

Qualitative perspectives of early surgeon users on the value of the daVinci 5 surgical system

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Abstract

Objective:

To understand the value and experience of using the da Vinci 5 (dV-5) robotic surgical system among early-adopting surgeons in the United States

Introduction:

In March 2024, da Vinci 5 was released with new features such as a haptic technology (called Force Feedback) and Case Insights, a tool leveraging artificial intelligence (AI) to deliver video recordings of cases with objective metrics of performance. Few studies have assessed the value and challenges experienced by surgeons using this new system.

Methods

Twenty-three semi-structured qualitative interviews were completed with surgeon-participants over video conferencing software representing a selection of surgical specialties, case volumes, and practice types. Interviews were recorded, transcribed verbatim, and deidentified. Results were analyzed by one reviewer using an inductive-deductive thematic approach and further validated by another reviewer. Themes were mapped to value domains and challenges with adoption.

Results

Among the participants, there were a higher proportion of males, surgeons who practiced at community hospitals, and those with medium to high volumes of robotic cases. Thematic analysis revealed two main themes with seven subthemes exploring either the value beliefs or barriers/challenges with adoption to the new system. Participants found the most value in dV-5 with its ergonomic comfort, ability to support future training of surgeons, and an economic benefit in reducing operative time. There were mixed findings around its impact for improving clinical outcomes given the early system maturity.

Conclusion

The dV5 system offers better ergonomics and may have implications for some key surgical metrics such as tissue tearing and operative time.

Introduction

Over the last decade, there has been rapid adoption of robotic-assisted surgery (RAS) as a minimally invasive surgery (MIS) option.[1] RAS is now commonly applied across various surgical specialties including general surgery, gynecology, and urology.[2, 3] The da Vinci Surgical System (dV) has been used in over 10 million surgeries worldwide and is now recognized as a standard treatment for certain procedures in the United States.[4][5] Numerous studies have documented the clinical benefits associated with RAS, including reduced hospital length of stay, pain, and surgical site infection compared to open surgery.[6–10] More recently, RAS has also been associated with improved access for marginalized groups to MIS treatment options.[11–13]

In March of 2024, the latest of Intuitive, Inc.'s systems called the da Vinci 5 (dV-5) was launched within the US market, introducing new features including force feedback, integration of artificial intelligence (AI), improved ergonomic comfort, and high-definition imaging.[14] These features have yet to be evaluated for their impact on clinical, economic and humanistic outcomes. However, early evidence from select procedures indicates that enhanced visualization and force feedback technology may be associated with modest improvements in clinical and perioperative outcomes.[15–17] Furthermore, the new platform is associated with improved ergonomic support for surgeons, which has previously been a challenge. [18]–[19] Advancements in this new RAS technology may have implications on workflow, training, and outcomes.

To date, most published literature on the value of RAS and specifically the dV system has focused on quantitative and database studies. Few qualitative studies have assessed the experience of nurses, physicians and patients with dV systems.[20–22] Given the limited literature on user-centered perspectives, we sought to evaluate the perspective of early surgeon users to assess the claims of potential impact with the dV-5 system. This study leverages qualitative research methodologies to understand the surgeon experience of dV-5, assessing both its potential novel value, barriers to adoption, and new system challenges.

Methodology

Study Design

A qualitative descriptive design was used, employing the grounded theory framework. This underlying framework focuses on generating a theory from the data collected and analyzed.[23] The approach explored how the features of dV-5 potentially deliver clinical, economic, and humanistic benefits across diverse healthcare settings, focusing on the experiences of surgeons as early adopters. A qualitative design allowed for a contextual exploration of surgeon experience including both the value, barriers, and challenges that they have found with adopting the new robotic system. [24] This method was chosen over quantitative approaches due to the ability to uncover motivation in surgeon decision-making, and nuances in discussions of perception of value. To the best of our knowledge, this study is the first to explore the value of dV-5 among early adopting surgeons across different practice settings.

Participant selection

The target population was surgeons from any specialty background that used the dV-5 system. The specific inclusion criteria were that surgeons had at least 10 dV-5 cases completed, and a lifetime of 50 or more robotic cases completed at the time of recruitment. These criteria allowed for a selection of surgeons with enough dV-5 experience who could compare this latest robotic system to previous robotic systems and other forms of minimally invasive surgeries. Additionally, this allowed for a large sample size of surgeons to recruit from given the conservative dV-5 case estimate.

A master list of eligible surgeons was created using an internal surgeon registry (N = 753) provided by Intuitive Surgical, to allow for identification of surgeons who met the inclusion criteria of having used both robotic platforms in the aforementioned quotas, and to further characterize participants by sociodemographic and surgeon-specific variables available in the database. Next, code was developed to randomly sample participants from this master list with an equal distribution of surgical specialty, case volume, and practice type. This resulted in a sample of 100 participants who were then eligible for recruitment. This quasi-random, purposive sampling technique allowed for a balance between identifying surgeons who met all the criteria in a timely manner while also reducing selection bias through randomness to ensure a generalizable distribution of specialty, experience (robotic and dV-5 case volume), and practice type (academic/community hospital).

Following WCG Institutional Review Board (IRB) approval (20233310 on 11/2024), initial contact via email was made by a contracted market research vendor to minimize recruitment bias from having recruitment associated with a specific robotic device company. A week after the initial contact by the vendor, an email reminder was sent followed by a phone call a week later as needed. All participants were offered an honorarium of \$200, paid by the vendor directly and funded by Intuitive Surgical, as the rate set to reflect fair market value for surgeon time.. Interview scheduling continued amongst participants who consented until content saturation was achieved. Response rate from the contact efforts and dropout rate after eligibility was recorded and is represented in a flow chart (Fig. 1).

Data collection

Participants who responded to the study invitation were scheduled for a 45-minute semi-structured interview over a video conferencing software (Zoom) with author ZAF (female), formally trained in human subjects' research and who had prior experience with qualitative data collection. The non-clinical background of the interviewer was considered advantageous in minimizing hierarchical bias during data collection with surgeons. Interviews were chosen over focus group discussions due to their ability to be in-depth and reduce power dynamics in conversations, especially amongst low versus high volume surgeons. Additionally, the semi-structured interviews provided opportunities for the participants to speak to the value pillars through their own practical experience beyond the pre-set questions. An interview guide was used to collect background information about the participant and included pre-set

interview questions that were designed collaboratively by members of the research team, and validated by a senior surgeon (Supplemental files 1).

Before the start of an interview, participants underwent an informed consent process with author KD to understand the study's purpose, procedures, and potential risks and benefits. Interviews were audio and video recorded and then transcribed verbatim. No other non-participants were present during the interviews, and no prior relationship was established with interviewees. All personal health information was de-identified from interviews after transcription to protect confidentiality. The 'consolidated criteria for reporting qualitative research' (COREQ) checklist was used to report this study.[25]

Data Analysis

A hybrid inductive-deductive thematic approach was used to analyze the interview transcripts combining pre-existing hypothesized themes with emergent themes from participants[24]. Both transcription and analysis were conducted using MAXQDA software [version 24, VERBI, Germany]. A codebook was developed before interviews were conducted whereby an inductive list of codes, descriptions and examples were generated to capture the hypothesized themes including clinical, humanistic, economic and surgeon-specific value. After transcription of each interview, open coding was performed by one reviewer (author ZAF) to identify emergent ideas directly from the data. Each of these deductive themes were then categorized into parent inductive themes. Through team discussions and validation by a senior surgeon, themes were refined to ensure relevance and accuracy. Content saturation was monitored in parallel to thematic analysis, with it being operationalized as three consecutive interviews in which no new codes or variations in existing themes were revealed.

At the end of the first round of analysis, validation of a subset of interviews and themes was performed by another reviewer (author KD) to ensure credibility of analysis. Finally, themes were compared against existing literature to contextualize findings and uphold triangulation. The steps for data analysis are summarized in the apriori determined protocol (Supplementary files 2).

Reflexivity statement

Given that the study was led by employees of Intuitive Surgical, considerations around bias were addressed wherever possible. Employee assumptions about surgical technology may have shaped the data collection and analysis, and reliance on feedback from early adopters may have introduced potential biases given familiarity with the dV5's purported benefits. Mitigation strategies employed included sampling across diverse surgeon characteristics (sex, practice type, case volumes, and specialty), validation of themes, literature feedback loops, and systematic reflexivity throughout the study. Additionally, the interview guide was developed prior to recruitment and chosen to be semi-structured to allow participants to guide the discussion. During the analysis, themes that emerged were documented in the codebook and iteratively classified through consensus discussions to ensure alignment with findings rather than researcher's assumptions. Finally, we intentionally chose a hybrid

inductive-deductive thematic analysis approach to reflect a balance between a systematic evidence analysis and openness to emergent themes, fostering transparency and co-ownership of the findings.

Ethical Considerations

The study was reviewed and approved as a sub-study amendment under the parent protocol by WCG IRB (approval number: 20233310). The study prioritized confidentiality and anonymity of participants by using encrypted data storage and anonymizing responses in the final analysis. Participants were fully informed about the purpose, methods, and potential implications of the study through a detailed informed consent process. They had the right to withdraw from the study at any point, and data was stored in compliance with relevant regulations, including the Health Insurance Portability and Accountability Act (HIPPA).

Results

Participant Demographics

The final cohort consisted of 23 surgeon participants, with a higher proportion being male, practicing in community hospitals, and from the general surgery subspecialty. Case volume cut-offs were created using quartiles from the master list with dv-5 volume thresholds being 0–20,21–40, 41–60, and 61 or more while RAS thresholds being 0-500, 501–800 and 801 or more, respectively for low, medium and high volume. Participant characteristics are summarized in Table 1.

Table 1
Baseline characteristics of study participants

Characteristics	Sample size, N (%)
Sex	
Female	5 (21.7)
Male	18 (78.3)
Practice type	
Community	17 (73.9)
Academic	3 (13.0)
Other	3 (13.0)
Experience level (RAS only)	
Less than 10 years	16 (69.6)
More than 10 years	7 (30.4)
dV-5 volume	
Low (≤ 20)	5 (21.7)
Medium Low (21–40)	7 (30.4)
Medium High (41–60)	7 (30.4)
High (≥ 61)	4 (17.4)
RAS volume	
Low (≤ 500)	8 (34.8)
Medium (501–800)	6 (26.1)
High (≥ 801)	9 (39.1)
Surgeon specialty	
Obstetrics and Gynecology	5 (21.7)
Gynecological Surgery	1 (4.3)
General Surgery	15 (65.2)
Thoracic	2 (8.7)
Abbreviations: RAS – Robotic-assisted Surgery; dV-5 – da Vinci 5 surgical system	

Overall findings

Thematic analysis revealed 65.6% of themes were characterized as value beliefs of the new robotic system while 34.4% were characterized as challenges or barriers to adoption. Table 2 presents the coding framework including themes, subthemes and associated frequency across participant interviews. When stratified by surgeon volume of participants, a heat map revealed association between subthemes (Supplemental files 3). Notably, low-volume surgeons reported an increase in operational efficiency due to dV-5 and a greater degree of ergonomic comfort. In contrast, medium and high-volume surgeons reported more challenges in operationalizing the value of force feedback technology and found it to be useful for training/mentoring but not directly applicable to their own practice. Finally, high-volume surgeons also reported an increase in autonomy and consequently a decrease in operative time due to the system consolidation of features.

Table 2
Frequency of themes and subthemes

Inductive theme	Description of theme	Deductive subthemes	Frequency (%)
1. Surgeon value	Perceived benefits experienced by surgeons rather than patients or hospitals	• Ergonomic comfort of the system • Application to training/mentorship of surgeons. • Increase in surgeon autonomy. • Self-improvement using data metrics	25.8
2. Economic value	Perceived financial benefits or system-level value associated with dV-5 adoption	• Increase in operational efficiency. • Increase in patient throughput. • Sustainability and modularity of the system • Support in performing complex cases. • Decrease in OR time	18.6
3. Clinical value	Insights into the clinical advantages of the dV-5 system	• Decrease in LOS • Decrease in SSI/tissue tear. • Decrease in blood loss. • Less pain prescriptions • Safety/quality checks for clinical outcomes due to Case Insight data	13.5
4. Humanistic value	Perceived impact on the user experience, including patient-focused factors.	• More data for patient education and research purposes • Increase in accessibility of MIS for	7.7

Abbreviations: dV-5 – da Vinci 5; LOS – Length of stay; MIS – Minimally Invasive Surgery; RAS – Robotic Assisted Surgery; SSI – Surgical Site Infection; OR – Operative Room

			both patients and surgeons who are new to RAS. • Faster return to life for patients	
Challenges/barriers in dV-5 adoption	5. Provider level	Barriers stemming from individual surgeons' or care teams' attitudes, experiences, knowledge, or workflow concerns	• Interpretability of Case Insight data on objective performance indicators • Perceived relevance of force feedback technology • Limited translation of metrics into surgical decision-making and evidence for improved clinical outcomes	14.8
	6. Data infrastructure level	Barriers related to the technological systems and their analytic capacity	• System lag and/or instrument exchange delays • Gaps in data metrics recorded and device functionality	10.9
	7. System level	Barriers embedded in broader organizational, regulatory, economic, or policy contexts that influence adoption at a structural level	• Approval/roll-out lag in new technology • Learning curve for hospital staff/administrators • Regulatory uncertainty around data governance and legal exposure	8.7
Abbreviations: dV-5 – da Vinci 5; LOS – Length of stay; MIS – Minimally Invasive Surgery; RAS – Robotic Assisted Surgery; SSI – Surgical Site Infection; OR – Operative Room				

Subtheme 1: Surgeon value

There was consensus amongst all interviews for improved ergonomic comfort with the system's new head-in feature and its contribution towards less neck tension, fatigue and long-term well-being. Participants also emphasized the increase in their autonomy and control within the operating room with the consolidation of features in dV-5, particularly in settings with less experienced support staff.

"Majority of my cases are on the dV-5 and just this past Monday, I had to switch back over to the Xi and was able to clearly tell a difference from an ergonomic standpoint. Ergonomics are a big deal to me. I'm young in my career, and want to operate for another 30 years, and just noticing the difference in my neck

positioning and the kind of flexion that I'm having to incorporate" – (Male, GEN: GEN, high dV-5 volume, medium lifetime RAS volume)

"Several of our ORs that we have our robots in are tiny and so, being able to have the nurse start insufflation from any of parts that was huge. I've always dropped my pressure after I got my ports placed, and so not having to ask someone else to do it or having to get back up and go over and drop the pressure, being able to instead make that part of when I sit down... We have some great nurses, and we have some less familiar nurses. When I have someone great, I may not even get the chance to do it, because they've already done it but some of the others it's quite helpful to be able to be your own help instead of needing to rely on more people" – (Female, GYN:GYN, medium high dV-5 volume, medium lifetime RAS volume)

Additionally, participants noted the potential for various features of the system in improving training opportunities for new robotic surgeons, from better visualization in dV-5, the ability for telepresence and the use of metrics for assessment of progress during surgical education certification in residents.

"I like having the video recordings immediately available because if perioperative complications occur, I look back at a certain part of the case [for self-improvement]. Or I ask my more senior partner about a certain part of the case, and I can just immediately show it to him which is amazing" – (Female, GYN: GYN, low dV-5 volume, low lifetime RAS volume,)

"I foresee a future where you can do tele-mentoring and use it with the Hub to expand minimally invasive surgery to areas that maybe didn't have as much support or structure with robotics... I am also a reviewer for C-SATS so I see the benefit of reviewing video content and getting an expert opinion on qualitative and quantitative metrics on that, and I see that all being able to be integrated into this new platform and being able to have that right there" – (Female, GYN:GYN, medium high dV-5 volume, high lifetime RAS volume)

"I think I did a robotic Whipple with this trainee a month ago, and I let him do the gastrojejunostomy, which is the connection between the stomach and the small intestine and I told him to sew it one way, and then he sewed it a little bit differently, Afterwards he came and felt that his anastomosis was a little bit awkward. I tried drawing in a whiteboard, "I kind of expected you to do this, but you did that instead". He had no idea what I was talking about, because he's looking at the whiteboard, and it's a 2D representation. So, I was brought up the video [on case insight] and showed him. I used the video to point to what I thought he should have done vs. what he did. That made sense to him" – (Male, GEN: HPB, low dV-5 volume, low lifetime RAS volume)

Finally, the new data metrics included within Case Insights platform (Fig. 2) that comes with the dV-5 system were seen to be supportive of continuous learning due to its benchmarking ability and provided new opportunities for self-improvement including force applied during surgery.

“It has been helpful to look at all of our robotic surgeons and see what's the coordination of instruments for all the gynecologists, so we then standardized our pans down to just having one pan. Then we're going to see if someone's below or above a certain standard deviation compared to the national average for operation times. That's when we need to talk with them about [their times] and do some case observations or we need to do more module training [to support their improvement]. Not every surgeon is equal but we're trying to figure out, how do we make this very objective so that we can use the data shown to us to address an issue” – (Female, GYN: GYN, medium dV-5 high volume, medium lifetime RAS volume)

“I think the biggest contribution for the dV-5 over laparoscopy is that it flattened the learning curve for minimally invasive surgery. When I started out. I was learning how to use three hands, because the robot had three hands, how to clutch, and how to switch. The movements are not as exaggerated as laparoscopy. They're finer movements that took time to get used to and then, it took time to train to feel with my eyes, knowing how much I'm pulling by seeing how everything around it extends. Now you're removing layer by layer, the barriers to picking it (minimally invasive surgery) up” – (Male, GEN: HPB, low dV-5 volume, low lifetime RAS volume)

Subtheme 2: Economic value

The dV-5 system was associated with improved operational efficiency due to the features and instrumentation that support a streamlined workflow (Fig. 3) as well as better use of physical space in the operating room. Both these advantages contributed to a higher case turnover and a lower operative time.

“The instrumentation cone makes things a little quicker, because people can put instruments a little faster, since we know where it's going to be going and not worry about skewing something. So, I think it's made my cases faster and if you're doing 3 or 4 cases, you're saving 10–15 minutes for each case. That's another hour for which I can do another surgery” – (Male, GEN: BAR, high dV-5 volume, medium lifetime RAS volume)

“I think that as surgeons we need to be really cost conscious in what we do. You know, the biggest expense of any hospital system is going to be the operating room, and this is certainly a big expense. So, if we're able to demonstrate that time or length of stay is improved then I think that is kind of the biggest sell. From my personal experience, you know, I went from having adrenals that stayed a couple of days to now stay overnight, and I went from cases laparoscopically that took me about 4 hours console time to 50 to 60 minutes for these procedures on the dV-5. So, I think that that's a cost saving metric” – (Female, GEN: ENDO, medium high dV-5 volume, medium lifetime RAS volume)

“Starting from the physical side of things of the actual system itself. It's more self-contained and takes up less of a footprint in our operating room, which, you know, space is always at a premium” – (Male, GEN: GEN, low dV-5 volume, high lifetime RAS volume)

Some participants also noted that the dV-5 system enabled more complex surgery that would have been converted into open due to various features including the enhanced visualizations and force feedback technology providing haptics expanding case capabilities.

"I really wasn't doing big hiatal hernias with the robot in general, because I was worried about tissue damage. Now, with the dv5, I've been tackling more of those. I think specifically with the force feedback instruments, it lets you tackle more difficult cases you usually wouldn't because you were worried about tissue injury so now, you're gentler on the tissue, and you have better visualization of the anatomy. With the better optics and force feedback, I've been more comfortable doing a little more difficult surgeries than I was with that Xi" – (Male, GEN: BAR, medium high dV-5 volume, medium lifetime RAS volume)

Subtheme 3: Clinical value

Given the limited quantitative data on the clinical outcomes associated with robotic surgery on the dV-5 system compared to other technology, participants hypothesized or referred to anecdotal evidence of improved outcomes or the ability to support intraoperative safety as a contributing factor for quality improvement.

"Being able to see better and have 3D vision allows me to like find the ureters and know exactly where they are at all times, and really dissect out tiny little spaces, whereas laparoscopically, you can't see like tiny nerves very well, necessarily, or things that could be really consequential if you were to hit them" – (Female, GYN:GYN, low dV-5 volume, low lifetime RAS volume)

"The universal unit of energy in the body is ATP. When I talk with my students and residents about any operation, what I say is there's a fixed number of molecules of ATP that are going to be required to get over this operation. As a surgeon, your job is to cost the patient the fewest molecules of ATP and so every single thing that you can do to be more gentle, more precise, every single drop of blood that you spill, every single tissue plane that you violate more than is absolutely necessary. Everything is going to have a cost. I'm convinced already, from my own practice relative to other people around me that my care and delicate nature (with the support of force feedback), with the tissues results in superior outcomes, fewer complications, faster recovery, all that stuff. Everything that I have at my disposal to make me better at that is going to be better for the patient directly" – (Male, GEN: GEN, high dV-5 volume, high lifetime RAS volume)

"If you have less tissue trauma with force feedback then you're going to have less edema, which is a big deal in bariatric surgery, because after bypasses they [patients] can't drink or eat, and that keeps them another day in the hospital. I also think controlling the pressure [the way the dV-5 system allows for] and being able to do the surgery under less pressure sometimes will lead to less pain because you're inflaming the abdominal wall less" – (Male, GEN:BAR, high dV-5 volume, medium lifetime RAS volume)

Subtheme 4: Humanistic value

The dV-5 system features were associated with increased accessibility of both patients and surgeon trainees to access minimally invasive surgery through telepresence while case videos and associated metrics were found to be useful for patient education and shared decision making.

“I've shown [videos] to some patients who may have had a finding that have us make the interoperative decision that we shouldn't go forward so to explain that we didn't proceed with today's case because we found this and show that to them. Sometimes I take a picture, sometimes I share the video but that's something that's been helpful” - (Male, GEN: BAR, high dV-5 volume, high lifetime RAS volume)

“Specifically, the video recording, I think that that's been helpful. I also think that that's been helpful from a patient education standpoint. So I'm an endocrine surgeon. And so the kind of like highest value surgery that I do on the robot are adrenalectomies, and so explaining, showing people kind of in broad strokes. What that looks like, I think, is helpful from a patient education experience” – (Female, GEN:ENDO, medium high dV-5 volume, medium lifetime RAS volume)

“I think rural communities are definitely underserved. They just don't have enough doctors. People can't fly to some of these places so having an expert come and tele-proctor you on something, or watch you do a surgery would be a big win. Like I said, it's just not going to be viable for them to fly somebody out every time someone wants to do a robotic surgery so the more people you train, the better it will be for everybody. I think it will give the people access to better care” – (Male, GEN:BAR, high dV-5 volume, medium lifetime RAS volume)

“It means someone doesn't have to travel in order to have a specific case minimally invasively. We've got just a handful of surgeons that if they're going to convert, they're going to convert, no matter what. But if we could get it [telepresence] to be used where we try to ask for help before conversion on cases like when there's lots of scar tissue, then we would be able to give more patients better outcomes” – (Female, GYN:GYN, medium high dV-5 volume, medium lifetime RAS volume)

Subtheme 5: Provider-level barriers

Provider-level barriers were identified in the interpretation of metrics for new features including the Force Feedback and Case Insight technologies as well as some concerns around not having enough clinically relevant data to allow for implementation of the findings from the data into everyday practice.

“I think the challenge is really learning how the data [from case insights] can help you change your practice” – (Male, GEN:BAR, high dV-5 volume, medium lifetime RAS volume)

“I think if you can correlate the degree of force with complications, or show that someone who used 20% more force or x amount of more force ended up having more vascular injury, tissue scarring, -you name it, whatever the follow-up complication is- then, I think, setting some sort of standard for what that expectation may be beneficial. [Example] You shouldn't use more than X number of Newtons of force on this particular tissue when you're doing lymph nodes or when you're doing a hysterectomy, or when you're dealing with the bowel. I think would be helpful in training. We know that we can't feel the force of

the robot, but we know that it's strong and it has no limit, and you can tear things very easily. But what is that number [of safe force], we don't really know yet" – (Female, GYN:GYO, medium low dV-5 volume, low lifetime RAS volume)

Subtheme 6: Data infrastructure barriers

The data infrastructure set of barriers included delays in computing or instrumentation exchange as well as unmet technological needs around device functionality. Additionally, some interviews revealed insights into metrics yet to be captured with the current update of the system that would have been valuable for surgeons.

"In the surgeon console where the computing is happening, there are significant delays occasionally when swapping instruments. You can tell it [the console] just stopped thinking. I think those are little glitches, or another example is that the smoke evacuator works well sometimes and other times not" – (Male, GEN:GEN, high dV-5 volume, high lifetime RAS volume)

"I mean there's a lot of part of the surgery that is just dissection so it's really not getting to the meat of what's really needs to be done [in a surgery]. I think AI can really help with that to determine [what parts of the video in case insights to cut and edit together]. I'm sure there's products out there already that do it [stitching together a video]. But having it integrated into case insight would be pretty neat" (Male, THORACIC, high dV-5 volume, high lifetime RAS volume)

"It'd be nice if there was some way for AI generated feedback, to go through specific touch points of the case and say, "Well, you get an A + for this portion of the procedure but on this portion of the procedure you only get a B minus, and these are all the things that you can do to improve. Having more actionable items, I think [is valuable]" – (Female, GYN:GYN, medium high dV-5 volume, high lifetime RAS volume)

Subtheme 7: System level barriers

Challenges at the hospital system level were identified among surgeons. Barriers of note included a learning curve for staff in the OR in adjusting to the new system, and legal and regulatory challenges around data ownership for Case Insight videos.

"I don't know where the archive of that video [from my Case Insights] is going to stay because it's going to stay somewhere. I don't think it's going to be deleted completely [even when I delete it on my account]. I'm telling you this because it's important, you might be giving more tools for the attorneys and for an expert witness. Believe me, even if the case looks perfect, you can find a defect that's for sure" – (Male, GYN:GYN, medium low dV-5 volume, high lifetime RAS volume)

"I think as long as both parties have an understanding of the role of that teleconference, right? If it's me calling a partner who I otherwise would call into the room but they're seeing patients in the office, and I can say, "Hey, take a look at this like, what do you think about that?" They could give me some advice about it. I think that's a bit of a different context, and probably more useful. I think what many people are concerned about, which is what are the legal ramifications of, say, a surgeon who I'm not a partner with

who's calling me from, say, someplace in our hospital system and then I am documented in the note as someone who okay-ed the surgeon to do this procedure (or gave advice on it) and then say, there's a complication. Even though I'm not in the room, what is the legal responsibility of giving advice when someone is calling you and asking you for help [especially if something goes wrong]" – (Female, GYN:GYO, medium low dV-5 volume, low lifetime RAS volume)

"I don't really have to relearn anything majorly. I mean, the technology is very much same. I sometimes have to remember the finger clutching to switch instrumentation since I use the Xi a lot where I am using the foot pedal to switch my instrumentation. It does take a little bit of mental preparation to remember that I can switch my instrumentation using the toggling" – (Male, GEN:BAR, high dV-5 volume, medium RAS lifetime volume)

Discussion

In this qualitative study, the underlying value and barriers with adoption of the dV-5 system were explored among surgeons of different specialties, case volume and practices. From the twenty-three interviews, the most recurrent value-belief of dV-5 was cited at a surgeon-level (25.8%) which included improved ergonomics, increased autonomy due to system consolidation, and the use of data metrics for training and self-improvement. This was followed by economic (18.6%), clinical (13.5%) and humanistic (7.7%) value-beliefs. The most frequently cited challenges were identified at the provider-level (14.8%) followed by the data infrastructure (10.9%) and system levels (8.7%). Finally, when these subthemes were stratified by surgeon volume, low-volume surgeons ascribed more value to novel features of the dV-5, including force feedback technology, when compared to high-volume surgeons. This subjective observation may indicate that novel features of the dV-5 system provide value specifically for surgeons earlier on their learning curve for RAS.

Similarly, with the dV-5 demonstrating improved ergonomics compared to earlier generations of the platform, it continues to help narrow the gender gap in surgical ergonomics. Prior literature has documented disparities in ergonomic strain between male and female surgeons during non-robotic operations.[26, 27] This gender disparity exists even after controlling for confounding variables such as surgeon height and duration of operation, and has been associated with an increase in work-related injuries.[27, 28] Robotic surgery has been documented to decrease some of this strain including on the neck, back, hip, knee, ankle, foot and shoulder but previous version of robotic system were still associated with a gender difference in pain.[29] As more women enter the surgical workforce, ongoing enhancements in ergonomics—particularly those incorporated into the dV-5—are likely to have a positive impact on female surgeons, including during pregnancy, when ergonomic optimization is especially critical.[30]

The predominance of training-related themes identified in this analysis is aligned with and underscored by previous literature. Gall et al., conducted a randomized control trial that found that surgical trainees performing robotic surgery had fewer suture errors and better physical comfort levels compared to

trainees using laparoscopic.[31] This is validated by surgeon quotes from our study that demonstrated the unique dV-5 features including video capture, objective performance metrics, force data and improved ergonomics had use-cases for self-improvement, teaching new residents and quality benchmarking. A systematic literature review found that such novel training methodologies incorporated in robotic system upgrades have been linked to positive effects on surgical proficiency.[32]

Finally, the findings also pointed out the emerging value of Case Insights data which was used for patient education, self-improvement and training. In the past decade, the demand for clinically relevant performance metrics as part of robotic surgical training that can support procedure-specific learning has increased.[33] Studies have validated the use of such metrics against trained research staff and found a high degree of correlation suggesting that these measures are reliable for use in assessing surgeon skill and proficiency.[34] The dV-5 system further expands on this with force and instrument exchange data, thereby providing an enhanced basis for assessing surgeon proficiency. However, notable barriers in the use of Case Insights included limited understanding of how to interpret data metrics and their clinical relevance, as well as potential legal ramifications associated with storing surgical video data. This underscores the importance of data governance in promoting the wider adoption of digital products associated with surgical platforms.

Beyond the surgeon, the technological refinements of the dV-5 also empower non-surgeon team members. As one interviewee noted, “the instrumentation cone makes things a little quicker, because people can put instruments in faster... without worrying about skewing something.” Since instrument exchanges are typically performed by trainees or other non-surgeon team members, these design improvements—with built-in safety checks—enhance team confidence, streamline workflow, and reduce cognitive load at the bedside. This is particularly valuable in rural or community hospitals, where limited availability of experienced assistants can pose a barrier to efficient robotic surgery.[35, 36] These features in addition to the possibility of telesurgery can support expanding rural MIS access, which was seen as a priority for health system strengthening after the COVID-19 pandemic.[37, 38] The dV-5’s safety-driven and user-friendly design therefore not only benefits the primary surgeon but also strengthens the overall surgical team dynamic and procedural flow.

The study methodology is limited in its representativeness and data collection tool. Recruited surgeons were sourced from an internal registry and thus only represent a sample of robotic surgeons in the United States. The participants may also hold a favorable view of robotic surgery given that they were early adopters of technology and may have biased the results towards a higher proportion of value-beliefs. Finally, participants who consented and were interviewed made a higher proportion of male, general surgeons and those that practiced in community hospitals; these perspectives represent only a subset of views and experiences in robotic surgery. In contrast, the timing of the study may have had implications on participants’ views given the early system maturity that limited participants from experiencing all the benefits purported for features that are evolving (e.g. force feedback). The data collection tool used in this study was semi-structured interviews which has been shown in literature to suffer from subjectivity and recall bias.[39] This could have impacted questions that probed operational

time, efficiency, and clinical outcomes when comparing dV-5 to previous systems or laparoscopic surgery. However, measures were taken to reduce these limitations including the use of a third-party vendor to recruit participants in the effort to reduce selection bias, application of randomized selection for participants, and the independent validation of themes during analysis. Regardless, the findings of this work would benefit from follow-up studies to validate the themes, especially around clinical benefits, using quantitative studies.

Despite the limitations stated, the study provides a comprehensive and timely snapshot of the different value domains of the new robotic system. This allows for comparisons to be made as the system matures or to triangulate the claims against quantitative evidence. Moreover, the study's quasi-random sampling allowed for surgeons of various specialties, case volumes and practice types to be interviewed, which lead to themes being stratified to surface patterns that quantitative data alone would not capture. This also allowed comparison of themes and subthemes across these various domains to contextualize barriers/challenges with adoption across hospital settings and surgeon volumes. Finally, allowing surgeons to relate examples within their practice to themes illustrated how some features may have future benefits that are yet to be realized such as telesurgery, standardized robotic training using benchmarks, and increased access of robotics to rural communities.

Thus, the findings from this study postulates the value of the dV-5 system in surgeon training, improved ergonomics and increasing operational efficiency, while also highlighting the need for further research on clinical outcomes. The qualitative nature of the study adds essential interpretive depth into the practical benefits and barriers surgeons are currently experiencing with the system within their delivery of care.

Declarations

Competing Interests

Authors DE and CC have no competing interests to declare. Authors ZF, KD, FZ, and GJ report being employed by Intuitive Surgical during the conduct of the study.

Author Contribution

Conceptualization: FZ, ZAF, GJ, KD. Methodology: FZ, ZAF. Data curation: ZAF, KD. Formal analysis: ZAF. Validation: KD. Writing, Original Draft: ZAF. Writing – Review & Editing: FZ, GJ, KD, DE, CC

Data Availability

De-identified data from this study is available upon reasonable request to the corresponding author.

References

1. Wah JNK (2025) The rise of robotics and AI-assisted surgery in modern healthcare. *J Robot Surg* 19:311. <https://doi.org/10.1007/s11701-025-02485-0>
2. Sheetz KH, Dimick JB, Clafin J (2020) Trends in the Adoption of Robotic Surgery for Common Surgical Procedures. *JAMA Netw Open* 3. <https://doi.org/10.1001/jamanetworkopen.2019.18911>
3. Wright JD, Herzog TJ, Tsui J, Ananth CV, Lewin SN, Lu Y-S, Neugut AI, Hershman DL (2013) Nationwide Trends in the Performance of Inpatient Hysterectomy in the United States. *Obstet Gynecol* 122:233–241. <https://doi.org/10.1097/AOG.0b013e318299a6cf>
4. Chopra S, Srivastava A, Tewari A (2012) Robotic radical prostatectomy: The new gold standard. *Arab J Urol* 10:23–31. <https://doi.org/10.1016/j.aju.2011.12.005>
5. DiMaio S, Hanuschik M, Kreaden U (2011) The da Vinci Surgical System. In: Rosen J, Hannaford B, Satava RM (eds) *Surgical Robotics: Systems Applications and Visions*. Springer US, Boston, MA, pp 199–217
6. Wong C, Beaumont M, Klassen T, McCavour A, Rendon R, Shayegan B (2025) The far-reaching impact of robotic-assisted surgery on healthcare systems. *Healthc Manage Forum* 38:156–165. <https://doi.org/10.1177/08404704251327561>
7. Joe, Fairbanks, Office of Primary Care and Rural Health Development, Owens V, Garner J, Rose J, Kimpel M, Castleberry J, Kusi S (2017) (2015) *Oklahoma Health Workforce Data Book*
8. Oklahoma State Department of Health, Muskogee County Health Department (2017) *Sstate of the County's Health Report*
9. Anderson JE, Chang DC, Parsons JK, Talamini MA (2012) The First National Examination of Outcomes and Trends in Robotic Surgery in the United States. *J Am Coll Surg* 215:107–114. <https://doi.org/10.1016/j.jamcollsurg.2012.02.005>
10. Ricciardi R, Seshadri-Kreaden U, Yankovsky A, Dahl D, Auchincloss H, Patel NM, Hebert AE, Wright V (2025) The COMPARE Study: Comparing Perioperative Outcomes of Oncologic Minimally Invasive Laparoscopic, da Vinci Robotic, and Open Procedures: A Systematic Review and Meta-analysis of the Evidence. *Ann Surg* 281:748–763. <https://doi.org/10.1097/SLA.0000000000006572>
11. South C, Megafu O, Moore C, Williams T, Hobson L, Danner O, Johnson S (2025) Robotic Surgery in Safety-Net Hospitals: Addressing Health Disparities and Improving Access to Care. *Am Surg* 91:639–643. <https://doi.org/10.1177/00031348241312121>
12. Fong ZV, Wall-Wieler E, Johnson S, Culbertson R, Mitzman B (2025) Rates of Minimally Invasive Surgery After Introduction of Robotic-Assisted Surgery for Common General Surgery Operations. *Ann Surg Open Perspect Surg Hist Educ Clin Approaches* 6:e546. <https://doi.org/10.1097/AS9.0000000000000546>
13. Mitzman B, Johnson S, Lichtveld M, Culbertson R, Fong ZV (2025) Minimally Invasive Surgery Deserts: Is There a Role for Robotic Assisted Surgery? *JSLs J Soc Laparosc Robot Surg* 28. <https://doi.org/10.4293/JSLs.2024.00039>. e2024.00039
14. Intuitive Surgical Meet the da Vinci 5 robotic surgical system. <https://www.intuitive.com/en-us/products-and-services/da-vinci/5>. Accessed 10 Jul 2025

15. Covas Moschovas M, Saikali S, Gamal A, Reddy S, Rogers T, Chiara Sighinolfi M, Rocco B, Patel V (2024) First Impressions of the New da Vinci 5 Robotic Platform and Experience in Performing Robot-assisted Radical Prostatectomy. *Eur Urol Open Sci* 69:1–4.
<https://doi.org/10.1016/j.euros.2024.08.014>
16. Asadizeidabadi A, Hosseini S, Vetshev F, Osminin S, Hosseini S (2024) Comparison of da Vinci 5 with previous versions of da Vinci and Sina: A review. *Laparosc Endosc Robot Surg* 7:60–65.
<https://doi.org/10.1016/j.lers.2024.04.006>
17. Reddy SK, Covas Moschovas M, Saikali S, Ozawa Y, Gamal A, Sharma R, Rogers T, Sandri M, Patel V (2025) Perioperative outcomes comparing the DaVinci 5 with DaVinci Xi in patients undergoing robotic-assisted radical prostatectomy. *Prostate Cancer Prostatic Dis* 1–6.
<https://doi.org/10.1038/s41391-025-01025-z>
18. Gamal A, Moschovas MC, Saikali S, Reddy S, Ozawa Y, Sharma R, Kunta A, Rogers T, Patel V (2025) Comparing the Technological and Intraoperative Performances of Da Vinci xi and DaVinci 5 Robotic Platforms in Patients Undergoing Robotic-Assisted Radical Prostatectomy. *Int Braz J Urol* 51:e20240569. <https://doi.org/10.1590/S1677-5538.IBJU.2024.0569>
19. Cooper H, Lau HM, Mohan H (2025) A systematic review of ergonomic and muscular strain in surgeons comparing robotic to laparoscopic approaches. *J Robot Surg* 19:252.
<https://doi.org/10.1007/s11701-025-02401-6>
20. Moloney R, Coffey A, Coffey JC, Brien BO (2023) Nurses' perceptions and experiences of robotic assisted surgery (RAS): An integrative review. *Nurse Educ Pract* 71:103724.
<https://doi.org/10.1016/j.nepr.2023.103724>
21. Wu Q, Pei H, Ran X, Chen X, Limei J, Wei A, Xiang X, Wang Y, Gan X (2022) Qualitative Study on the Information Needs of Patients Undergoing Da Vinci Robotic Surgery. *Clin Nurs Res* 32.
<https://doi.org/10.1177/10547738221103337>
22. Moloney R, Coffey A, Coffey C, O'Brien B (2023) Patients' experience of robotic-assisted surgery: a qualitative study. *Br J Nurs* 32. <https://doi.org/10.12968/bjon.2023.32.6.298>
23. White RE, Cooper KB (2022) *Qualitative Research in the Post-Modern Era*. Springer US
24. Green J, Thorogood N (2018) *Qualitative Methods for Health Research*, 4th edn. Sage, London, UK
25. Tong A, Sainsbury P, Craig J (2007) Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care* 19:349–357.
<https://doi.org/10.1093/intqhc/mzm042>
26. Altin E, Majeed H, Verma R, Paterson E, Yanagawa B (2025) Promoting gender diversity and ergonomic equity in the cardiac surgery operating room. *Curr Opin Cardiol* 40:91.
<https://doi.org/10.1097/HCO.0000000000001195>
27. Armijo PR, Flores L, Pokala B, Huang C-K, Siu K-C, Oleynikov D (2022) Gender equity in ergonomics: does muscle effort in laparoscopic surgery differ between men and women? *Surg Endosc* 36:396–401. <https://doi.org/10.1007/s00464-021-08295-3>

28. Stucky C-CH, Cromwell KD, Voss RK, Chiang Y-J, Woodman K, Lee JE, Cormier JN (2018) Surgeon symptoms, strain, and selections: Systematic review and meta-analysis of surgical ergonomics. *Ann Med Surg* 27:1–8. <https://doi.org/10.1016/j.amsu.2017.12.013>
29. Plerhoples TA, Hernandez-Boussard T, Wren SM (2012) The aching surgeon: a survey of physical discomfort and symptoms following open, laparoscopic, and robotic surgery. *J Robot Surg* 6:65–72. <https://doi.org/10.1007/s11701-011-0330-3>
30. Jacovides CL, Guetter CR, Crandall M, McGuire K, Slama EM, Plotkin A, Kashyap MV, Lal G, Henry MC, Committee for the A of WSP (2024) Overcoming Barriers: Sex Disparity in Surgeon Ergonomics. *J Am Coll Surg* 238:971. <https://doi.org/10.1097/XCS.0000000000001043>
31. Gall TMH, Alrawashdeh W, Soomro N, White S, Jiao LR (2020) Shortening surgical training through robotics: randomized clinical trial of laparoscopic versus robotic surgical learning curves. *BJS Open* 4:1100–1108. <https://doi.org/10.1002/bjs5.50353>
32. Azadi S, Green IC, Arnold A, Truong M, Potts J, Martino MA (2021) Robotic Surgery: The Impact of Simulation and Other Innovative Platforms on Performance and Training. *J Minim Invasive Gynecol* 28:490–495. <https://doi.org/10.1016/j.jmig.2020.12.001>
33. Younes MM, Larkins K, To G, Burke G, Heriot A, Warriar S, Mohan H (2023) What are clinically relevant performance metrics in robotic surgery? A systematic review of the literature. *J Robot Surg* 17:335–350. <https://doi.org/10.1007/s11701-022-01457-y>
34. Quinn KM, Chen X, Runge LT, Pieper H, Renton D, Meara M, Collins C, Griffiths C, Husain S (2023) The robot doesn't lie: real-life validation of robotic performance metrics. *Surg Endosc* 37:5547–5552. <https://doi.org/10.1007/s00464-022-09707-8>
35. Finlayson SRG (2005) Surgery in Rural America. *Surg Innov* 12:299–305. <https://doi.org/10.1177/155335060501200403>
36. Thompson MJ, Lynge DC, Larson EH, Tachawachira P, Hart LG (2005) Characterizing the General Surgery Workforce in Rural America. *Arch Surg* 140:74–79. <https://doi.org/10.1001/archsurg.140.1.74>
37. Feizi N, Tavakoli M, Patel RV, Atashzar SF (2021) Robotics and AI for Teleoperation, Tele-Assessment, and Tele-Training for Surgery in the Era of COVID-19: Existing Challenges, and Future Vision. *Front Robot AI* 8. <https://doi.org/10.3389/frobt.2021.610677>
38. Anvari M (2005) Reaching the rural world through robotic surgical programs. *Eur Surg* 37:284–292. <https://doi.org/10.1007/s10353-005-0183-y>
39. Flick U (2017) *The SAGE Handbook of Qualitative Data Collection*. Sage Publ, pp 1–736

Figures

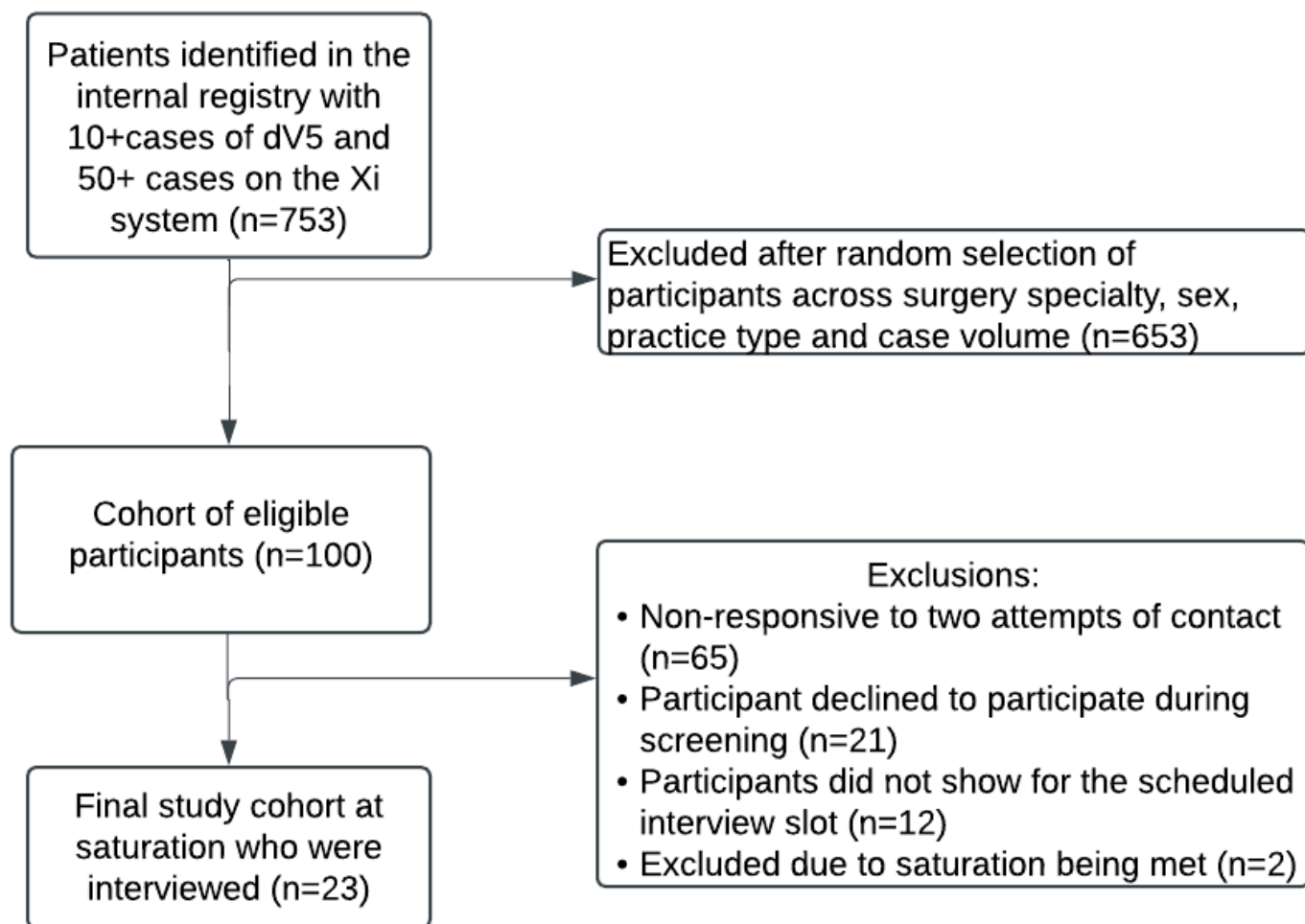


Figure 1

Flow diagram of cohort selection

Descriptive caption: A flow diagram that demonstrates the initial sample size of 753 participants who were identified in an internal registry to meet the inclusion criteria, and were then sampled down to 100 participants randomly selected across sex, specialty, practice type and case volume. The final study cohort included only 23 participants from the initial 100 with exclusions due to non-response, drop-out, and saturation being met.

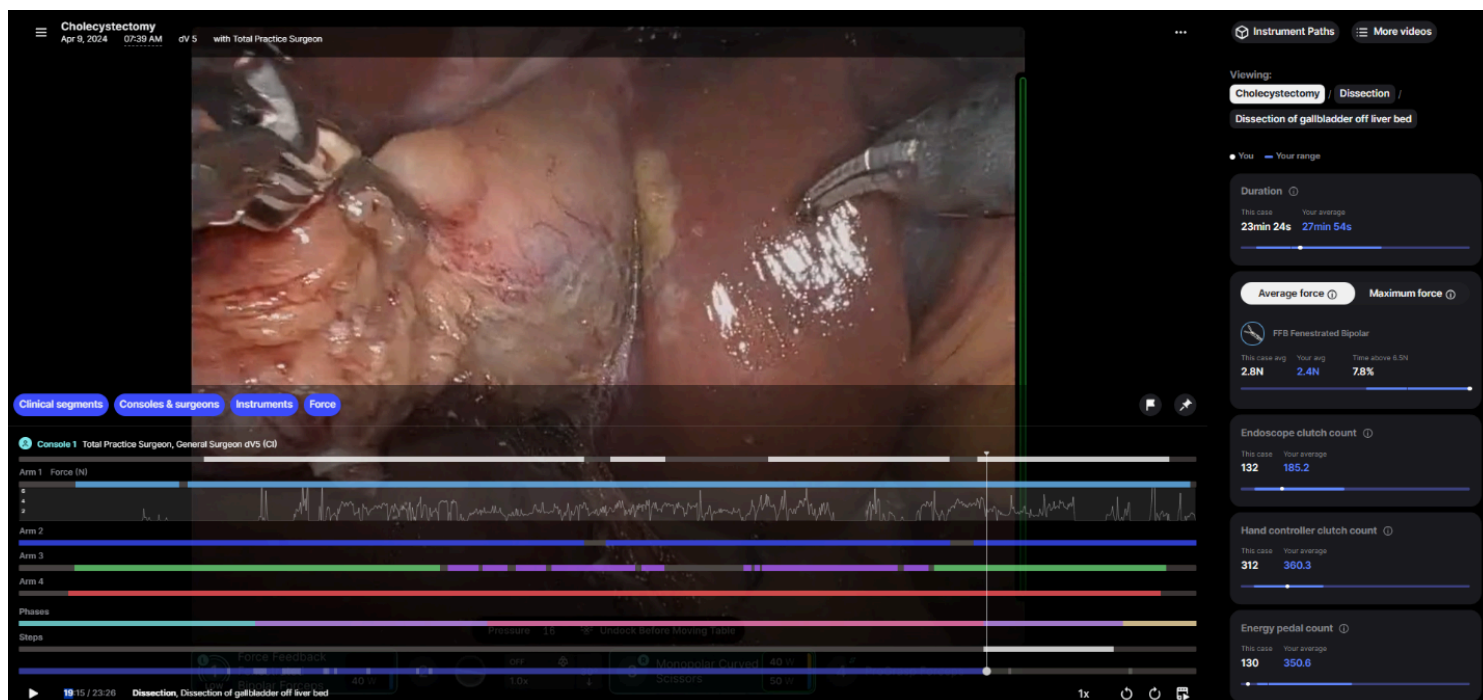


Figure 2

Case Insights platform

Descriptive caption: Screenshot of the Case Insights surgical analytics application displaying a video review snapshot of a robotic cholecystectomy during the transection phase. The main portion of the screen shows an intraoperative view of the gallbladder being dissected using robotic instruments. A timeline overlay beneath the video indicates activity from Console 1 and Arms 1 through 4, with color-coded bars showing instrument usage and activation over time. Additional segmented tracks display the procedure phases and individual steps. On the right-hand panel, case-level Objective Performance Indicators (OPIs) are listed, including total duration, average force with an instrument, endoscope clutch count, hand controller clutch count, and energy pedal count.

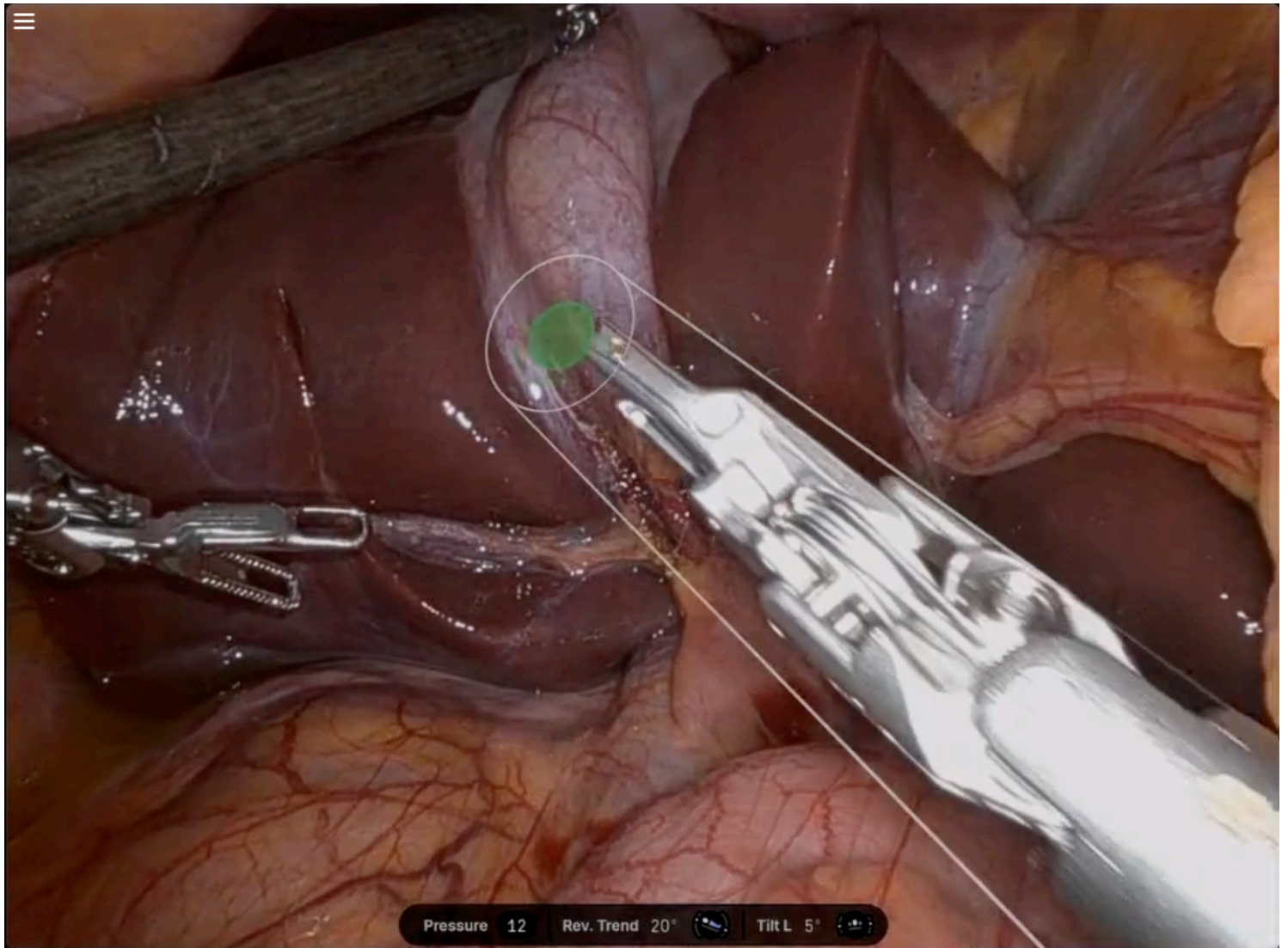


Figure 3

Guided instrument exchange

Descriptive caption: Screenshot of a robotic surgical console display during a guided instrument exchange in a cholecystectomy. The image shows an internal view of the liver and gallbladder region. A robotic instrument is centered in the frame, highlighted with a translucent circular target and alignment guides indicating the system's guided exchange feature. On-screen visual overlays assist with positioning and alignment during the instrument swap. At the bottom of the screen, interface indicators display real-time metrics including pressure (12), reverse trend angle (20 degrees), and tilt (5 degrees), providing situational awareness to the surgeon or operating room support staff during the exchange process.

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