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Achieving robotic program best practice performance and cost versus laparoscopy: Two case studies define a framework for optimization

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Abstract

Background: Robotic surgery is seen by many hospital administrators and surgeons as slower and more expensive than laparoscopic surgery despite the implementation of commonly held robotic best practices. Multiple factors, including surgeon learning curves and program governance, are often overlooked, precluding optimal robotic program performance.

Methods: An assessment of several leading robotic surgery publications is presented followed by real-world case studies from two US hospitals: an existing robotic program in a mid-sized, regional hospital system and a small, rural hospital that launched a new program.

Results: Improvements in robotic surgery costs/program efficiency were seen at the hospital system vs baseline at 18 months post-implementation; and high-performance robotic efficiency and cost benchmarks were matched or surpassed at the rural hospital at 1 year post-launch.

Discussion: When best practices are utilized in robotic programs, surgical case times, costs, and efficiency performance metrics equaling or exceeding laparoscopy can be achieved.

1 | INTRODUCTION

Despite reports of robotic surgery falling below the performance benchmarks of laparoscopy, robotic surgery—when performed by experienced robotic surgeons, in appropriately selected patients, in advanced, best practice programs, as herein described—is highly efficient, and capable of superior fiscal performance when compared with laparoscopic surgery. With the singular exception of cervical cancer surgery,[1] for which both laparoscopic and robotic surgery have been linked with decreased 3-year survival rates vs open surgery (99.0% open vs 93.8% for laparoscopic and robotic procedures), the documented and patient-perceived clinical benefits of robotic surgery with the da Vinci vs laparoscopic or open surgery, across many surgical procedure types, collectively include: increased patient satisfaction, reduced postoperative pain, less narcotic use, reduced perioperative blood loss, fewer blood transfusions, lower risk of infection, shorter hospital stays, faster return to work/family, and lower likelihood of reoperation.[2-6]

Regardless, a significant portion of hospital administrators continue to remain skeptical of robotic surgery, seeing it as slower and more costly than laparoscopic surgery; expressing uncertainty regarding robotics' clinical advantages vs laparoscopy; and or maintaining the view that robotics cannot be made profitable. These perceptions are collectively rooted in more than 15 years of published literature from robotic programs and their surgeons, and can also commonly be found reflected in the lay press. Further, some of these publications—including those that have become gold standard benchmarks—present their outcomes as representative of best practices, yet in fact fail to represent state-of-the-art, robotic best practices upon closer evaluation.

To establish a comparative point of reference between robotic programs that fail to achieve optimal performance vs those that achieve best practice metrics, it is first helpful to assess several notable publications that compare robotic to laparoscopic surgery, and then compare these findings to two real-world, best practice robotic case studies.

1.1 | Notable publications

One study, by Wright et al,[7] published in 2013, was used as the basis of a 2015 Committee Opinion by The American College of Obstetricians and Gynecologists (ACOG) and the Society for Gynecological Surgeons (SGS), together with an endorsement from the American Urogynecologic Society (AUGS), which set forth their collective recommendations for the use of robotics in benign gynecological surgery.[8]

The Committee Opinion was reaffirmed in 2017. The study included a cohort from the Premier Healthcare Database encompassing nearly 265 000 women treated at 441 hospitals between 2007 and 2010, and assessed hysterectomy in women with benign gynecologic disease.[7] The authors concluded that while robotic surgery can be as efficacious as laparoscopic surgery, and was equivalent or superior in selected clinical metrics, its higher total cost, reported as $2189 greater on average, did not justify wider usage. On the basis of this conclusion, ACOG, SGS and AUGS determined that robotic benign gynecologic surgery had "similar morbidity" to laparoscopic surgery but results in "significantly higher cost," thus recommending the continued use of vaginal hysterectomy over robotic surgery.

It is important to note, however, that this study has several drawbacks that collectively fail to fully represent robotic surgery as it is generally practiced today. Specifically:

- The 2007-2010 timeframe addressed in this study was an especially high-growth period for robotic surgery. During this time, many surgeons were new users who did not perform robotic surgery at the same level as "mature," experienced robotic surgeons. Operative times, for example, are typically shorter for expert surgeons compared to those still learning.[9,10]
- The study is based on data from the Premier Perspective Database, which includes hospital and healthcare system administrative, healthcare utilization and financial data that is self-reported, unaudited and not verified by a third party for accuracy. Specifically, Wright et al reference in its methods section that the Premier Perspective Database is "validated in previous publications," and provides two references in support of this claim.[11,12] The references are by Lindenauer et al: one from a 2010 JAMA publication on COPD and the second from a 2005 NEJM publication on beta blocker use in non-cardiac surgery. However, neither publication is related in any way to robotic surgery nor do they serve to validate the accuracy of the database's robotic data, thus failing to support the assertion that the Premier database is "validated" with reliable data in the field of robotic surgery.
- Hospital charge master, supply files, and cost accounting are often highly variable and error-prone based on real-world assessments.[9]
- Hospitals routinely add the cost of the robotic equipment into any robotic vs laparoscopy comparison *while failing to include similar costs of laparoscopic equipment to the assessment*.[9]
- Robotic surgery is also frequently placed at the highest tier for charges and costing by hospital accounting administrators because it is often designated internally for "complicated" surgery. This means that operating room time is often billed at a higher rate for robotic cases than for laparoscopic procedures. Thus, if both lap and robotic case times are equivalent for a similar case, the cost would be cited as greater for the robotic case.[9,10]

Another high visibility 2013 study critical of robotic surgery costs by Rosero et al referenced an even larger database, and hence carried the most weight.[13] With the *United States 2009 and 2010 Nationwide Inpatient Sample* serving as the data source, 804 551 hysterectomies performed with either laparoscopic or robotic surgery were assessed to determine differences in length of stay, in-hospital complications, and hospital charges. Hospital costs were reported to be $2489 greater on average for the robotic group vs the laparoscopic group.[13]

This study, however, has weaknesses similar to Wright et al because it evaluated data from nearly a decade ago, during which time robotic surgery was rapidly on the rise in gynecology when surgeons' collective robotic learning curves created a highly material, negative impact on surgeon performance.[9] The da Vinci robot was first approved in the United States for hysterectomy in 2005; robotic procedures have increased dramatically since then (Figure 1).[14-16] For example, during the 1-year period covered by in study (2009-2010) the number of robotic minimally invasive hysterectomies in the United States increased by more than 40% (from 9.5% to 13.6%; P = .002). Robotic surgeons learning how to perform these cases during their learning curve—which vary from scores to hundreds of cases, based on the surgeon—would predictably result in slow case times and high supply and or reposable costs per case, or both.[9,17] Moreover, robotic Operating Room (OR) efficiency and case time reduction are also directly impacted by the skill and training of the crew, with similar early adoption and learning curve challenges negatively impacting these stakeholders' performance as well[16,18-20] (Figure 1).

A further consideration in the comparison of robotic surgery efficiency and cost vs laparoscopy lies in the general improvement in robotic surgeon performance metrics over the past several years. As demonstrated in part in a long-range study performed at the University of California, San Diego, between 2005 and 2016,[21] this wide-ranging assessment encompassed 3203 robotic surgeries, 45 trained robotic surgeons in 6 specialties, and 54 unique case types. As a snapshot, the average robotic case time in 2005 was 453 minutes. However, just 2 years later, average robotic case times had reduced to 236 minutes, with total OR time decreasing by 20 minutes (7%) and average operative time decreasing by 17 minutes (5%).

As noted, the learning curve for new robotic surgeons has a dramatic effect on costs as well as case times, as further illustrated in a study comparing outcomes in colorectal surgery performed by robotic surgeons over a 4-year period in a large US healthcare system with

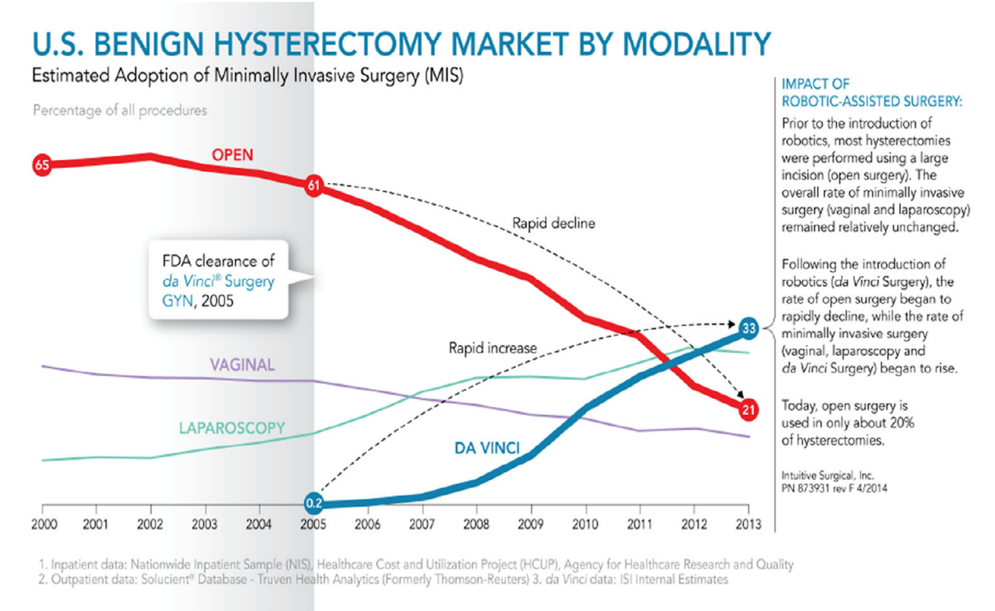

FIGURE 1 US benign hysterectomy market by modality. Learning curve vs proficiency: a major consideration for performance and costs in robotic surgery

32 hospitals.[6] Of the 957 robotic procedures performed, 56% were performed by high-volume surgeons and 44% were performed by low-volume robotic surgeons, respectively. Along with outperforming their low-volume counterparts in a number of categories (ie, shorter operative times, fewer complications and lower conversion rates), the high-volume surgeons were much more cost effective: the average total cost per colectomy was $4977 less for experienced robotic surgeons compared to lower-volume peers. Further, a review of robotic colorectal resection data between the years 2012 and 2014 from more than 467 hospitals, including 95 million patient encounters, revealed a steadily decreasing difference between robotic and laparoscopic surgery in index admission costs of nearly 48%, from $2698 in 2012 to $1402 in 2014[6] (Figure 2). However, when case costs between a *reasonably proficient robotic surgeon* (minimum 100 cases performed) and an *average laparoscopic surgeon* are compared, robot-lap cost disparities often dissolve.

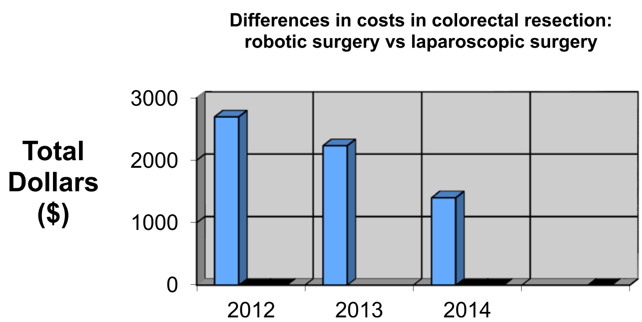

FIGURE 2 Differences in costs in colorectal resection: robotic surgery vs laparoscopic surgery. Of the 36 701 procedures included the study, 32 783 (89.3%) were laparoscopic resection and 3918 (10.7%) were robotic resection

2 | MATERIALS AND METHODS

In contrast to the above studies, two comparative case studies are presented to support the assertion that robotic program best practices can produce surgical and operational performance and efficiency metrics that equal or exceed laparoscopic performance.

Case Study 1, discussed below, presents a review of audited, real-world robotic surgery data from the Catholic Health System (CHS), a regional hospital system in Buffalo, New York, with a 4-hospital robotic program, undertaken following implementation of a best practice robotic optimization program over a 2-year period (see Case Study 1). Robotic and laparoscopic performance data were exported from CHS' Electronic Medical Record (EMR), cost accounting and supply data sources and then normalized with additional costs for capital, depreciation and robot maintenance contracts. Metrics comparing robotic and laparoscopic surgery are highlighted in Table 1.

2.1 | Capturing the right data: A key to robotic program optimization

Understanding what leads to the underperformance of a robotic surgery program requires insight into multiple parallel issues. Most importantly, hospitals struggle to capture, audit, and effectively analyze their data, and robotic surgery data is no exception.[9,10,22] Moreover, many institutions do not correctly compare their facility's robotic performance (if known) to laparoscopic and open surgery performance, either clinically or financially.[9] Without knowledge of head-to-head robot/lap/open surgical performance metrics, it is very difficult to identify where and how to make programmatic

TABLE 1 Comparison of average laparoscopic[a] to proficient robotic surgeons[b]

Case type	Method	No. of cases	Total supply cost ($, mean)	Case time (incision to close in minutes, mean)	Total direct costs[c] ($, mean)	Readmissions (count)	Readmissions (%)	LOS (days, mean)
Hysterectomy	LS	116	953	101	5319	1	0.86	0.31
	RS[d]	355	2301	77	4857	2	0.56	0.47
Cholecystectomy	LS	1927	640	38	3535	28	1.45	1.15
	RS	76	888	61	3566	0	0.00	0.07
Ventral hernia	LS	74	1014	103	7490	4	5.4	4.88
	RS	145	2307	69	5972	4	2.8	1.83
Inguinal hernia	LS	1095	572	41	2708	9	0.8	0.55
	RS	113	1893	39	3770	0	0.0	0.27

Abbreviations: LOS, length of stay; LS, laparoscopic surgeon; RS, robotic surgeon.
[a]Laparoscopic surgeons in the Catholic Health System (CHS) are not included for the specific cases types, since some of the volumes were too low compared to robotic volumes. To get an adequate laparoscopic sample, the metrics for this category reflect pooled averages of all laparoscopic surgeons in the CHS system.
[b]For each case type, results for the top robotic surgeon in that category in the CHS are defined based on comparison to the benchmarks available nationally for case times and cost. A designation of "proficient" requires that the surgeon complete at least 100 robotic cases, not necessarily all in the same case type.
[c]Totals do not include the capital cost or service of both laparoscopic equipment and robot.
[d]This surgeon performed only robotic surgeries.

improvements.[23] Compounding these data blind spots, many institutions additionally struggle with ineffective robotic program governance, policies, and procedures. Currently, there are no established, standardized robotic program best practice guidelines publicly available. Policies related to surgeon training, credentialing, privileging, and ongoing competency are often ad hoc and substantially different between hospitals, even within the same system. Additionally, OR crew competency and team-based training and simulation is frequently missing in surgical programs.[16,18-20,23,24]

Commonly, the question thus arises: Does improving an existing but under-performing/suboptimal robotic program offer the greatest opportunity to achieve best practice performance? Or does launching a new robotic program, using optimal best practices from "day 1," promise better long-term success?

2.2 | Defining a framework for best practice robotic program optimization

Case Study 2, discussed below, examines the launch of a new robotic program, allowing for the design and deployment of a solid foundation of superior policies, surgeon and crew training, and committee and program governance, supported by accurate data analytics and a strong program vision/business plan. Prelaunch preparations may take 6 months, or longer, depending on the size and complexity of the facility. Ongoing stakeholder support, inclusive of provider training and mentoring, as well as regular programmatic course corrections, are typically essential for 24 months or longer to ensure that a program's infrastructure is secure and sustainable.

At the outset, performance metrics (ie, case times, non-da Vinci supplies, da Vinci supply/reposable case costs, crew performance, and other key endpoints) must be defined for all key robotic service lines and case types (ie, benign gynecology, gynecologic oncology, general surgery, urology), with robotic surgeons generally required to perform a minimum of 24 robotic cases annually, as cited by The American Academy of Gynecologic Laparoscopy (2015 recommendations). This minimum case volume per year serves as the threshold below which a robotic surgeon's clinical and economic performance metrics very often trail off significantly.[9,10] Moreover, surgeon learning curves, including pathways for robotic surgery residents and fellows, must be traversed rapidly and safely while also satisfying key quality endpoints (ie, case times, LOS, supply/reposable consumption, readmissions, and reoperation rates).

2.3 | Supporting and optimizing an existing robotic program

Taking an existing robotic program from an average or even suboptimal performance level to that of a superior program can be a time- and resource-intensive exercise, with many hospital administrators avoiding such endeavors based on the perspective that their facility's robotic program "is what it is," is "good enough," serves as a "loss leader," or is needed largely to attract desirable surgeons in support of the overall surgical program. Indeed, a hospital that desires a robotic optimization program that will succeed should foster a strong quality culture, superior surgeon engagement/peer-to-peer relationships, and open access to the required data. Further, the robotic optimization effort must be supported by a commitment to accountability from both the hospital's providers and administrative stakeholders. Clinical quality and operational efficiency benchmarks (internal, national or best-practice) must be available, audited for accuracy and transparently reported to identify sub-par performance. Policies must provide a mechanism to monitor competency of all stakeholders and define remediation with the goal of providing quality and cost-effective surgery.

Core best practice elements for surgical robotic programs (new and existing)
• Proforma and business planning
• Data collection, normalization, auditing, and analytics/reporting
• Governance: program policies, credentialing, provider training (surgeon and crew)
• Best practice clinical and financial performance metrics with benchmarks
• Stakeholder accountability
• Performance transparency and reporting
• Technology selection and contracting

3 | RESULTS: TWO CONTRASTING ROBOTIC PROGRAMS ILLUSTRATE PATHWAYS TO SUCCESS

3.1 | Case Study 1

CHS, a $1.5 billion non-profit, faith-based healthcare system, provides care to western New York state across a network of hospitals. Five da Vinci robots (three Xi and two Si models) are currently deployed across four sites.

In 2016, CHS leadership made the commitment to optimize its robotics program by engaging an outside firm (CAVA Robotics International, www.cava-robotics.com) to help improve the quality, operational, and fiscal performance of its existing program.

It was determined during the first year that implementing best practices could generate annual savings of up to $152 587 in supply costs and up to an additional $218 000 by improving operational efficiencies (Table 2).

Following the first year of program improvement activities, it was further observed that robotic surgery outperformed laparoscopic surgery in a number of categories, with two categories deserving special attention: case time and total direct costs. Capital costs of the robot and laparoscopic equipment were removed from the total costs to provide a more even comparison between robotic and laparoscopy cases.

Defying common perception, robotic surgery *cut-to-close* time at CHS was less for robotic surgery in three of four common cases types, with *total costs* lower in two case types and virtually equivalent in another.

One disparity, however, was that *total supply costs* for robot-assisted hysterectomy were reported as more than twice as high for robotics than for laparoscopic surgery. Upon further review, however, it was revealed that the CHS robotic surgeon for this specific case type performed only robotic surgery; due to his extensive experience, the surgeon frequently handled a very high percentage of highly complex referral cases, thus driving up case costs significantly. Despite the burden of dramatically higher robotic case complexity, the *total direct costs* for this surgeon were nevertheless *lower than* the *average* CHS laparoscopic surgeon (Table 1).

Supply cost: total cost of all opened supplies in a particular case, including the wasted and consumed supplies
Direct variable cost: costs that vary with patient activity, such as room and board, laboratory tests, medications and nursing expenses

As seen in Table 3, robotic case volumes across the CHS system trended higher as the robotic program expanded, with improvements in numerous time and cost parameters over a 24-month period. By 2018, 26 of 28 surgeons were better than the 50th percentile in supply usage, and 14 of 28 were in the top 10th percentile. Average case time for benign hysterectomy was 123 minutes, better than the national average (128 minutes). For Inguinal hernia, by 2018 the average *cut to close* time had reduced to 65 minutes, saving more than 6000 minutes of OR time annually. Supply costs had improved such that 12 of 13 robotic surgeons were better than the 50th percentile, and 8 of 13 were better than the top 10th percentile. These were the two most common cases at CHS, accounting for nearly 1000 cases per year. In addition to robotic supplies, administrative and surgeon leadership addressed other non-da Vinci supply savings targets such as hemostatic agents, suture selection, and mesh choices. Quality also improved with a significant 69% decline in readmissions, from 35 in 2017 to 11 in 2018 (Table 3).

TABLE 2 Economic opportunities based on real-world, best practice improvement of robotic surgery efficiency at Catholic Health System

Operational efficiency opportunities								
Case	**Reposables used**	**CAVA best practice**	**Cost of current**	**Cost of best practice**	**Number of cases**	**Opportunity (60%)**	**Opportunity (80%)**	**Opportunity (100%)**
Hyster	4	3	$1050	$830	467	$61 644	$82 192	$102 740
Inguinal	3	2	$800	$460	174	$35 496	$47 328	$59 160
Ventral	3	2	$800	$460	165	$33 660	$44 880	$56 100
Total						**$130 800**	**$174 400**	**$218 000**

Note: Actual results of supply savings in 2018 compared to 2017 exceeded expectations. Hyster, benign hysterectomy; inguinal, inguinal hernia; ventral, ventral hernia.

TABLE 3 Actual supply savings in 2018 compared to 2017 at Catholic Health System by hospital site

Actual Supply Savings				
			Supply savings ($, per case average)	
Location	2018 Volume	Trend (%)	2017	2018
SOC	775	106	$2015	$2314
KMH	451	113	$1470	$1442
MHB	627	96	$3033	$1922
			Supply savings ($, total for all cases)	
SOC			$231 725.00	
KMH			($12 628.00)	
MHB			($696 597.00)	
Total supply savings			($477 500.00)	

Abbreviations: KMH, kenmore mercy hospital; MHB, mercy hospital buffalo; SOC, sisters of charity hospital.

Over the course of 24 months, administrative leadership focused on establishing a quality-centric program resulting in:

- Optimization of EMR, cost accounting, and supply chain data acquisition, auditing, and analytics.
- Defining key time, cost, and outcomes-related performance metrics, creating a culture of data sharing and transparent performance assessment.
- Initiation of training for selected robotic surgeons, including case videotaping and outside quality reviews.
- Revision of the robotic surgeon credentialing policy.
- Creation of a mandatory robotic program quality policy associated with annual surgeon privileging renewals.
- Retraining of OR crew with a focus on case efficiency and supply standardization.
- Highlighting specific cost-saving and time-based performance benchmarks for all clinical stakeholders.
- Monthly data reports for hospital leadership on program performance including case times, volumes, LOS, readmissions, outlier cases, and other surgeon-specific issues.
- Evaluation of new robotic technology and associated contracting, as needed.

To summarize Case Study 1, CHS leadership focused at the outset on more comprehensive program governance, improved surgeon credentialing, improved robotic and laparoscopic surgery performance data metrics, and making robotic training and simulation a priority. Highest performing CHS robotic surgeons (based on a combination of case volumes, best times, and lowest costs) were appointed as robotic program Chairs at each robotic program site, and a robotic steering committee was established to meet monthly. Clinical and fiscal performance weak points were identified in monthly data reports and committee meetings once the data were audited by robotic and administrative stakeholders. Between March 2016 and March 2018, 49 of 63 targeted performance categories had achieved a "good" or better rating, with 24 categories qualifying for optimal status.

3.2 | Case Study 2

Munson Healthcare Otsego Memorial Hospital (OMH) is a small, rural hospital in Gaylord, Michigan. Hospital leadership determined in 2016 that it wanted to launch a robotic program to enhance the quality of its minimally invasive surgery program offering, and to help attract younger robotically-trained surgeons. A feasibility study was performed to assess whether robotic surgery was within the hospital's scope. Its small size (46 beds and three ORs) combined with its rural location presented challenges, especially attracting appropriate clinical talent. Through the study, OMH determined it was ready to pursue robotics for three key reasons:

1. The hospital was located in an underserved region regarding robotic surgery.
2. There were many champions of robotic surgery at the hospital.
3. The medical staff welcomed the new technology.

The success of Otsego's robotic program depended on implementation of best practices-based training and ongoing surgeon and crew performance monitoring in its work with CAVA. Otsego exceeded its projection of 208 robotic surgeries for its first year, completing 223 robotic cases by the end of month 12, with its robotic surgeons consistently surpassing Intuitive Surgical performance benchmarks in numerous cost drivers including procedure time. Moreover, top 10% CAVA best practice benchmark levels in supply cost management were surpassed by three of their surgeons performing benign hysterectomy and cholecystectomy robotic cases by 6 months post-launch (Table 4).

The launch of the robotic program at OMH was predicated on several key factors: its surgeon training; the quality of its data management and commitment to analytics; and its strict adherence to transparent reporting of performance metrics to all stakeholders. The requirement of rigorous prelaunch training, including the completion of simulator modules for its incoming robotic surgeons combined with identification of mentor surgeons, provided its surgical team with a

TABLE 4 Comparison of robotic surgery costs vs benchmarks for individual surgeons at Otsego Memorial Hospital (OMH) at month 6 post-launch[a]

Type of robotic surgery	No. of cases by surgeon	OMH average da Vinci supply costs	da Vinci benchmark: top 50%	da Vinci benchmark: top 10%	Achieved benchmark or better	
					Top 50%	Top 10%
Total laparoscopic hysterectomy	3	$1102	$1378	$1175		✓
Cholecystectomy	16	$907			✓	
	18	$800	$1236	$875		✓
	24	$742				✓
Inguinal hernia repair	14	$1049	$1181	$875	✓	

[a]Surgeons with ≤2 cases for a given case type surgery have been excluded.

critical head start prior to beginning its first live cases. Training was incentive-based in that it was tied directly to achieving robotic credentialing. Further, a proctor signed-off on each new surgeon's training before the novice robotic surgeon was allowed to begin live cases. All robotic cases were video recorded, with surgeons receiving additional feedback/training customized to the needs identified in their videos from the mentor surgeon. To assure that a surgeon's skill set matched his or her case-specific challenges, each surgeon was required to complete a performance assessment of his or her basic-level robotic cases before being granted permission to perform surgery on advanced robotic case types.

In parallel, key governance was established to sustain the program's infrastructure, the OR crew received best practice training, and the robotic program was framed within an environment of ongoing process improvement which included a trained robotic coordinator who coordinated everything on the surgical side, taking direction from the governance committee. The robotic coordinator, moreover, was not a medical professional, thus reducing bias or preconceived notions about surgical procedures. Additionally, the program included a multidisciplinary governance committee that met monthly to examine ongoing performance, with a focus on cost control enabling the rapid achievement of the supply cost management outlined in Table 4. Committee participants included the surgeons and crew, hospital CEO, VP of market development, senior financial administration, and personnel in risk management.

Surgeons, OR techs, and OR nurses met monthly to review operations and decide on pathways to improve training and performance. Full transparency in performance metrics was the adopted policy, providing efficiency reports on the previous month's cases to the governance committee, with all outlier cases reviewed and deconstructed.

Another important feature of the OMH robotic program was that it evaluated its performance through a “wide-angle” lens. By having a multidisciplinary team assesses and monitoring its robotic program, problems and opportunities were continually identified rapidly and proactive action was taken. Equipment usage, for example, was reviewed by the robotic coordinator, the OR director, and the VP of market development. Their findings were discussed at both the robotic committee and in governance meetings which helped to prevent unnecessary costs and inefficiencies from going unnoticed.

4 | LIMITATIONS

The supply cost and case time data presented in these two case studies represent real-world, pragmatic findings. As such, statistical limitations of these data, including assessments such as *P*-values, confidence intervals, medians, and SD, are not included. Such analyses may provide further insights. Additional quantitative research should be performed in future assessments to corroborate these findings, and to refine their associated recommendations.

5 | DISCUSSION

Much of the prior research that assessed robotic surgery's perceived higher cost and inefficient, slower case times vs laparoscopy may be seen differently if evaluated through a lens of programmatic and operational best practices which are better understood today than 5 or 10 years ago. Such new studies may prove enlightening, helping both providers and administrators of hospitals to better understand the means and methods required to drive down robotic costs, improve overall case efficiency, and improve the overall delivery of care thereby advancing the Triple Aim of improving the health of the general population, improving the patient care experience, and reducing the per capita cost of healthcare.

In short, when robotic OR time and supply costs are improved, overall direct case costs are reduced. This demonstrates that when case time and supply efficiency targets are set—together with well managed surgeon learning curves, a focus on quality, and non-negotiable efficiency benchmarks—the robotic performance results look very different than those described in the Wright et al and Rosero et al studies.

6 | CONCLUSION

In appropriately selected patients and case types, robotic surgery has well-acknowledged proven and perceived clinical advantages over laparoscopic surgery. Although the usage of robotics has expanded dramatically in recent years, a large percentage of hospital administrators and surgeons still believe that robotic surgery's benefits vs laparoscopy remain unclear, and that it is very challenging to be made profitable. Other hospitals may see robotics as technically advantageous in certain case types or service lines, but largely believe that offering robotic surgery serves mainly to keep the hospital current in the surgical technology race. If this is the *only* reason an institution embraces robotic surgery, however, there is very often little investment in developing a programmatic pathway to superior quality, efficiency, cost savings, or best practices.

The two main cost concerns associated with robotic surgery—the cost of robotic supplies and reposables and increased operating room/case time—do not represent *fact*. As the experience of the two case studies herein illustrate, the cost and case time performance of robotic surgery—two parameters that serve as reasonable proxies for quality—can be equivalent or even superior to that of laparoscopic surgery, especially when driven by audited performance analytics and a commitment to best practices. When a high volume of superior, efficient robotic procedures are performed by surgeons and crew in a clinical and operational environment where the entire team performance is reported accurately and transparently, the value of robotics is markedly enhanced.

CONFLICT OF INTEREST

Josh Feldstein is the President and HerbCoussons, MD, is the Medical Director of CAVA Robotics International, LLC. There were no sources of funding for this manuscript or for the data which it contains.

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