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Do Costs of Robotic Surgery Matter?

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1. Introduction

Although robots began as theoretical constructs devised from science fiction novels, they soon became a reality in the automobile industry in 1958 when general Motors introduced the Unimate to assist production (1). Since then robots have been used in a variety of applications including many industrial tasks, and deep-sea and space exploration (2). The first concept of surgical robotics was developed in the late 1980s at the National Aeronautics and Space Centre (NASA). Together with Stanford Research Institute, virtual reality and surgical robotics were integrated and the first steps toward telepresence surgery were made (3). The original model, known as the PUMA 560, was used for neurosurgical stereotactic maneuvers under computed tomographic guidance (2). Commercialisation of robotic surgery started in the early 1990s with the development of complete robotic systems HERMES (Computer Motion, Goleta, CA, USA) and AESOP (Computer Motion, Goleta, CA, USA) (2,4). These systems used voice recognition to control the laparoscopic camera, light source, insufflation and printer. They were designed to reduce surgeon fatigue and to offer a stable visual field. The ZEUS robotic system (Computer Motion, Goleta, CA, USA) and the Da Vinci robotic system (Intuitive Surgery, Mountain View, CA, USA) were introduced in the late 1990s (5,6). Both systems have remote manupilators that are controlled from a surgical workstation. In 2003, Computer Motion was acquired by Intuitive Surgery (6). Today the Zeus system is no longer commercially available and the Da Vinci system is the only telerobot on the market (6). The Da Vinci robot was approved for general surgery by the US Food and Drug Administration (FDA) in 2000, for the use in urology in 2001 and for gynecology in 2005 (6). The use of robotic assisted surgery has grown exponentially over the last few years as there is a clear trend in surgery, driven by patient demand, to develop less invasive approaches to common procedures (7). By the end of 2010 Intuitive Surgery had sold a total 1752 units. Robotic technology has gained popularity in various surgical specialities such as urology, gynecology, thoracic surgery, general surgery, and currently head and neck surgery.

2. The Da Vinci surgical system

The Da Vinci Surgical system has been described nicely by several authors (2,6,8). In brief it has three major components. The first component is the surgeon console. The surgeon sits ergonomically behind the console and controls the robotic system remotely. The console can be placed anywhere in or even outside the operating room. While operating, the surgeon is viewing a stereoscopic image projected in the console and controls the robotic arms with hand manipulators and foot pedals. The second component is the Insite Vision System. This creates three dimensional view by means of two camera control units and two light sources built in the unit. A 12 mm endoscope is used. The viewer gives a six to ten times magnification of the operating field. Because of the 3D view, the visual feedback is excellent and allows the surgeon to work precisely, even without haptic feedback. The third component is the patient-side cart with the robotic arms. The first series of Da Vinci systems had three robotic arms, and the new series all have four robotic arms. One of the arms holds the laparoscope and the other arms holds the various EndoWrist instruments, which measure either 5-8 mm in diameter. Each grasping instrument has its own preprogrammed maximum pressure and can be used in 10 operations before being obligatory replaced. These laparoscopic instruments have 7 degrees of freedom that replicate the full motion of the surgeon's hand. The external robotic arms provide 3 degrees of freedom (insertion, pitchband yaw) and the EndoWrist mechanism provides 4 additional degrees of freedom (pitch, yaw, rotation and grip). These enable the surgeon to manipulate, coagulate, dissect and suture intuitively. The system also allows variety of scaled motion for precise control while eliminating tremors.

3. Advantages of robotic surgery

Robotic-assisted and laparoscopic surgery eliminates the need for large morbid and less esthetical incisions and often decreases blood loss, post-operative pain, use of pain medication and length of hospital stay (2,6), especially when compared to open surgery. Advantages of robotic surgery compared to laparoscopy and open surgery are: improved dexterity, more precise movements and tremor reduction, and better visualisation of the operating field (magnification and 3D). In addition the robot fingertip hand control mechanism is "intuitive", meaning that the robotic instruments will move just as your hands move, rather than as a mirror image movement as in laparoscopy. This eliminates the fulcrum effect observed in laparoscopy in which a surgeon must move his hand in the opposite direction to the intended location. For example, to have the laparoscopic scissor tips at the patients right ovary, the surgeons hand must move left (8). The robotic digital process allows scaling down the surgeons's hand movements to a level at which microvascular or microscopic procedures are feasible. Difficult, minimal invasive surgery is accesable for surgeons without advanced laparoscopic training as it has a short learning curve (6, 9). Fatigue and frustration become less of a limiting factor for the robotic surgeon compared to the laparoscopic surgeon (10).

4. Limitations of robotic surgery

The major drawback of the Da Vinci system is the loss of tactile and force feedback. This can be surmounted by training and is partially compensated for by the 3-D visual feedback. However it often leads to rupturing of suture material during knot tying by beginning robotic surgeons. In addition placing the trocars is limited in order to avoid collision of the robotic arms. With the current equipment this leads to difficulties to operate in the lower and upper abdomen simultaneously. In gynecologic cancer staging procedures, requiring higher paraaortic lymph node dissection, the robot sometimes must be dedocked after completing the pelvic portion of the surgery, the operating table turned 180 degrees , new ports placed, and the robot redocked facing the upper abdomen (8). This problem can be partially solved by positioning the robot lateral to the patient and not in between the legs, but currently remains a drawback. With laparoscopic surgery, the surgeon tends to place the ports in more 'natural' and anatomical positions. Esthetically, ports of a laparoscopy are much better located (eg the umbilicus and just medial to the anterior superior iliac spine) than the 'forced' trocare placements in an arch, commonly used for robotic assisted procedures. The use of larger trocars (11mm versus 5 mm) is an additional esthetical disadvantage for robotic surgery compared to laparoscopy. The cart with the robotic arms, which is positioned close to the patient, makes access to the patient limited. Particularly in gynecologic surgery it is sometimes difficult to remove the uterus and other specimens from the vagina after the robot has been docked (2). Due to the sophisticated technology a robotic team of specialized surgeons, anaesthesists and dedicated nursing staff is mandatory to make a robotic program function optimally. Particularly the surgeon and nursing staff need specific training. This makes the use of robotic surgery less practical for non-elective cases. Conventional open surgery, laparoscopic surgery and robotic surgery require different skills. As the robot is a high tech complicated instrument to master, adequate training is mandatory before embarking on surgery in patients. It is important to train basic laparoscopic and robotic skills in a box trainer, on a cadaver or on animals (6). However the major disadvantage of robotic surgery are the high cost of purchase, maintenance and instruments of the robotic system.

5. Cost of robotic surgery

5.1 Equipment

There is a major difference in operative costs between open, lapoaroscopic, and robotic surgery resulting from added expense of specialized equipment. Equipment costs associated with laparoscopic surgery have a relatively low per-case cost as it is multipurpose (eg. monitors and cameras can be used for laparoscopy but also for hysteroscopy) and can be used by different specialities for many types of surgery (11). On the contrary, the Da Vinci robot, costsing over 1.500.000 Euro, and requiring a yearly service contract of 150.000 Euro, has a more limited number of applications. The fixed costs depend greatly upon the number of cases being operated over the amortized life span of the robotic system. If utilized for 300 cases per year and amortized over 7 years it adds more then 1000 Euro per case, but if less patients are operated yearly the costs of robotic assisted surgery increase even more. Such costs are not reimbursed by the hospital. The robot also offers a distinct financial disadvantage because each instrument only has a limited preprogrammed (n=10) number of uses, such that the added cost for instruments and drapings per case can be as high as 1700 Euro per case. The major factor affecting the costs of laparoscopic surgery is the price of laparoscopic instruments. This depends on the type and number of instruments which are used. Generally (semi)reusable instruments are cheaper per case compared to disposable instrument (12). Although one would expect equipment costs to decrease with time (analogous to the retail computer market) there has been an increase in costs that exceeds inflation despite an increase in the number of procedures performed nationwide (11,12). There has been no decrease in the costs of robot-related products due to the lack of market competition.

5.2 Operative times

Operative times play an important role in determining the operative costs. They include the time to start up the procedure, to do the surgery and to prepare the surgical theatre for the next operation. These costs are calculated in 15-30 min intervals. Costs of anesthesia also increase over similar time intervals. In general, the set-up and brake-down of the robotic system takes significantly longer compared to the preparation of laparoscopic or open surgery. For many procedures operative times are lower for open surgery, intermediate for robotic surgery and slightly longer for comparable laparoscopic surgery (10). As experience grows with a certain techniques operative time becomes shorter until they stabilize at a certain level. Lenihan et al showed that the the total operative times for robotic hysterectomies stabilized at approximately 95 minutes after 50 cases (9) A study that evaluated the learning curve in a series of robot assisted laparoscopic prostatectomies found that the learning curve may range from a low of 13 cases to a high of 200 cases depending on the surgeon (13). The average initial time to perform this procedure in this cohort was 424 min, with a final operative time of 230 min per case. The costs of the learning curve are high and can vary widely. For robot assisted laparoscopic prostatectomies costs of the initial learning cure varied from 49,613 US Dollars to 554,694 US dollars with an average of 217,034 US dollars (13, 14). As in most centers surgeons already went through their learning curves for open and/or laparoscopic surgery the robotic learning curve is an added cost. To overcome these extra costs, the concept of high volume centers is of great importance. In such units the learning curve can be rapidly traversed and costs minimized. Robotic surgery is specifically suitable for virtual reality training , as the operation itself is computer guided. Different companies are developing virtual reality simulators for robotic surgery. This may reduce the learning curve significantly and is likely to be the training of choice for the surgeons of tomorrow (15).

5.3 Hospital stay

Room and board costs represent an important part of the overall cost of hospitalization. For many procedures, the main financial advantage for the laparoscopic and robotic approach is the decreased hospital stay (11,16). The reduced number of impatient hospital days and earlier return to regular diet allows for cost savings. These savings can compensate for added expenses in the operating room and result in cost superiority of some procedures. It is important to realize that the costs of hospitals beds vary between hospital, especially between community hospitals and academic medical centres (6). Up to now, there have not been any publications demonstrating an advantage of a robotic-assisted laparoscopic approach over ‘pure’ laparoscopic approach in terms of rooms and board (11).

5.4 Other costs

In general laparoscopic and robotic procedures allow patients to resume their normal family and professional activities sooner (8,10). It is difficult to calculate the savings for society as sick leave, insurance for inability to work, etc… vary enormously on an individual basis. There is no evidence that long term morbidity varies considerably between open, laparoscopic and robot-assisted procedures (16).

An interesting advantage of robotic surgery is the more ergonomic position of the surgeon to perform a procedure. Loss of economic productivity of surgeons related to doing laparoscopic and open surgery (eg cervical hernia) is a severely underestimated factor. A recent survey by Matern et al on this subject shows that 97% of surgeons think improvement of ergonomics in the operating theatre is necessary (17).

6. Cost analysis of robotic procedures

6.1 Gynecologic surgery

Sarlos et al compared the costs of 40 consecutive robot-assisted hysterectomies with 40 matched total laparoscopic hysterectomies. There were no conversions to laparotomy or major morbidity in both groups (18). Operating time was 83 (55-165) versus 109 (50-170) minutes, and hospital stay 3.3 (2-6) versus 3.9 (2-7) days. Average surgical costs were 4067 Euros for the robotic group compared to 2151 Euros in the laparoscopic group.

Using the Premier Hospital Database Paric et al identified women above 18 years of age with a record of minimally invasive hysterectomy performed in 2007 to 2008. Of 361888 patient records analyzed from 358 hospitals, 95% (N=34527) of laparoscopic hysterectomies were performed without robotic assistance (19). Inpatient procedures with and without robotics cost 9640 vs 6973 USD, respectively (difference strongly significant). Similar differences were found for outpatient procedures (7920 vs 5949 USD). There were little clinical differences in perioperative and postoperative events. Only surgical times were significantly longer for robot-assisted procedures.

Barnett et al used decision modeling to compare costs associated with robotic, laparoscopic and open hysterectomy (20). The societal perspective model predicted laparoscopy (10128 USD) as the least expensive approach followed by robotic (11476 USD) and open hysterectomy (12847 USD). In the hospital perspective models laparoscopy was least expensive (6581 USD) followed by open (7009 USD) and robotic hysterectomy (8770 USD).

Rodgers et al made a comparison with open surgery and calculated that robotic surgery increased the costs for tubal anastomosis by 1446 US dollars (21). However Dharia Patel et al found that the cost per delivery was equal (22). Robotic rectopexy proved to be 755 USD more expensive than laparoscopic rectopexy (23). Advicula et al showed that robotic myomectomy had less complications and shorter hospital stay (24). They calculated that mean hospital reimbursement was 30064 USD (SD: 6689) for the robotic procedure vs 13400 USD (SD:7720) for open surgery

Outcomes and costs for endometrial cancer staging via traditional laparotomy (N=40), standard laparoscopy (N=30) and robot assisted surgery (N=40) were compared in one single institution by Bell et all (25). Patients undergoing robotic assisted hysterectomy and staging experienced longer operative times than the laparotomy cohort but with no difference in comparison to the laparoscopic cohort (184 min vs 108 mi vs 171 min, $p > 0.0001$, $p = 0.14$). Estimated blood loss was significantly reduced for the robotic cohort in comparison to the laparotomy cohort and comparable to the laparoscopic cohort. The complication rate was lowest in the robotic group (7.5%) relative to laparotomy (27.5%) and laparoscopic group (20%) ($p = 0.015$, $p = 0.03$). Average return to normal activity for the robotic patients was significantly shorter then those undergoing laparotomy (24 vs 52 days, $p < 0.001$) and those undergoing laparoscopy (31 days, $p = 0.005$). Lymph node yields were similar in all groups. The total average cost for hysterectomy with staging completed via laparotomy was 12943 USD, for standard laparoscopy 7569 USD and for robotic assistance 8212 USD.

6.2 Urologic surgery

One of the largest cost analyses of robotic surgery, compared to open and laparoscopic surgery, was made by Bolenz et al for radical prostatectomy (26) . The study included 643 consecutive patients who underwent a radical prostatectomy: 262 robotic_assisted laparoscopic radical abdominal prostatectomy (RALP), 220 laparoscopic radical prostatectomy (LRP), and 161 open (retropubic) radical prostatectomy (RRP) Disease characteristics were similar in the three groups. Lymphadenectomy was more commonly performed in RRP (100%), compared to LRP (22%) and RALP (11%) (p<0.001). Nerve sparing was performed in 85% of RALP procedures, 96% op LRP procedures and 90% of RRP procedures (p< 0.001). Mean length of hospital stay was higher RRP than for LRP and RALP. The median direct costs were higher for RALP compared to LRP or RRP (RALP 6752 USD, LRP 5687 USD, ORP: 4427 USD, p< 0.001). The main difference was in surgical supply cost (RALP 2015 USD, LRP 725 USD, RRP 185 USD, p < 0.001) and operating room costs (RALP: 2798 USD, LRP: 2453 USD, ORP: 1611 USD, p < 0.001). When considering purchase and maintenance costs for the robot, the financial burdon would increase by 2698 USD per patient, given an average of 126 cases a year. The authors conclude that these costs may have significant impact on overall costs of prostate cancer care in the United States.

Smith et al performed a comparative cost analysis of 20 prior cases of robotic and open cystectomy. Mean fixed operating room costs for robotic surgery were 1634 USD higher than for open cases. Operating room variable costs were also higher by a difference of 570 USD directly related to increased operating room time. Hospital costs were nearly identical for the fixed component while variable costs were 564 USD higher for the open approach secondary to higher transfusion costs and longer mean length of stay. Based on these findings robotic assisted laparoscopic cystectomy is associated with a higher financial cost of + 1640 USD than the open approach in the perioperative setting.

6.3 Gastrointestinal surgery

Costs of robotic assisted and laparoscopic cholecystectomy were analyzed in a case-control study by Breitenstein et (28). Fifty consecutive patients undergoing robotic assisted cholcystectomy between December 2004 and February 2006 were matched 1:1 to 50 patients with conventional cholecystectomy. No minor and one major (2%) complication occurred in each group and there were no conversions to open surgery. Operation time (skin to skin: 55 min vs 50 min, p=0.85) and hospital stay (2.6 vs 2.8 days) were similar. Overall hospital costs were significantly higher for robotic assisted cholecystectomy: 7985 USD (SD 1760) versus 6255 USD (SD 1956), p < 0.001, with a raw difference of 1730 USD (95% CI 991-2468) and a difference adjusted for confounders of 1606 USD (95% CI 1076-2136). This difference was mainly related to the amortization and consumables of the robotic system.

Hubens et al performed a retrospective analysis on 45 patients (mean BMI 44.2) who had a Roux-en-Y gastric bypass procedure (RYGBP) with the aid of the Da Vinci robot system compared to 45 patients (mean MI 43.9) who underwent a laparoscopic RYGBP (29). Although the initial total operating time was shorter for the laparoscopic cases, the last ten robotic cases were performed in a similar time as the laparoscopic cases (136 vs 127 min). There were no differences in postoperative complications between the two groups in terms of anastomotic leakage or stenosis. In the robotic group more conversions to open surgery were noted (five patients) because of laceration of the intestines with the robotic arms. This is probably inherent to the learning curve of the procedure. The costs were higher for robotic surgery than for standard RYGBP, mainly because of the extra equipment used.

6.4 Thoracic surgery

The financial impact of employing minimally invasive techniques for lobectomy compared with traditional open thoracotomy was assessed by Park et al (30). A retrospective review was conducted using ICD9 codes for thoracotomy, video-asisted thoracic surgery (VATS) and robotic VATS lobectomy to determine total average costs associated with the resultant hospital stay in Memorial-Sloan Kettering Cancer Center (USA). Robotic VATs lobectomy had higher associated costs then VATS only, primarily attributed to increased costs of the first hospital day, but was still less costly than thoracotomy. The average cost of VATs is substantially less than thoracotomy primarily because of a decreased length of stay. Casali and Walker could partially confirm these data in a retrospective analysis of 93 patients undergoing a VATS lobectomy and 253 a lobectomy by thoracotomy in the Royal Infermary of Edinburgh (UK) (31). Overall cost for a VATS lobectomy was 8023+/-565 Euro which was less than open lobectomy 8178+/-167 Euro (p=0.0002).

6.5 Cardiac surgery

Jones et al prospectively analyzed two cohorts undergoing off-pump coronary revascularization by minithoracotomy using robotic procedure or by classic sternotomy (32). The patient groups were matched for the number of coronary arteries revascularized and risk factors known to influence perioperative outcome. Patients undergoing robotic minithoractomy had shorter intubation times (4.8 vs 12 hours, $p < 0.001$), intensive care unit stay (22 vs 51 hours, $p < 0.001$)), total hospital stay (3.8 vs 6.4 days, $p< 0.001$) and lower blood transfusion requirements (0.2 vs 1.4 units, $p < 0.001$). Despite increased operative costs for supplies, longer operating room times, and additional radiology services, the total hospital costs were equivalent between groups. However, this analysis did not include the initial acquisition of the robot ! These authors found that the advantages of robotic technology had the greatest impact on postoperative cost for patients with characteristics that places them at high risk for long hospital stays (eg elderly, ejection fraction 20%, poorly controlled diabetes, chronic obstructive pulmonary disease and receiving home oxygen). The incidence of major postoperative cardiac and cerebrovascular events was 26% in the open CABG group compared with 4% after robotic mini-CABG (hazard ratio 3.9; 95% CI: 1.4-7.6; $p = 0.008$). Minimally invasive CABG was associated with significantly shorter time to return to work versus sternotomy (44 vs 93 days, $p = 0.16$). These findings are particularly relevant to low-risk patients, a subgroup who are especially concerned with the adverse effects of a prolonged recovery on early quality of life.

Robotic mitral valve repair (MVR) has been performed in Australia since 2004. Kam et al retrospectively compared 107 robotic and 40 conventional MVRs and performed an ad hoc cost analysis (33). The post-operative degrees of mitral regurgitation were comparable. Total operating time was 18% longer in robotic compared to conventional (239 vs 202 min, $p< 0.001$). In robotic cases intensive care unit stay (37 vs 45 hours, $p= 0.002$) and hospital stay (6.4 vs 8.8 days, $p< 0.001$) was reduced. Mean hospital cost, without including capital costs, was comparable (18503 AUD vs 17880 AUD, $p=0.176$).

Morgan and colleagues conducted a retrospective review of clinical and financial data of 20 patients undergoing atrial septal defect closure, and 20 patients who underwent mitral valve repair (MVR) using either robotic techniques or a conventional approach by sternotomy (34). Robotics did not significantly increase the total hospital cost for ASD closure or MVR. However when including the initial capital investment for the robot total hospital costs were increased by 3773 USD for robotic ASD closure and 3444 USD for robotic MVR (p = 0.021 an p=0.004).

6.6 Pediatric surgery

Anderberg et al calculated costs using regional hospital prices for their first 14 robot-assisted fundoplications in children, compared to their last ten similar laparoscopic and open procedures (35). The mean costs of the robotic procedure was 9584 EUR, of the laparoscopic surgery 8982 EUR and of the open surgery 10521 EUR. Patients seemed to benefit from the use of robotic surgery having less postoperative pain and a shorter hospital stay.

7. How important are costs

Technologic innovation in health care is an important driver of cost growth. Doctors and patients often embrace new modes of treatment before their merits and weaknesses are fully understood (36). Robotic technology has been readily adopted over the last five years in both Europe and the United States (16). The number of robot-assisted procedures that are performed world wide has nearly tripled since 2007, from 80000 to 250000 in 2009 (36). The present review of the literature shows that currently robot-assisted surgery is consistently more expensive then video-laparoscopy and in many cases to open surgery. Across the full range of 20 types of surgery for which studies exist the average additional variable cost was about 1600 USD per patient, rising to more then 3000 USD when the amortized cost of the robot itself was included. It seems that currently only for very complex surgical procedures, such as cardiac surgery, its costs can be competitive to similar open surgical procedures. Some authors have suggested that robotic technology may have contributed to the substitution of surgical for non-surgical treatment for certain diseases (36). The observed pattern matches evidence from the Surveillance, Epidemiology and End Results Medicare database, and shows that Medicare beneficiaries who received a diagnosis in of prostate cancer in 2005 were about 14% more likely to have undergone surgery by 2007 than their counterparts whose prostate cancer was diagnosed 3 years earlier (37). This is likely affecting costs on the long run as some studies show more adjuvant radiotherapy is used after robotic prostatectomy (38) It has been calculated that if robotic assisted surgery would replace conventional surgeries for the full range of procedures for which cost studies have been done, it would generate nearly 2.5 billion US$ in additional health care costs in the United States (36).

The development of new technology and new medications often has a financial motive and the willingness of hospitals and healthcare systems to acquire these advancements often is an economic consideration (16). Patients only demand the robot because it is marketed to them by hospitals and purchasers of the machines in hopes of a nice return on investment. The health care system in many countries is prepared to cover new technologies at higher rates than older technologies, even when there is no proof that the newer technologies provide an additional benefit. Therefore the crucial question is whether robotic surgery, being more expensive, is better than comparable traditional video-endoscopic and open surgery. Generally most robotic and laparoscopic procedures have less short term morbidity, blood loss, intensive care unit and hospital stay then open surgery (6,11,18-35). Up to now no major differences have been found between robot-assisted and classic video-assisted procedures for these factors. Most experience on cost calculation for robotics has been gathered in urology. In a recent editorial in European Urology Graefen writes "Are these extra costs justified ? Maybe yes, if an advantage for robotic assisted radical prostatectomy over other approaches were documented, but this is currently not the case" (38). Reviewing the literature on this subject this author concludes that it is clear that high surgical volume is crucial to have a good results, but functional outcome (ie continence and erectile function) is not better and in fact significantly more salvage radiotherapy is necessary after robotic surgery. Currently, long term oncologic outcome is not certain after robot-assisted prostatectomy. Similar echos are coming from the other side of the Atlantic. Lotan from Texas wrote in 2010 in Current Opinion in Urology :"These added costs have not been associated with significant improved outcomes over pure laparoscopy or open procedures. In order for the robot to be cost effective, efficacy needs to be improved over alternative approaches and costs of the robot or instruments need to be decreased" (11). Breitenstein goes even further by saying "Costs of robots are high and currently do not justify the use of this technique due to the lack of proven benefit for patients. A reduction of acquisition, maintenance and disposable costs of the robotic system is a prerequisite for large scale adoption and implementation of this technique. The exponential use of robotic surgery is not based on evidence based benefits but mainly patient driven, stimulated by enthusiastic surgeons who love these "high tech toys" and a smart marketing machine driven by the manufactures. In order to stay viable, robotic programs will need to pay for themselves on a per case basis. Although it is likely that there is a great future for robotic surgery its advantages should not be taken for granted and should be further investigated. Multicenter international trials including a health economic section are needed to demonstrate that the higher costs are warranted by superior outcomes. Until then physicians have a responsibility to society and their patients to deliver the best possible care at justifiable cost.

8. Future perspectives

It has been estimated that the introduction of robotic surgery has increased the costs of certain forms of health care significantly with little proven benefit. Attempts can be made by the surgeon to minimize the costs of robotic surgery by reducing the number of instruments used (4 in stead of 5 instruments: use of only one needle driver saves 292 Euro), reducing the operating time of a procedure (get more experience), training dedicated robotic surgeons (not everybody can and should do this surgery in a unit), and stimulating early discharge of the patient when possible (savings will be greater in high cost university hospital vs low cost hospital). The hospital can decrease the costs by increasing the case load by stimulating multidisciplinary use of the robot centralization of robotic surgery. Robotic surgery should only be used for complex surgery. Last but not least: it is of paramount importance that the price of the robot, the maintenance costs, and the price of the drapings and instruments is reduced by the manufacturer in order to keep robotics affordable in most health care systems. Intuitive Surgical virtually has a monopoly in robotic surgery and competition is needed in this field. Manufacturers of laparoscopic devices should be creative to make laparoscopic surgery more accessible to facilitate the use of video-endoscopic surgery, which up to now seems to have a similar efficacy as robotic surgery. However, the future of robotics looks bright as robots will become even smaller and easier to handle, surgeons will get better performing robotic surgery, and eventually robots will become cheaper as almost all electronic devices did when they became more mature with many competitors on the market.

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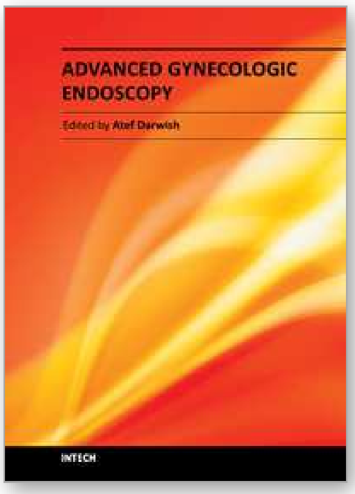

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The main purpose of this book is to address some important issues related to gynecologic laparoscopy. Since the early breakthroughs by its pioneers, laparoscopic gynecologic surgery has gained popularity due to developments in illumination and instrumentation that led to the emergence of laparoscopy in the late 1980's as a credible diagnostic as well as therapeutic intervention. This book is unique in that it will review common, useful information about certain laparoscopic procedures, including technique and instruments, and then discuss common difficulties faced during each operation. We also discuss the uncommon and occasionally even anecdotal cases and the safest ways to deal with them. We are honored to have had a group of world experts in laparoscopic gynecologic surgery valuably contribute to our book.