dissection of the seminal vesicles in order to avoid injury to the erectile nerves. The catheter is then removed from the urethra, and the fourth robotic arm is employed for upward traction on the seminal and deferential structures.

Once this is completed, electrocautery is not used for the remainder of the case. The rectum is taken down using blunt and sharp dissection. The surgeon must be careful not to enter the plane closest to the prostate within the lateral pelvic fascia. This is the most avascular plane and may be the most tempting to follow because it is the most apparent. However, this plane of dissection typically places the surgeon within the prostatic capsule and therefore increases the chance of having a positive surgical margin. A surgeon working on the da Vinci must continue the dissection just outside this visually inviting plane, in order to achieve negative surgical margins.

After the rectum is completely mobilized, a single Heme-O-Lock clip is applied to the vascular pedicle bilaterally. Blunt scissors are used to transect the pedicle. It is usually evident when the entire pedicle has been released. Once the pedicle has been transected, the entire neurovascular

Table 34-1. Demographic Information and Preoperative Information of the 76 Patients Who Have Undergone a da Vinci Robotic-Assisted Laparoscopic Radical Prostatectomy at Our Institution

	Mean	Median	High	Low
Age (y)	59.4	60	72	44
Height (in)	70.5	71	79	61
Weight (lbs)	192.6	182	300	131
BMI	27.3	26.4	47.0	19.9
Preop HCT	43.1	43.8	49.2	36.3
PSA	6.1	5.4	19	1.4
Preop Gleason	6.3	6	8	4

bundle is sharply and bluntly mobilized to the urethra. A layer of fascia should always be left on the surface of the prostate to avoid positive margins. We attempt to preserve the veil of lateral pelvic fascia around the prostate, but we do not make this as much of a priority as does Menon. Small bleeders on the neurovascular bundle will be eventually controlled by the pneumoperitoneum alone, and efforts to obtain strict hemostasis are probably better avoided unless bleeding continues after complete specimen resection.

The dorsal vein is then transected with scissors, and a long urethral stump is bluntly dissected. If proper mobilization of the nerve bundle has been performed, nerve injury should be minimized. The urethra is taken with a catheter in place so as to avoid transection of the prostatic apex. The specimen is bagged for later retrieval. The anastomosis is completed using a double armed 3-0 absorbable suture. An 18 French latex catheter is passed after the posterior wall is completed, and the fourth robotic arm is used to hold one side of the double-armed suture so as to aid in the creation of the anastomosis. A completely watertight anastomosis should be expected. We have found that minimal usage of irrigation will lead to minimal drain output during the hospitalization.

OUR EXPERIENCE

At the time of this writing, a total of 76 da Vinci robotic-assisted laparoscopic radical prostatectomies (dVRP) have been performed at the George Washington University Hospital. The mean age of the men undergoing a dVRP was 59.4 years, with a range of 44 to 72 years. The typical male had a body mass index (BMI) of 27.3 (range: 19.9–47.0). The average preoperative PSA and Gleason scores were 6.1 (range: 1.4–19) and 6.3 (range: 4–8), respectively. We have divided this population of men into groups of 10 in order to monitor our progress during the learning process. There was very little variation in the distribution of the age of the patients, their BMIs, their preoperative PSAs, and their preoperative Gleason score throughout the subgroups of 10 patients (Table 34-1).

The placement of the robotic and laparoscopic ports, and the docking of the robot, typically takes 26 minutes. This time element has remained constant. If the operating surgeon has significant laparoscopic experience and is comfortable with the placement of laparoscopic ports, this step can be mastered early in his/her robotic experience. We found the greatest learning occurred in the cadaver laboratory, during the earliest phase of our learning curve. Once we started performing the procedure in living patients, we were already relatively comfortable with port placement and the docking of the robot. As we have gained experience, we have become more willing to treat patients with a history of previous intra-abdominal surgery. In these cases, it has been necessary to perform a moderate amount of enterolysis prior to placing the ports. This is reflected in our range of times (12–47 minutes) in performing the port placement and docking.

Once the robot is docked and the operative instruments are in place, the bladder is dropped and the endopelvic fascia is opened. This step took us 32 minutes in the first 10 patients and improved with the first three groups of 10 patients. After we had completed our first 30 cases, we have averaged

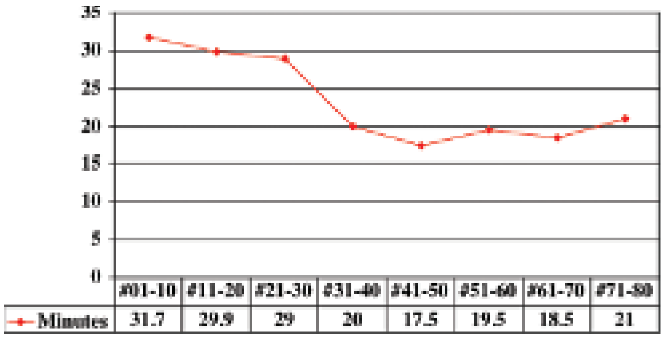

FIGURE 34-4. Line graph depicting the average time required to drop the bladder and open the endopelvic fascia. The *x*-axis shows the patient number in groups of 10. The *y*-axis shows the average number of minutes used to complete this step in the operation.

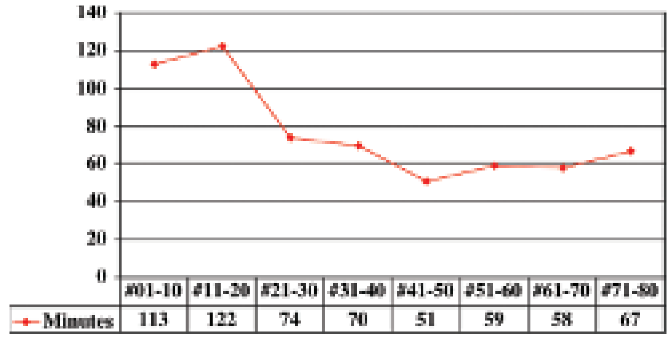

FIGURE 34-6. Line graph depicting the average time required to excise the prostate. The *x*-axis shows the patient number in groups of 10. The *y*-axis shows the average number of minutes used to complete this step.

16–21 minutes for this step (Figure 34-4). With our heavier patients (higher BMI), we typically encounter more fat while taking down the median and medial umbilical ligaments, and this can consume more operative time.

We control the dorsal venous complex (DVC) by using an absorbable suture placed around the DVC and another absorbable suture as a back bleeder at the bladder neck. In our first 10 patients, we averaged 25 minutes for this step. After our first 30 patients, we have consistently averaged between 8 and 15 minutes (Figure 34-5). Although other centers advocate using an endoscopic stapler for this step, we have been hesitant to make this change because of the potential problem of having permanent staples in and around the anastomosis.

The development of the proper plane between the bladder neck and the prostate is one of the most challenging parts of this procedure. In robotic surgery, the fat peels off of the prostate easily but is adherent overlying the bladder. Using this anatomic variation, aided by the movement of the Foley balloon by the assistant surgeon (to further delineate the bladder neck), we no longer find this step to be a problem. We had performed more than 30 cases before we felt comfortable with this particular site of dissection. For example, the prostate dissection and removal in our first 20 cases took us nearly 2 hours, but this time has dropped to approximately 1 hour in the last several sets of 10 patients (Figure 34-6). Completion of the vesicourethral anastomosis averaged 45–65 minutes in the first 20 cases. This has only modestly improved during the last 50+ patients, and we now average between 35 and 45 minutes.

Undocking of the robot has consistently required 4–5 minutes, with very little variation over time. Removal of the specimen and closure of the skin port sites continue to take between 20 and 30 minutes. The house staff scrubbed in on the case typically perform this part of the procedure.

RESULTS

Total robot time showed continual improvement for the first 50 cases (Figure 34-7). The average robot time across the entire population of patients has been 164 minutes

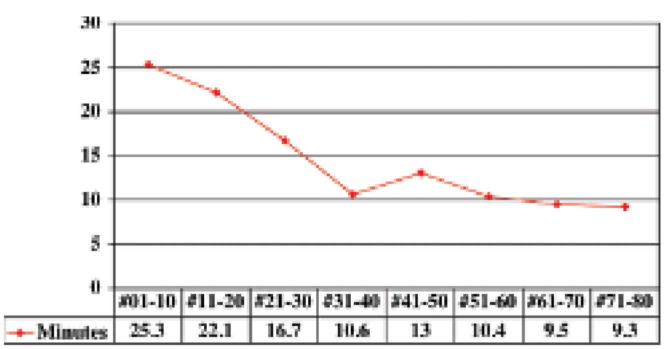

FIGURE 34-5. Line graph depicting the average time required to place the dorsal venous complex (DVC) and back bleeding stitch. The groups of 10 patients set up the *x*-axis. The *y*-axis shows the average number of minutes used to complete this step.

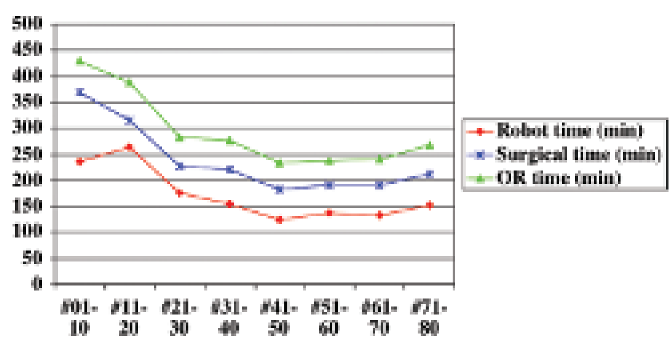

FIGURE 34-7. Line graph depicting the average robot time (red line), the average total surgical time (blue line), and the total OR time (green line). The *x*-axis shows the patient number in groups of 10. The *y*-axis is the average number of minutes.

(range: 75–390 minutes). The first 20 cases averaged 237–263 minutes. The third and fourth groups of 10 patients averaged 176 and 154 minutes, respectively. We now average 130–150 minutes of total robotic time for each case.

The total surgical time started at 369 minutes for the first 10 cases, 263 for the next 10 cases, and 227 minutes for the third group (Figure 34-7). Total surgical time has averaged less than 220 minutes, after our first 30 cases. A total of four patients required conversion to an open procedure. All of these cases were included within the cohort of the first 30 patients who underwent the procedure. The first case was converted to an open prostatectomy because we were not sure that the proper plane had been developed between the bladder neck and prostate. The second conversion, which was our third case, occurred because of improper placement of the camera port. This caused great difficulty with proper visualization of the operative field early in the procedure. The third conversion occurred in case #15 when a rectal injury was noticed; our team did not feel comfortable repairing the injury with the robot. The fourth conversion occurred in case #26, when we attempted a radical prostatectomy on an obese male with a BMI of 39.2. We found a large amount of intra-abdominal adipose tissue in the wall, in the bowel mesentery, and around the bladder, which obscured adequate visualization and impaired our ability to achieve hemostasis.

Total OR time averaged 430 minutes for the first 10 cases, but we currently average a time of 4–4½ hours, which reflects a 45% reduction (Figure 34-7).

The estimated blood loss (EBL) has averaged 399 cc (mean), with a median of 250 cc (range: 50–3500 cc). The 3500 cc blood loss occurred in one of the cases, which was converted into an open procedure as a result of the large body habitus, poor visualization, and nonprogression.

The urologic robotic program at George Washington University Medical Center was initiated with three attending surgeons (one academic urologist, one private practitioner, and one urologist practicing with a large HMO). All three surgeons had significant laparoscopic experience. The operation was divided into the steps noted above. The surgeons agreed to rotate positions during each case, thereby providing everyone with the opportunity to perform each step of the operation. Each surgeon discovered their strengths and weaknesses. There is no doubt that the younger surgeons had an easier time adapting to this approach.

FLOOR NURSING

In our early experience, patients stayed in the hospital 2 to 3 days following surgery, which is typical for open radical retropubic prostatectomy patients. We noted, however, that the robotic patients consistently looked prepared to go home on the first postoperative day (POD #1). We created standard orders for our patients, as well as a document of nursing care requisites for the nurses on the ward. Currently, our patients are discharged on POD #1. To accomplish this goal, we initiate patient pain control in the OR by infiltrating the wounds with 0.25% marcaine; the anesthesiologist then administers intravenous (IV) ketorolac prior to extubation. Pain management on the floor consists of IV ketorolac with oral acetominophen with codeine administered as needed for severe pain. All patients are out of bed to a chair on the day of surgery and then ambulating in the morning following surgery with assistance. Patients are also strongly encouraged to perform incentive spirometry 10–20 times per hour. A clear liquid diet is begun on the afternoon or evening of surgery and quickly advanced to a regular diet on the morning of POD #1.

By 9 AM on the morning of POD #1, patients are on a regular diet with their IV heparin locked, they are ambulatory, and the sequential compression devices are discontinued. Patients receive leg bag training, and the perivesicle drain is removed if the output has been less than 100 cc per shift. If drain output exceeds 100 cc per shift, we choose to leave the drain in place and schedule an outpatient follow-up visit 2 to 3 days later, in order to remove the drain. Each patient is discharged to home after lunch on POD #1 if they are tolerating a regular diet without nausea or vomiting and remain afebrile. Since implementing these standard orders, our average hospital stay once the patient leaves the OR is less than 24 hours.

FINANCIAL CONSIDERATIONS

Achievement of profitability for a robotic urology program can be a challenge. Equipment costs for the initial purchase of the robotic system, system maintenance, and per case instrument costs can be prohibitive.[12,13] Robotic prostatectomy, however, has advantages that should lend itself to monetary benefit, which include shortened hospital stays when compared to open radical prostatectomy and decreased requirement for autologous blood donation and banking. At our institution, our robotic operative times are comparable to that of open radical prostatectomy, which presents neither an advantage nor a disadvantage.

A prospective review of a hospital's managed care contracts should be performed, with the expectation of renegotiation. A special ICD-9 code for robotic surgery does not currently exist. Although Medicare reimburses hospitals on the basis of a diagnosis-related group (DRG), most private insurers pay a fixed amount for each day that the patient is in the hospital. Thus, shortened hospital stays can actually serve as a disadvantage in terms of hospital reimbursement.

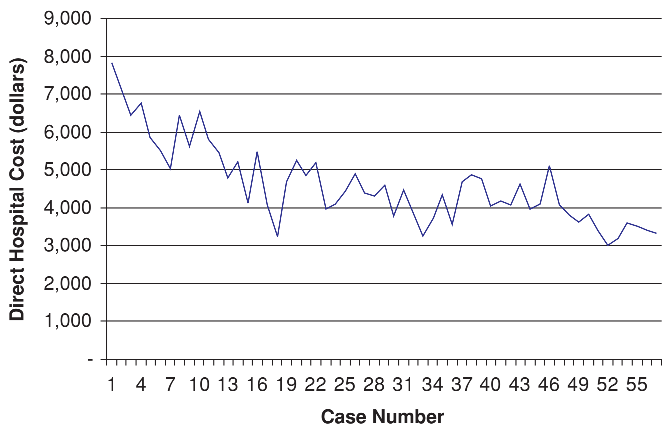

FIGURE 34-8. Line graph depicting the hospital cost per case. The *x*-axis is the case number in sequential order. The *y*-axis is the hospital cost for that particular case.

We have, therefore, found Medicare reimbursements to be uniformly profitable, while other insurance carriers fail to cover the cost of a robotic urologic procedure.

The reduction in direct hospital cost per case over time at our institution is depicted in Figure 34-8. This table excludes the cases requiring conversion to open surgery, because different hospital reimbursements apply. Direct hospital cost was determined using the Eclipsys costing methodology. This system categorizes direct departmental expenses as either variable or fixed. Fixed costs include labor, equipment, OR, hospital facility, and other costs. Variable costs include consumable supplies. Several of these costs are allocated according to relative value unit (RVU).

Reduction in hospital cost has been accomplished by our reduction in robotic operating time with experience (Figure 34-7). We performed a careful review of the instrumentation opened for the procedure and eliminated instruments that were not crucial for the operation. An open operative surgical set, which would be required in the case of conversion, is available in the room but remains in the sterile container. Our technique has also evolved such that we require the usage of only four da Vinci instruments: a hook electrode, a bipolar Maryland grasper/dissector, a single needle driver, and blunt tip scissors. This represents a reduction in two instruments over our original technique and equates to a $400 cost reduction per case. Although average operative time can plateau within 30–40 cases, direct hospital costs have continued to decrease as these ongoing modifications are applied.

RESIDENT TRAINING

A new urologic robotic program will directly impact upon resident training. As more patients are requesting the robotic-assisted laparoscopic radical prostatectomy, the number of open radical prostatectomies will decrease, which directly affects a resident's surgical experience. The robotic-assisted radical prostatectomies are being performed with two attending surgeons: one attending as the operating surgeon at the surgical console and the other attending surgeon as the patient-side assistant. At the George Washington University Medical Center, we invited urology residents to serve as the patient-side surgeon, once we, as attending surgeons, gained a margin of confidence in our robotic skills. Residents place the laparoscopic and robotic ports and perform any of the pure laparoscopic surgery that may be necessary such as lysis of adhesions. They also help with docking of the robot, undocking of the robot, removal of the specimen, and closure of the wounds. We envision that, once a resident has gained sufficient experience as the bedside surgeon (often requiring 30–40 cases), the resident should be eligible to complete the Intuitive robotic training course. This may allow the resident to perform small segments of the procedure as the operative surgeon.

HOSPITAL CREDENTIALING

As this technology is becoming more widely available throughout the medical community, each hospital will have to delineate credentialing standards for use of the da Vinci Surgical System. At the George Washington University Medical Center, we require that each applicant for da Vinci credentials hold full hospital privileges in the Department of Urology. The urologic surgeon must have recent ongoing experience in advanced laparoscopic surgery and performed at least 10 major laparoscopic cases in the past year. A "major" case would include radical nephrectomy, nephroureterectomy, adrenalectomy, cystectomy, pyeloplasty, pelvic lymph node dissection, and retroperitoneal lymph node dissection. Each surgeon must further provide evidence of comprehensive training with the da Vinci robot, including certification by Intuitive Surgical. This training should include hands-on laboratory experience utilizing tissue and/or animal models, with no less than two inanimate dry runs with the team and vendor. Once the Intuitive certification is granted, the urologic surgeon must observe at least two live urologic cases utilizing the da Vinci surgical platform. Upon documentation of an adequate training experience, each surgeon must be supervised and mentored for a minimum of four cases: the surgeon must perform each of the primary roles (bedside assistant and console surgeon) twice before competence can be certified as the primary surgeon. The mentor should, of course, be an experienced robotic urologic surgeon.

The hospital will also accept official robotic training during residency and/or fellowship, which must be verified with a letter of certification of competence from their departmental chairman and accompanied by a surgical case log. A minimum of four additional cases should be observed, with the surgeon performing each of the primary roles (bedside assistant and console surgeon) twice before competence is certified.

CONCLUSION

Successful implementation of a new urologic robotics program requires a well-orchestrated effort, with significant cooperation between the hospital administrators and financial personnel, the OR staff, the anesthesia team, and the urologic surgeons. The initial expenditure is great, and the required training is extensive but absolutely necessary. A team approach is critical to the ultimate success of the program. These issues have been highlighted here and can be used as a road map for other medical centers as they launch this new technology in their facility.

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