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Step-by-step roadmap to building a robotic acute care surgery program (RACSP) in a level I trauma center: outcomes and lessons learned after 1-year implementation

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SUMMARY

Minimally invasive surgical techniques have demonstrated superior outcomes across various elective procedures. Laparoscopic surgery (LS) is established in general surgery with laparoscopic operations for acute appendicitis and cholecystitis being the standard of care. Robotic surgery (RS) has been associated with equivalent or improved postoperative outcomes compared with LS. This increasing uptake of RS in emergency general surgery has encouraged the adoption of robotic acute care programs across the world. The key elements required to build a sustainable RS program are an enthusiastic surgical team, intensive training, resources and marketing. This review is a comprehensive layout elaborating the step-by-step process that has helped our high-volume level I trauma center in establishing a successful robotic acute care surgery program.

INTRODUCTION

Minimally invasive surgical techniques have demonstrated superior outcomes across various elective procedures, as evidenced by reduced hospital stays, accelerated return to daily activities, and earlier resumption of work.[1–4] Laparoscopic surgery (LS) is established in general surgery with laparoscopic operations for acute appendicitis and cholecystitis being the standard of care.[5 6] Previous studies have found that robotic surgery (RS) has been associated with equivalent or improved postoperative outcomes compared with LS.[7–9] Robotic surgical system offers features such as deep magnification, stereoscopic vision, motion scaling, and better ergonomics, which may better facilitate the ability to perform these procedures and optimize outcomes.[10] Between 2012 and 2018, there was an eightfold increase in general surgical robotic interventions, reaching up to 15.1% of all general surgical procedures in the USA.[9] This trend prompted the publication of a position paper by the World Society of Emergency Surgery.[11] Recent literature has found that LS reportedly decreased for cholecystectomies and colectomies from 2013 to 2021. RS was associated with a lower conversion rate to open surgery (OS) in cholecystectomies, colectomies, inguinal hernia and ventral hernia. Additionally, RS was linked to a shorter postoperative length of stay compared with LS for colectomies, ventral hernia, and inguinal hernia.[12] This increasing uptake of RS in emergency general surgery has encouraged the adoption of robotic acute care programs across the world.[11 13 14]

The key elements required to build a sustainable RS program are an enthusiastic surgical team, intensive training, resources and marketing. A thorough design and implementation process are imperative for a seamless transition and successful adoption of RS. With a well-developed robotics program, a hospital can maximize its financial success while delivering cutting-edge healthcare to patients.

The rising demand for minimally invasive surgery (MIS) coupled with our desire to provide our patients with the best care possible encouraged us to build a robotic acute care surgery program (RACSP) at our institution. This review is a comprehensive layout elaborating the step-by-step process that has helped our high-volume level I trauma center in establishing a successful RACSP.

Step 1: The ision

Recognizing the growing demands for MIS and the desire to improve patient outcomes, we sought out to enact a vision of creating a RACSP. The goal of the program was to achieve reduction in the rates of OS and provide tangible benefits for patients in the form of decreased length of hospital stay and swift postoperative recovery.[12 15]

Our primary objectives were to reduce the rate of conversion to OS, grow the robotic acute care service, provide evidence-based surgical care, incorporate innovative surgical practices, enhance modern surgical skill development among training surgeons, and to bring forth future leaders in acute care surgery (ACS).

Step 2: Navigating the market and empowering communities

To understand the implications of pursuing a RACSP, we assessed our hospital footprint and compared benchmark data to the market average rates (New York-Newark-Jersey City, NY-NJ-PA Metropolitan Statistical Area (CBSA 35620)) using data derived from the IQVIA database (table 1).[16 17] The IQVIA database leverages three major sources

Table 1 MIS vs. open rates based on emergency general surgery procedures

Procedures	Robotic (%)	Laparoscopic (%)	Open (%)	Market average open (%)
Cholecystectomy	10	61	29	7
Colectomy	32	0	53	68
Inguinal hernia repair	24	34	47	66
Ventral hernia repair	3	12	57	84

The rates are institutional compared with market average open rates (CMS, state-level departments of health, and switches and claims intermediaries).
CMS, Centers for Medicare & Medicaid Services; MIS, minimally invasive surgery.

and inadvertently reducing costs, thus benefiting the patient and the center.

Our center possessed a well-defined robotics program for gynecology and urology. This existing program demonstrated the benefits and utility of RS to the management, enabling them to fully support the RACSP.

Step 3: Building a RACSP task force and mobilizing stakeholders for change

The next step is to appoint a clinical champion leader to advocate on behalf of RACSP. At our center, the chief of trauma/ACS took up this role.

The clinical champion leader's responsibilities included:

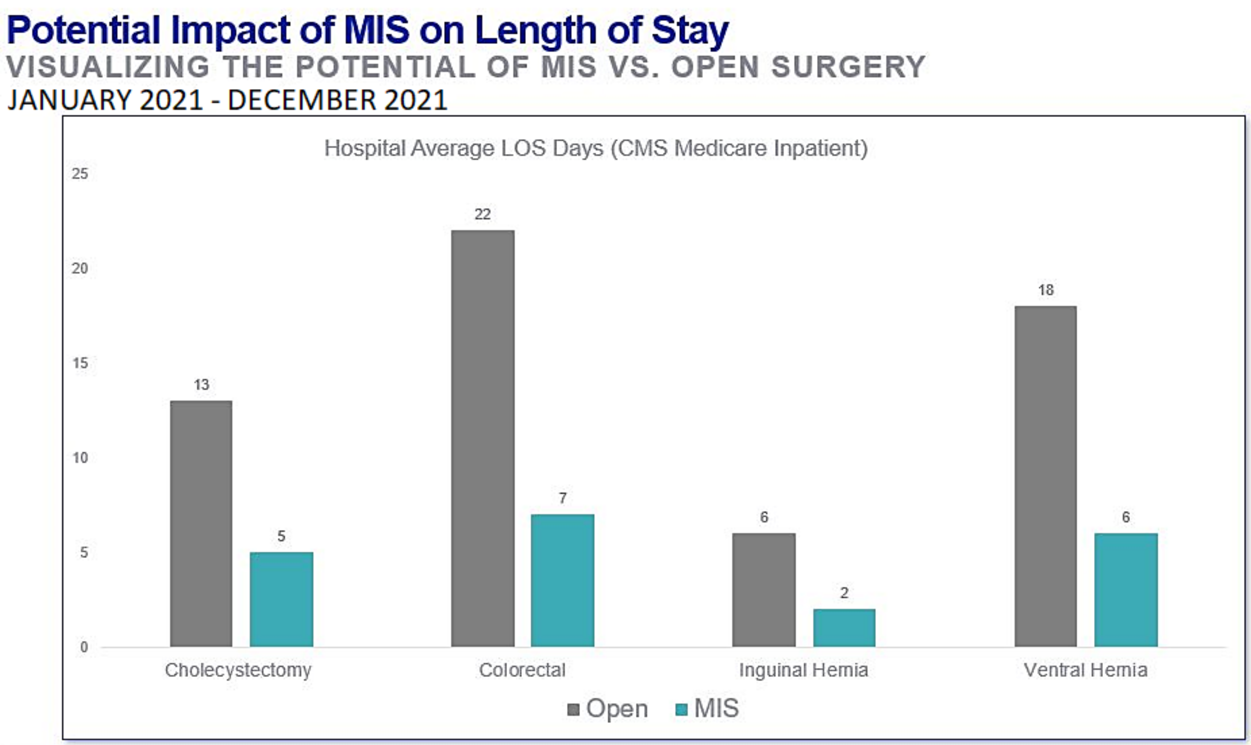

Figure 1 Average hospital length of stay (LOS) days between Open and MIS using CMS Medicare Inpatient Database. CMS, Centers for Medicare & Medicaid Services; MIS, minimally invasive surgery.

of data (the Centers for Medicare & Medicaid Services (CMS), state-level departments of health, and switches and claims intermediaries) in the medical claims landscapes in its hospital procedures and diagnosis models to estimate procedure volume and Open/MIS mix.

To put things into perspective, we looked into the potential impact of MIS on the length of stay in comparison to OS based on the CMS Medicare Inpatient Database, which publishes data on the full complement of inpatient (IP) and outpatient (OP) data for all procedures performed on Medicare patients.[18] The measured difference in average hospital length of stay was lower for MIS cases compared with open cases for cholecystectomy (7 days vs. 13 days), colorectal procedures (7 days vs. 22 days), inguinal hernia repair (2 days vs. 6 days) and ventral hernia repair (6 days vs. 18 days) (figure 1) based on CMS data comparing our institution. In addition to providing a high standard of care and allowing patients to return home sooner, performing MIS increases the hospital's capacity to provide care to a larger patient volume by increasing the availability of beds,

- ► Advocate for RACSP.
- ► Articulate the vision for RS within the division/hospital/network.
- ► Have measurable and attainable goals that can be tracked.
- ► Draft a letter of intent to the leadership with their plan for the program.

The executive/administrative champion is another key player whose role is critical in aligning the plan with the hospital's leadership, supporting the clinical champion leader, and identifying key stakeholders and allies to create the RACSP task force to drive the initiative forward.

In advocating for RACSP, the task force brings forth several potential benefits of RS for routine MIS such as cholecystectomy and hernia repair. Among these advantages are the potential for enhanced precision, improved visibility, and better control over surgical instruments and the operating field with the additional advantage of being able to incorporate fluorescence imaging, offering a more refined understanding of the biliary tree anatomy, thereby promoting safer handling of structures.[19 20] In the context of hernia repair, this transition will enable primary defect closure, resulting in a robust repair and eliminating the need for tackers, which contribute to postoperative pain.

Our overarching objective was to reduce the overall prescription of narcotics for patients and facilitate a quicker return to work compared with our current practices.

Step 4: The blueprint for success

The clinical champion leader with the trauma/ACS team developed a comprehensive strategy aimed at facilitating a seamless transition toward robotic training and adoption in ACS. These initiatives include:

- Build a team cadence by training one surgeon at a time.
- Funnel elective cases for a minimum of 90 days.
- Partner with administration regarding models of productivity/compensation.
- Secure regular block for daytime cases (elective and emergency general surgery).
- Expand robotic access 24/7 for add-on and emergent cases.

These efforts were undertaken concurrently, with some milestones already accomplished and others still in progress. Acute care surgeons face unique time challenges while managing call days, trauma/ACS, clinics, and intensive care. To address this, we decided to prioritize a single surgeon at a time with a bolus of cases within 90 days. Each surgeon in the trauma/ACS team pooled up their elective cases to facilitate their colleague's training, showcasing exceptional teamwork and camaraderie.

The goal was to overcome the learning curve quickly and efficiently without disrupting the current clinical practice. In addition, this ensured one-on-one training with the RS representative and adequate surgical volume for each surgeon to be confident in their skills. This way, each surgeon is set up for success in their own timeframe.

We decided against training several surgeons at a time as we lacked the resources for it. Additionally, training two or three surgeons at once would cut into the number of elective cases that each surgeon performed on, undermining their confidence and skills, which could hurt patients and the program.

The RS representative played an important role in managing the surgeon's schedules, coordinating their call days, robotic training days, and RS days. To further facilitate the training process, 2 days of the week were dedicated to robotic ACS in addition to elective block time to ensure more than adequate clinical training time was provided to the trainee surgeon.

Step 5: Preclinical training pathway

For the safe implementation of robotic ACS, standardized training based on established criteria is essential. The da Vinci technical training pathway for physicians is divided into three phases.[21 22] Phases I and II occur during 4–8 weeks. During phase I, the surgeon in training is introduced to the technology and involves a trial on the equipment, gallbladder case video review, cholecystectomy, and inguinal hernia repair presentation. After this, the trainee surgeon would have a mentoring visit, where they would observe cases performed by a high-volume robotics center/surgeon.

This is followed by phase II, which involves online training (modules and certification), in-service training (docking practice and port placement philosophy), suture practice, procedure test drive, online assessment, and dry run (mock procedure). The purpose of the mock procedure is to teach the trainee surgeon about docking and performing mock surgical procedures on the trainer box with the representative prior to practicing at the wet lab.

Step 6: Clinical implementation—a united front

After the training lab, the first procedure is scheduled the subsequent week and is the first of five proctored cases. In phase III of the training program, a robotic-trained surgeon from a partner hospital/high-volume robotics center assumes the role of a proctor. Their responsibilities include evaluating the trainee surgeons, providing guidance on new skills, and, when necessary, assuming leadership of the surgical case based on clinical requirements. While our program mandates a minimum of five proctored cases to obtain temporary credentials, the number required to instill confidence in each surgeon varies. Assessment of the trainee surgeon is conducted using a standardized proctoring form.

On receiving the proctor's evaluation, the task force/credentialing committee deliberates on whether to grant the trainee surgeon a credential or whether further training is necessary. This evaluation encompasses preoperative, intraoperative, and postoperative performance, with the intraoperative score ranging from 1 to 3, representing inadequacy to competence, respectively, supplemented by proctor's additional remarks. A letter of preliminary credential is given to the trainee after they have finished the first five proctored cases.

The first five cases were chosen after a critical review of the patient profile to ensure the cases were uncomplicated. An essential part of smooth transitioning was to be selective with cases, and not to overwhelm surgeons to perform cases that they were not comfortable performing or did not feel safe for their patients. It was implied that any case that the credentialed surgeon could perform laparoscopically, they had the freedom to perform robotically after receiving adequate training. Surgeons were not required to be credentialed in particular laparoscopic cases to be allowed to do the same procedure using the robotic technique. However, if a surgeon wanted to operate on a particular case outside of their credentialed procedure sets, a proctor proficient in managing that case would provide one-on-one training for a minimum of five cases or until they were confident enough to take on the case.

The subsequent 15 cases are uncomplicated OP cases, and in our RACSP, the first 20 cases for all training robotic surgeons included uncomplicated cholecystectomies and inguinal hernia repairs. These 15 cases were performed by the preliminary credentialed trainee without a proctor present. Near the end of the 20 cases, the training surgeon can take on more challenging IP cases of cholecystectomy and inguinal hernias. This graduated skill development allowed the trainee to seamlessly transition into performing any grade of robotic cholecystectomy case or inguinal hernia case. The combined efforts of the entire surgical team were needed to support the growth and evolution of the program.

A total of 20 cases must be completed to obtain full unrestricted credential/privileges from the administration/hospital to perform RS. Aside from the first trainee surgeon, all subsequent surgeons who received training had a fellow trained surgeon present in the operating room (OR) at all times for troubleshooting/assistance during the procedure.

After each robotic case, there is a debriefing session to evaluate both the smooth transition between surgical steps and answer queries that may have risen during the case. Any deviations from the standard protocol during surgery are addressed in the postoperative debriefing sessions.

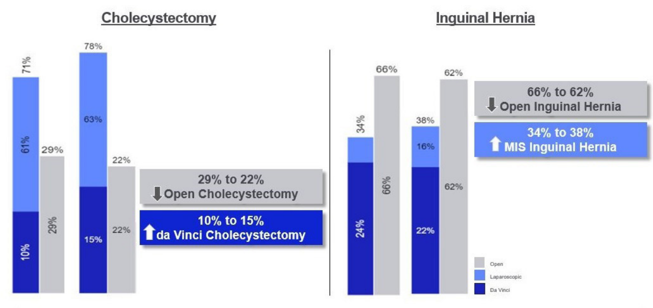

Figure 2 Impact of first 81 robotic procedures on open rates. MIS, minimally invasive surgery.

During the initial stages of RACSP, cases that the surgeon is not comfortable performing in a minimally invasive fashion were not considered for robotic repair. The reasons for this may include patient condition, need for OS or surgical history. Over time, as surgeons became more proficient in RS, they increasingly opted for the robotic approach even in cases of high acuity and complexity. However, the choice of RS as the preferred method still largely depended on each surgeon's comfort level in managing complex cases using robotic techniques.

Step 7: OR requirements

The presence of established robotic urology and gynecology services granted us convenient access to the in-house robotic surgical system. However, as we encountered scheduling conflicts and limited block times, the need for a third robot arose to manage the case volume across the three services. Initially equipped with two dedicated ORs, the introduction of the third robot and an additional dedicated OR enabled us to effectively accommodate the training needs of multiple surgeons.

Step 8: Unifying services

We developed a comprehensive training plan for the OR staff and nursing team which included online modules, in-service training sessions with RS representatives focusing on docking, draping, assessments, certification processes, and case observations.

Initially, the OR staff observed cases, after which the RS representative guided them through their intraoperative responsibilities via case simulations. This involved providing instructions on connecting robotic system components, calibrating the robot, and troubleshooting technical issues during procedures.

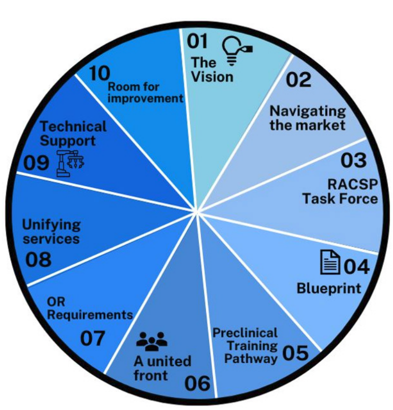

Figure 3 Steps to build a robotic acute care surgery program (RACSP). OR, operating room.

A thorough rehearsal of this comprehensive plan ensured that technicians were well prepared to support cases, and circulatory nurses were actively involved in the same. Additionally, on the onboarding of new staff, RS representatives were promptly notified to conduct in-service training. This approach ensured a smooth and efficient integration of new personnel into the RS program. Key contributors to our OR team included nurse educators, nurse managers, equipment managers, RS coordinator, and the robotic physician assistant. OR directors organized training sessions, allocated OR space, provided necessary supplies, and ensured comprehensive training for the OR staff.

Coordination with senior leadership, including the vice president of perioperative services, directors of scheduling, and OR managers, was crucial. This collaboration ensured logistical readiness for robot movement between rooms and confirmed staff availability for after-hours cases. The OR staff had the responsibility of scheduling robotic procedures, ensuring the availability of instruments for these procedures, providing intraoperative assistance during robotic procedures, conducting patient and staff member education, and contributing to research efforts and data collection.

Step 9: Technical support

The robotic representative is accessible 24/7 for the first 20 cases. The robotic surgical system is cloud connected at all times and allows rapid response to errors which can be remotely diagnosed and often fixed. This remote technical support provides reassurance that in the event of an equipment error or system fault, help is only a telephone call away. RS representatives are also equipped to assist with small-scale malfunctions.

Step 10: 'There's always room for improvement'

Strategic adaptation and goal reassessment are essential to ensure the program aligns with the evolving needs of the community, the center's ambitious goals and the growing patient population, paving way for more growth and better results. The robotic surgical system enables consistent, precise, and reliable data collection which aids in evaluating both the program's performance and individual surgeon's proficiency through personalized profiles. These profiles track various metrics such as instrument usage, console time, stapler firing issues, and instrument malfunctions, allowing surgeons to monitor their progress over time, identify trends, and assess procedure durations.

In the initial 12 months of the program, significant growth and success were observed with the adoption of RS. In 2022, a total of 81 procedures were performed by three surgeons, including 16 inguinal hernia repairs and 65 cholecystectomies, marking a pivotal learning phase for both trainees and the program as a whole. By the first quarter of 2023, with ongoing adjustments, a total of 75 procedures were performed within 3 months. These included cholecystectomy, inguinal hernia repair, ventral hernia repair, G-tube placement, and colostomy closure. Notably, the rates of open cholecystectomy decreased from 29% to 22%, and of open inguinal hernia repair decreased from 66% to 62% (figure 2). The present objectives are aligned with the long-term vision of providing patients access to a broader range of acute care surgical services and developing a robotic curriculum for general surgery residents to equip them with essential skills early in their careers. These initiatives are summarized in figure 3.

CONCLUSION

Introducing a RACSP into a level I trauma center serving a population of 3 million has positioned the center as a regional leader in care, despite the initial challenges encountered. While the program initially faced hurdles such as a shortage of robotic-trained acute care surgeons, perseverance, dedication, and alignment around a shared vision have enabled its development. Our program serves as a positive example for other centers facing similar obstacles in establishing a RACSP. A competent and efficient robotics program requires adequate infrastructure tailored to the resources of each center. While profitability may take several years to achieve a return on investment, reaching the break-even point signifies the program's potential to enhance a hospital's long-term financial stability and standard of care.

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