TECHNOLOGY REVIEW (MINI-HTA)

ROBOTIC-ASSISTED SURGERY FOR GYNAECOLOGICAL DISORDERS

Malaysian Health Technology Assessment Section (MaHTAS)
Medical Development Division
Ministry of Health Malaysia
03/2025

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EVIDENCE INFORMED DELIBERATIVE PROCESS

This Technology Review underwent an evidence informed deliberative process during the Health Technology Assessment (HTA) Technical Advisory Committee meeting, chaired by the Director, Medical Development Division, MOH. Then it was endorsed in the HTA-CPG Council meeting chaired by the Director General of Health.

Published by:

Malaysian Health Technology Assessment Section (MaHTAS)
Medical Development Division
Ministry of Health Malaysia
Level 4, Block E1, Precinct 1
Government Office Complex
62590, Putrajaya
Tel: 603 8883 1229
Available online via the official Ministry of Health Malaysia website: http://www.moh.gov.my

Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available from the National Library of Malaysia

eISBN 978-967-2887-97-3

e-ISBN:978-967-2887-97-3

SUGGESTED CITATION: Nur Farhana M, Roza S, and Izzuna MMG. Robotic-Assisted Surgery for Gynaecological Disorders. Technology Review. Ministry of Health Malaysia: Malaysian Health Technology Assessment Section (MaHTAS); 2025. 120 p. Report No.: 03/2025. eISBN no : 978-967-2887-97-3

DISCLOSURE: The author of this report has no competing interest in this subject and the preparation of this report is entirely funded by the Ministry of Health Malaysia.

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EXECUTIVE SUMMARY

Background

Gynaecological disorders, including uterine fibroids, endometriosis, pelvic organ prolapse, and various malignancies, represent significant health challenges affecting women globally. According to the World Health Organization (WHO), these disorders substantially impact women's quality of life, fertility, psychological well-being, and overall health. Worldwide, approximately 10% of women suffer from endometriosis, while uterine fibroids affect up to 70% of women by age 50. The prevalence of pelvic organ prolapse and urinary incontinence also rises with advancing age, significantly affecting postmenopausal populations.

In Malaysia, the prevalence of gynaecological disorders mirrors global trends, with uterine fibroids and endometriosis among the most commonly reported conditions in women of reproductive age. Endometriosis affects approximately 10% to 15% of Malaysian women, significantly impacting fertility, work productivity, and healthcare utilization. Similarly, pelvic organ prolapse has increasingly been diagnosed due to an aging population, raising concerns regarding long-term management and resource allocation within the public healthcare system.

Traditionally, gynaecological disorders have been managed through conservative medical treatments, minimally invasive laparoscopic surgery, or open surgery for severe cases. Minimally invasive laparoscopic techniques have become the standard of care due to reduced morbidity, shorter hospital stays, and faster recovery compared to open surgery; however, these approaches remain technically challenging in complex cases.

Robotic-assisted surgery has emerged as an innovative surgical option, offering enhanced visualization, greater precision, and improved ergonomics, particularly in complex gynaecological procedures. Given the promising benefits yet significant costs associated with robotic surgery, the Medical Services Development Section, Ministry of Health (MOH) Malaysia, has requested this technology review to comprehensively evaluate the clinical effectiveness, safety, and cost-effectiveness of robotic surgery for gynaecological disorders. The review aims to provide evidence to guide informed decision-making and justify the potential expansion of robotic surgical services within MOH healthcare facilities across Malaysia.

Objective/ aim

The objective of this technology review was to assess the effectiveness, safety, and cost-effectiveness of robotic-assisted surgery for gynaecological disorders.

Methods

A systematic search was conducted on the following databases without any restriction on publication language and publication status. The Ovid interface: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily 1946 to March 3rd, 2025. Searches were also run in Cochrane Embase, PubMed, and INAHTA databases. Google was used to search for additional web-based materials and information. Additional articles were identified by reviewing the references of retrieved articles. The last search was conducted on 3rd March 2025.

Results and conclusions

Search results

A total of 590 records were identified through the Ovid interface and PubMed while 15 were identified from references of retrieved articles. Thirty-three duplicate references were found; 557 potentially relevant titles were screened using the inclusion and exclusion criteria. Of these, 44 relevant abstracts were retrieved in full text. After reading, appraising, and applying the inclusion and exclusion criteria to the full-text articles, 33 were included while the other 11 were excluded since the studies were included in the systematic reviews, had irrelevant populations and few were narrative reviews. All full-text articles finally selected for this review were 18 systematic review and network meta/meta-analysis, 6 systematic reviews, one HTA, one cohort study, two cross-sectional studies, two qualitative studies, and three cost analyses.

Efficacy/ effectiveness

Robotic-Assisted Surgery for General Gynaecological Disorders

Multiple meta-analyses and systematic reviews demonstrated that robotic-assisted surgery showed comparable effectiveness to conventional laparoscopic and open surgeries for general gynaecological conditions including benign and malignant conditions, with similar clinical outcomes. Although robotic surgery consistently involved longer operative times compared to laparoscopic approaches, it provided notable advantages over open surgery, including reduced length of hospital stay and lower estimated blood loss.

Robotic-Assisted Surgery for Myomectomy

Evidence from systematic reviews and meta-analyses showed that compared to laparoscopic myomectomy and open myomectomy, robotic-assisted myomectomy significantly reduced estimated blood loss, lowered conversion rates from minimally invasive to open surgery, and shortened hospital stays relative to open myomectomy. However, operative times were consistently longer for robotic-assisted myomectomy compared to laparoscopic myomectomy and open myomectomy.

Robotic-Assisted Surgery for Endometriosis

Evidence from systematic reviews and meta-analyses indicates that robotic-assisted surgery demonstrates comparable clinical effectiveness to conventional laparoscopic surgery for endometriosis. Robotic surgery showed no significant difference in intraoperative and postoperative complications, conversion rates, or estimated blood loss compared to conventional laparoscopy. However, robotic-assisted surgery consistently involved significantly longer operative times, with mean differences ranging from 28 to 51 minutes compared to laparoscopic surgery. For bowel deep infiltrating endometriosis, robotic surgery was associated with shorter hospital stays and comparable symptomatic relief, despite increased operative durations.

Robotic-Assisted Surgery for Hysterectomy

Evidence from systematic reviews and meta-analyses indicates that robotic-assisted hysterectomy significantly reduces hospital stays, blood loss, transfusion rates, and conversion rates compared to laparoscopic and open approaches. Robotic single-site hysterectomy also proved safe and feasible, exhibiting short hospital stays, minimal blood loss, and low conversion rates. Despite slightly longer operative times, RAH and RSSH offer clear clinical advantages, particularly beneficial in cases involving larger uteri or prior abdominal surgeries.

Robotic-Assisted Surgery for Endometrial Cancer
Evidence from multiple systematic reviews and meta-analyses demonstrates that robotic-assisted surgery for endometrial cancer offers superior perioperative outcomes compared to laparotomy and conventional laparoscopy, particularly in improving short-term surgical outcomes including significantly reduced blood loss, transfusion rates, and hospital stay, though operative times were longer. While long-term oncologic outcomes such as disease-free and overall survival are comparable across surgical approaches, some studies reported a slight advantage in disease-free survival for robotic-assisted surgery.

Robotic-Assisted Surgery for Sacrocolpopexy in Pelvic Organ Prolapse
Multiple systematic reviews and meta-analyses consistently showed robotic-assisted sacrocolpopexy is associated with less estimated blood loss, lower conversion rates, and high anatomical success, particularly for apical prolapse. Although it often involves longer operative times and higher costs, multiple systematic reviews and meta-analyses confirm that it achieves excellent anatomical outcomes, with cure rates up to 98.6% and low recurrence and reoperation rates.

Robotic-Assisted Surgery for Stress Urinary Incontinence
Robotic-assisted artificial urinary sphincter implantation in women with stress urinary incontinence has shown promising effectiveness in multiple recent studies, with continence rates ranging from 72% to 83% and significant improvements in quality-of-life measures.

Safety
Robotic-Assisted Surgery for General Gynaecological Disorders
Multiple systematic reviews and meta-analyses indicate that robotic-assisted gynaecologic surgery demonstrates a safety profile comparable to conventional laparoscopic surgery, with no significant differences in overall complication rates. Robotic single-port procedures show acceptable complication rates, predominantly minor, and rare conversion rates. Mortality rates associated with robotic gynaecologic surgery are extremely low, closely mirroring laparoscopic surgery outcomes. Robotic approaches in oncologic cases specifically resulted in significantly lower blood loss compared to open surgery, without increased complication risks.

Robotic-Assisted Surgery for Myomectomy
Multiple systematic reviews and meta-analyses indicate that robotic-assisted myomectomy has a favourable safety profile, showing comparable complication and transfusion rates to laparoscopic myomectomy. However, compared to open myomectomy, robotic procedures demonstrated significantly lower complication rates, reduced transfusion requirements, and decreased blood loss.

Robotic-Assisted Surgery for Endometriosis
Multiple systematic reviews and meta-analyses indicate that robotic-assisted surgery demonstrates comparable safety outcomes to conventional laparoscopy for endometriosis. Specifically, no significant differences were observed between robotic and laparoscopic procedures regarding intraoperative complications, postoperative complications, conversion rates to open surgery, or estimated blood loss.

Robotic-Assisted Surgery for Hysterectomy

Multiple systematic reviews and meta-analyses indicate that robotic-assisted hysterectomy is associated with favourable safety outcomes compared to other surgical approaches. Robotic-assisted hysterectomy showed significantly fewer complications than open hysterectomy, lower transfusion and conversion rates than laparoscopy, and slightly reduced readmission rates. Robotic single-site hysterectomy also demonstrated low intraoperative and postoperative complication rates, minimal blood loss, and no reoperations or readmissions within 30 days.

Robotic-Assisted Surgery for Endometrial Cancer

Evidence from multiple systematic reviews and meta-analyses consistently indicate that robotic-assisted surgery for endometrial cancer is associated with a favourable safety profile compared to laparotomy and laparoscopy. Robotic-assisted surgery significantly reduces intraoperative and postoperative complications, blood loss, transfusion rates, and conversion to open surgery. In patients with obesity, robotic-assisted surgery maintains low perioperative complication rates and shows reduced conversion rates.

Robotic-Assisted Surgery for Sacrocolpopexy in Pelvic Organ Prolapse

Multiple systematic reviews have demonstrated that robotic-assisted sacrocolpopexy is consistently associated with lower blood loss, fewer conversions to open surgery, and high anatomical success rates. Although overall complication and transfusion rates are similar between robotic and laparoscopic sacrocolpopexy, robotic sacrocolpopexy shows low rates of mesh-related complications and reoperations. Some evidence indicates increased postoperative pain and analgesic use with RSC, but serious adverse events remain uncommon.

Robotic-Assisted Surgery for Stress Urinary Incontinence

Evidence from recent studies suggests that robotic-assisted artificial urinary sphincter implantation in women with stress urinary incontinence offers favourable continence outcomes, with pooled rates ranging from 72% to 83%. However, complication rates remain considerable, with intraoperative complications reported in up to 21% of cases and postoperative complications in approximately 20–27%.

Economic Implications

Multiple studies highlight the substantially higher costs associated with robotic-assisted surgery compared to conventional approaches. Robotic hysterectomy was the most expensive among all hysterectomy types, primarily due to equipment and maintenance costs, while offering clinical benefits in complex cases. In gynaecologic oncology, robotic-assisted surgery demonstrated higher operative and equipment costs, but also yielded lower blood loss, fewer conversions, and shorter hospital stays in some studies. Cost-effectiveness appears limited and may only be achieved in high-volume centres or with cost-saving strategies.

Organisational Issues

Training

Despite widespread availability of robotic systems and simulators in training institutions, formalized curricula for robotic-assisted surgery remain limited. Many residents lack faculty-led instruction and hands-on opportunities to serve as primary surgeons. Key barriers include time constraints, limited simulator access, and faculty reluctance. However, most trainees express

strong interest in pursuing robotic certification and integrating robotics into future practice, highlighting the need for structured, standardized training programs in residency.

Perception of healthcare experts

Healthcare professionals generally perceive robotic-assisted surgery as a valuable innovation that enhances clinical performance and hospital reputation. However, adoption remains limited due to financial barriers, training gaps, and infrastructural constraints. While some experts support its selective use in complex cases, others advocate broader implementation due to perceived advantages in precision, ergonomics, and recovery time. Despite favourable views, concerns persist around resident readiness and inconsistent training exposure, suggesting a need for standardized curricula and robust credentialing pathways to support future adoption.

Guidelines

Numerous international and regional bodies have issued guidelines to support the safe, effective, and standardized implementation of robotic-assisted surgery in gynaecology. These guidelines consistently emphasize key areas including appropriate patient selection, surgeon training and credentialing, informed consent, and quality assurance mechanisms. In high-income and regional contexts alike, structured curricula, simulation-based training, and certification processes are promoted to ensure surgical proficiency.

Ethical Issues

While robotic-assisted surgery offers technological advancements and potential clinical benefits, it raises several ethical concerns. Key issues include ensuring informed consent amidst patient misconceptions, equitable access given the high cost of robotic-assisted surgery, and variability in training that may impact surgical competency and patient safety. Inconsistent evidence of clinical superiority, coupled with significantly higher costs, also raises questions about justifiable resource allocation in public healthcare. Additionally, potential conflicts of interest such as those driven by industry partnerships highlight the need for transparency and evidence-based decision-making to maintain ethical, patient-centered care.

Conclusion

Robotic-assisted surgery for gynaecological disorders demonstrates comparable safety and clinical effectiveness to conventional approaches, with potential advantages in reducing blood loss, shortening hospital stays, and enhancing surgical precision, particularly in complex cases. However, these benefits are accompanied by significantly higher costs, longer operative times, and limited long-term outcome data. Significant organizational challenges were identified, including inconsistent training, limited resident autonomy, and the absence of standardized curricula, all of which may compromise surgical proficiency and patient safety. Although international and regional guidelines emphasize structured education and credentialing, their implementation across settings remains highly variable.

TABLE OF CONTENTS

ABBREVIATION

Abbreviation	Definition
AEs	Adverse Events
AM	Abdominal Myomectomy
CASP	Critical Appraisal Skills Programme
CI	Confidence Interval
CL	Conventional Laparoscopy
DVSSP	Da Vinci Single-Site Platform
EBL	Estimated Blood Loss
FDA	Food and Drug Administration
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
HTA	Health Technology Assessment
ICER	Incremental Cost-Effectiveness Ratio
INAHTA	International Network of Agencies for Health Technology Assessment
LM	Laparoscopic Myomectomy
LMICs	Low- and Middle-Income Countries
LPS	Laparoscopic Surgery
LOS	Length of Stay
MaHTAS	Malaysian Health Technology Assessment Section
MD	Mean Difference
MOH	Ministry of Health
NMA	Network Meta-Analysis
OM	Open Myomectomy
OR	Odds Ratio
PGY	Postgraduate Year
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QALYs	Quality-Adjusted Life Years
RAH	Robotic-Assisted Hysterectomy
RALS	Robotic-Assisted Laparoscopic Surgery
RCT	Randomised Controlled Trial
RM	Robotic Myomectomy
ROB2	Risk of Bias 2 Tool
ROBIS	Risk of Bias in Systematic Reviews
RSSH	Robotic Single-Site Hysterectomy
R-LESS	Robotic Laparoendoscopic Single-Site Surgery
SLS	Standard Laparoscopic Surgery
SR	Systematic Review
VH	Vaginal Hysterectomy
WHO	World Health Organization

1.0 BACKGROUND

Gynaecological disorders, including uterine fibroids, endometriosis, pelvic organ prolapse, and various malignancies, represent significant health challenges affecting women globally. According to the World Health Organization (WHO), gynaecological disorders have a substantial impact on women's quality of life, fertility, psychological well-being, and overall health.[1] Worldwide, approximately 10% of women suffer from endometriosis, and uterine fibroids affect up to 70% of women by the age of 50 years.[2,3] Pelvic organ prolapse and urinary incontinence prevalence rates also increase with advancing age, significantly affecting postmenopausal populations.[4]

In Malaysia, the prevalence of gynaecological disorders mirrors global trends, with uterine fibroids and endometriosis being among the most commonly reported conditions among women of reproductive age. Endometriosis, for instance, affects approximately 10% to 15% of Malaysian women of reproductive age, significantly impacting fertility, work productivity, and healthcare utilization.[5] Similarly, pelvic organ prolapse has been increasingly diagnosed due to an aging population, raising concerns regarding long-term management and resource allocation within the public healthcare system.[6]

The traditional management of gynaecological disorders has involved conservative medical treatments, minimally invasive laparoscopic surgery, or open surgery for severe cases. While minimally invasive laparoscopic techniques have become the standard of care due to reduced morbidity, shorter hospital stays, and faster recovery compared to open surgery, these approaches can be technically challenging, especially in complex cases.[7] Robotic-assisted surgery has emerged as an innovative surgical option, offering enhanced visualization, greater precision, and improved ergonomics, particularly in complex gynaecological procedures. With robotic technology, surgeons can overcome some limitations of conventional laparoscopy, potentially improving surgical outcomes and reducing complications.[8,9]

Given the promising benefits yet significant costs associated with robotic surgery, the Medical Services Development Section *(Cawangan Perkembangan Perkhidmatan Perubatan)*, Ministry of Health (MOH) Malaysia, has requested this technology review to comprehensively evaluate the clinical effectiveness, safety, and cost-effectiveness of robotic surgery for gynaecological disorders. The review aims to provide evidence to guide informed decision-making and justify the potential expansion of robotic surgical services within MOH healthcare facilities across Malaysia.

2.0 OBJECTIVE / AIM

The objective of this technology review was to assess the effectiveness, safety, and cost-effectiveness of robotic-assisted surgery for gynaecological disorders.

3.0 TECHNICAL FEATURES

Robotic-assisted surgery has significantly advanced the surgical management of gynaecological disorders by combining the benefits of minimally invasive techniques with enhanced precision, improved ergonomics, and greater surgeon control. The da Vinci Surgical System, developed by Intuitive Surgical, is currently the predominant platform utilized globally for various complex gynaecological procedures, including hysterectomies, myomectomies, pelvic floor reconstructive surgeries, and treatments for endometriosis and gynaecological cancers.

The da Vinci system primarily consists of three integral components: the surgeon's console, the patient-side cart, and the vision cart. At the console, the surgeon operates remotely, controlling surgical instruments via master controls that translate the surgeon's hand, wrist, and finger movements into precise, real-time actions. The surgeon benefits from an ergonomically optimized setup that reduces physical fatigue and enhances surgical performance. Furthermore, the system incorporates tremor filtration, which steadies the surgical instruments and improves operative precision, critical during delicate tissue manipulation.[8,9]

The patient-side cart features robotic arms equipped with articulating surgical instruments. These instruments offer seven degrees of freedom and 90 degrees of articulation, exceeding the capabilities of traditional laparoscopic instruments. Such advanced manoeuvrability allows surgeons to perform complex dissections, precise suturing, and tissue manipulation, which is particularly advantageous in intricate anatomical regions encountered in gynaecological surgeries. The robotic instruments can also access confined pelvic spaces more effectively, enhancing surgical accuracy and reducing the risk of inadvertent tissue injury.[10,11]

The da Vinci vision system provides surgeons with high-definition, magnified three-dimensional visualization of the operative field. This superior visualization significantly aids in identifying intricate anatomical structures and differentiating pathological tissues, potentially resulting in reduced blood loss, fewer complications, and enhanced surgical outcomes. The system claims to facilitate surgeries with minimal invasiveness, shorter hospital stays, quicker recoveries, and reduced postoperative pain and scarring compared to conventional open or laparoscopic approaches.[8,12]

Besides the da Vinci Surgical System, other robotic platforms are available or in development for gynaecological surgery, including the HUGO™ Robotic-Assisted Surgery System by Medtronic, the Versius Surgical System by CMR Surgical, and the Toumai Surgical System by MicroPort MedBot. These robotic platforms offer varied configurations, flexible modular designs, and advanced visualization capabilities to meet diverse clinical requirements. The presence of multiple robotic systems highlights the continuous evolution and expanding possibilities in robotic surgery technology, aimed at enhancing surgical procedures and patient care outcomes in the field of gynaecology.[11]

Figure 1: The da Vinci system

4.0 METHODS

A systematic review was conducted. Search strategy was developed by the two authors and an *Information Specialist*.

4.1 SEARCHING

The following electronic databases were searched through the Ovid interface:

- MEDLINE® All < 1946 to 3rd March 2025>
- EBM Reviews - Health Technology Assessment 4th Quarter 2016
- EBM Reviews - Cochrane Database of Systematic Reviews 2005 to July 2024
- EBM Reviews - Cochrane Central Registered of Controlled Trials June 2024
- EBM Reviews - Database of Abstracts of Review of Effects 1st Quarter 2016
- EBM Reviews - NHS Economic Evaluation Database 1st Quarter 2016

Other databases: PubMed, US FDA, INAHTA

General databases such as Google Scholar was used to search for additional web-based materials and information. Additional articles retrieved from reviewing the bibliographies of retrieved articles. The search was limited to articles on human. There was no language limitation in the search. **Appendix 1** showed the detailed search strategies. The last search was conducted on 3rd March 2025.

4.2 SELECTION

A reviewer screened the titles and abstracts against the inclusion and exclusion criteria. Relevant articles were then critically appraised depending on the type of the study design. Studies were graded according to *US/ Canadian Preventive Services Task Force* (**Appendix 2**). All data were extracted and summarised in evidence table as in **Appendix 3**.

The inclusion and exclusion criteria were:

Inclusion criteria:

a.	**Population**	Adult patients with gynaecological disorder
b.	**Intervention**	Robotic-assisted surgery (da Vinci system)
c.	**Comparator**	Conventional surgery
d.	**Outcomes**	**Effectiveness:** Operative time (duration of surgery) Length of hospital stay Estimated blood loss Conversion rate to open surgery Clinical success rates (e.g., symptom relief, disease recurrence rates) Patient-reported outcomes (quality of life measures, patient satisfaction) Surgeon ergonomics and satisfaction Return to normal activities (recovery time) **Safety:** Intraoperative complications (e.g., injuries to adjacent organs, hemorrhage) Postoperative complications (e.g., infection rates, wound complications, thromboembolic events) Reoperation or readmission rates Mortality rate Device-related adverse events or failures Complications

		Economic implications: Direct surgical costs (initial equipment cost, consumables, maintenance, and operating costs) Hospitalization and postoperative care costs Cost-effectiveness analysis (incremental cost-effectiveness ratio – ICER) Cost-utility analysis (quality-adjusted life-years – QALYs) Cost-benefit analysis (monetary benefits versus costs) Cost-minimization analysis (comparison to existing standard procedures) Budget impact analysis (financial impact on healthcare system/MOH facilities)
e.	**Study design**	HTA reports, systematic review with/out meta-analysis, randomised controlled trial (RCT), cohort, case-control, economic evaluation studies
f.	Full text articles published in English	

Exclusion criteria:

a.	**Study design**	Case report, case series, animal study, laboratory study, narrative review
b.	Non-English full text articles	

5.0 RESULTS

5.1 Search results

An overview of the search is illustrated in Figure 4. A total of 590 records were identified through the Ovid interface and PubMed while 15 were identified from references of retrieved articles. Thirty-three duplicate references were found; 557 potentially relevant titles were screened using the inclusion and exclusion criteria. Of these, 44 relevant abstracts were retrieved in full text. After reading, appraising, and applying the inclusion and exclusion criteria to the full-text articles, 33 were included while the other 11 were excluded since the studies were included in the systematic reviews, had irrelevant populations and few were narrative reviews. All full-text articles finally selected for this review were 18 systematic review and network meta/meta-analysis, 6 systematic reviews, one HTA, one cohort study, two cross-sectional studies, two qualitative studies, and three cost analyses.

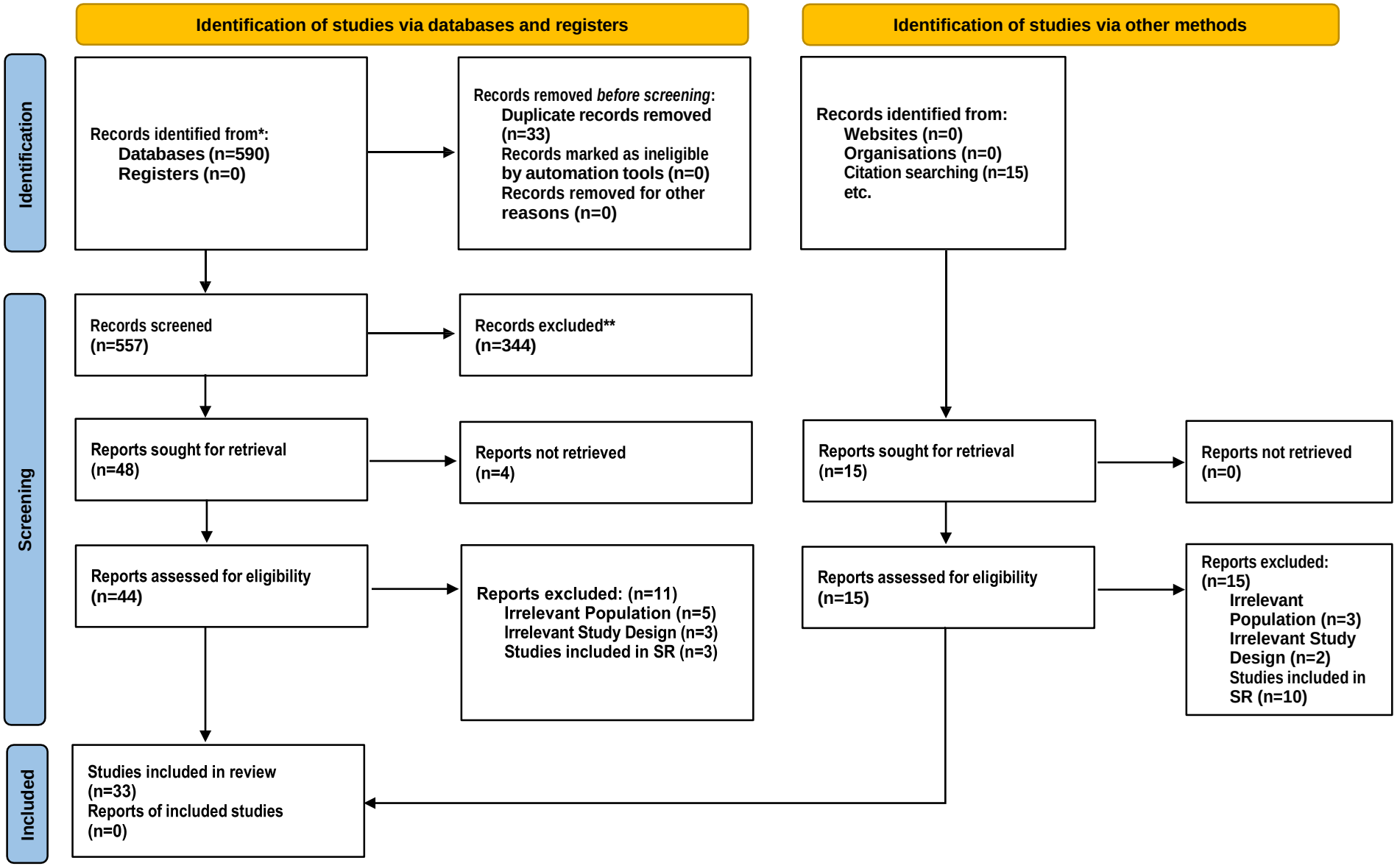

Figure 4: Flow chart of retrieval of articles used in the results

5.2 Quality assessment / risk of bias

Risk of bias was assessed using the Risk of Bias in Systematic Reviews (ROBIS) tool for systematic reviews. These assessments involved answering pre-specified criteria relevant to the review question and assigning a judgment relating to the overall risk of bias. Only one primary study (Dubois et al. (2025)) was a prospective cohort study, which was assessed using the CASP Cohort Study checklist. It was a well-designed study with clear methodology, validated outcome measures (PROMs), and minimal missing data. While the prospective data collection strengthens internal validity, potential limitations include its single-centre design, lack of a comparator group, and relatively short follow-up period.

5.2.1 Risk of bias assessment for included systematic review.

The risk of bias in the included systematic reviews was assessed using the Risk of Bias in Systematic Reviews (ROBIS) tool. Across all included systematic reviews on robotic surgery, several risk of bias criteria were consistently rated as low, while others showed areas of uncertainty. All reviews were judged to have low risk in terms of assessing relevance and applying clearly defined study eligibility criteria, indicating that they focused on appropriate research questions and used transparent inclusion methods. Most reviews also showed low risk in how they identified and selected studies, as well as in their overall risk of bias, suggesting that the reviews were generally methodologically sound and comprehensive in scope. However, more variability was noted in how data were collected and appraised, and especially in the synthesis and presentation of findings. While the majority of reviews maintained low risk for data collection and appraisal, several were marked as having unclear risk in this area, reflecting insufficient reporting or methodological transparency. The synthesis of findings was the domain with the highest frequency of unclear ratings, with over half of the reviews lacking clarity in how they combined and interpreted study results. These uncertainties may limit confidence in some conclusions. Nevertheless, the consistent low risk in relevance, eligibility, and study selection supports the overall reliability of these reviews, though some caution is warranted when interpreting results due to incomplete information in synthesis methods.

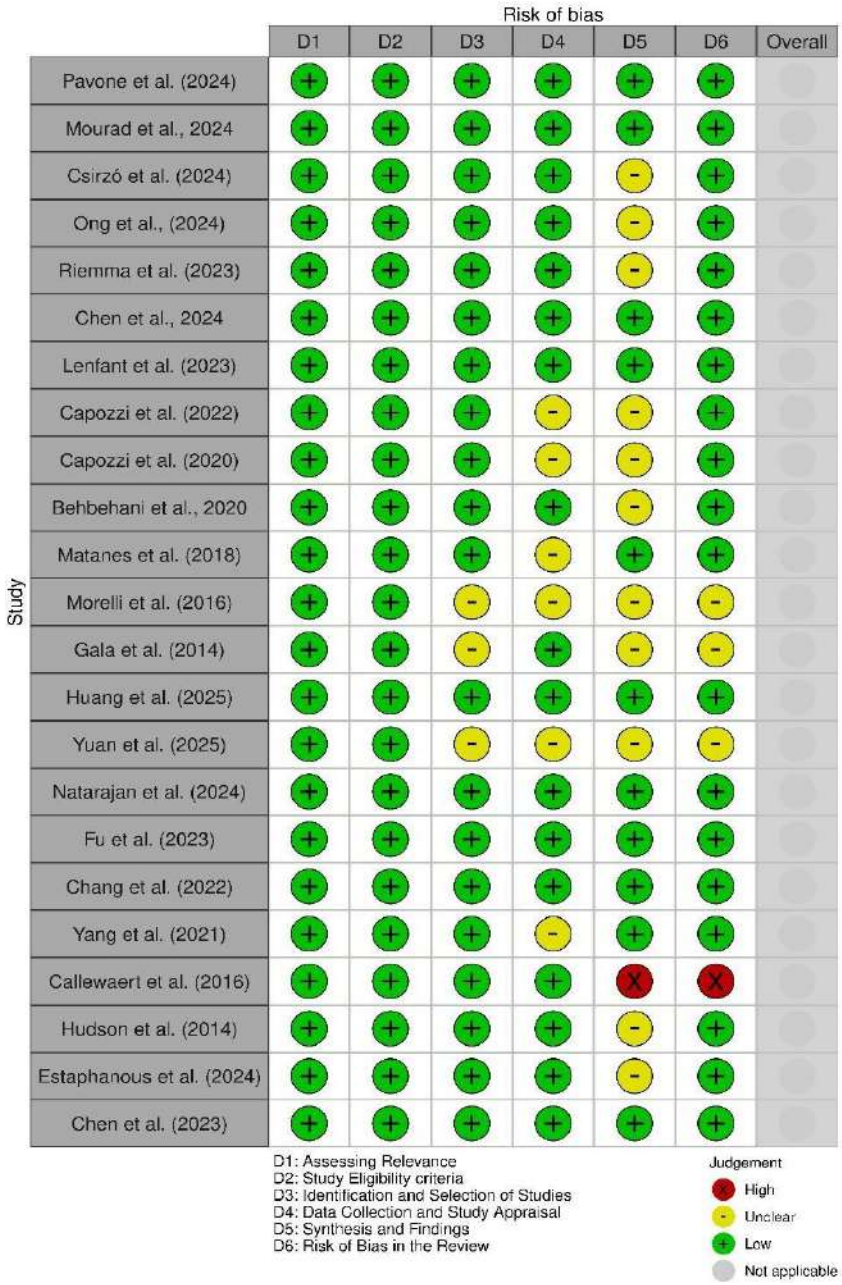

Figure 2: Summary of risk of bias assessment for systematic review using ROBIS

5.3 Characteristics of included studies

The systematic reviews and network meta/meta-analyses included in this review comprise 25 publications from 2014 to 2025, reflecting extensive international research on robotic-assisted surgery (RAS) in gynaecological practice. The studies reviewed were predominantly multinational or global, involving populations from diverse geographic locations. Most included studies focused on women undergoing surgery for benign gynaecological conditions, such as uterine fibroids (Pavone et al., 2024; Chen et al., 2024), endometriosis (Mourad et al., 2024; Csirzó et al., 2024; Ong et al., 2024), benign hysterectomy (Lenfant et al., 2023; Riemma et al., 2023; Behbehani et al., 2020), and pelvic organ prolapse (Simoncini et al., 2023).

Additionally, some reviews examined broader patient populations, covering both benign and malignant gynaecological conditions (Capozzi et al., 2022; Matanes et al., 2018; Gala et al., 2014). The primary intervention assessed across studies was robotic-assisted surgery, mainly using the da Vinci Surgical System. Comparators included conventional laparoscopic surgery, open abdominal surgery, and vaginal surgical approaches.

Outcome measures examined in these systematic reviews were comprehensive, covering clinical effectiveness, safety, and economic implications. Effectiveness outcomes commonly assessed were operative time, length of hospital stay, estimated blood loss, conversion rates to open surgery, clinical success rates, patient satisfaction, and quality of life improvements. Safety outcomes consistently evaluated included intraoperative and postoperative complications, adverse events, readmission rates, reoperation rates, and mortality.

Methodologically, most studies demonstrated a predominantly low risk of bias, particularly in domains such as assessing relevance, clearly defined eligibility criteria, comprehensive identification, selection, data collection, and appraisal processes. However, several studies showed unclear or moderate risk of bias in synthesis and findings and the overall assessment of bias within the review (Capozzi et al., 2022, 2020; Morelli et al., 2016; Gala et al., 2014). Several included reviews employed meta-analysis techniques, providing quantitative syntheses of effectiveness and safety data (Csirzó et al., 2024; Chen et al., 2024; Lenfant et al., 2023; Behbehani et al., 2020). Moreover, qualitative approaches captured expert perceptions, organizational readiness, and training adequacy, enriching the understanding of practical and systemic considerations for implementing robotic surgery (Barkati et al., 2023; Simoncini et al., 2023; Adkoli et al., 2024; Gressel et al., 2021).

Table 2: Characteristics of the included studies

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
EFFECTIVENESS/SAFETY					
General Gynaecological Disorders, Myomectomy, Endometriosis and Hysterectomy					
1. Pavone et al. (2024)[12]	SR and Meta-Analysis	14 studies (12 retrospective, 2 prospective) 2,709 patients deep endometriosis	Robotic-assisted surgery (RAS)	Laparoscopy	**Operative Time and Hospital Stay:** RAS demonstrated significantly longer operative times (standardized mean difference [SMD]=0.54; p<0.0001) and longer hospital stays (SMD=0.135; p=0.020) compared to laparoscopy. **Safety and Complications:** No significant differences between RAS and LPS in terms of intraoperative complications (RR=1.638; p=0.373), postoperative complications (RR=0.952; p=0.642), conversion rates (RR=1.262; p=0.734), or estimated blood loss (p=0.616).
2. Mourad et al. (2024)[13]	SR and Meta-Analysis	24 studies (mostly retrospective) Patients with uterine fibroids	Robotic myomectomy	Laparoscopic and open surgery	**Robotic vs. Laparoscopic Myomectomy:** • Similar operative times and complication rates. • Robotic approach resulted in significantly less blood loss but comparable transfusion rates. • Conversion rates favored robotic surgery. • Pregnancy rates were similar between both groups0.544 (0.364–0.725)

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					Robotic vs. Open Myomectomy: • Robotic surgery had less blood loss, fewer transfusions, fewer complications, and shorter hospital stays. • Open surgery was faster and typically performed on larger/heavier fibroids. • Pregnancy rates showed no significant difference.
3. Csirzó et al. (2024)[9]	SR and Meta-Analysis	13 studies (1 RCT, 4 prospective, and 8 retrospective cohort studies) involving 2,021 women with endometriosis	Robotic laparoscopy (RAL)	Conventional laparoscopy (CL)	**No statistically significant differences** were found between RAL and CL in: • Intraoperative complications (OR=1.07, CI 0.43-2.63) • Postoperative complications (OR=1.3, CI 0.73-2.32) • Conversion to open surgery (OR=1.34, CI 0.76-2.37) • Length of hospital stay (MD=0.12 days, CI -0.33-0.57) • Estimated blood loss (MD=16.73 ml, CI -4.18-37.63, not statistically significant) • Number of rehospitalizations (OR=0.95, CI 0.13-6.75) **RAL was inferior to CL in terms of operative efficiency**: • Significantly longer operative times (MD=28.09 min longer, CI 11.59-44.59) • Longer total operating room times (MD=51.39 min longer, CI 15.07-87.72)

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
4. Ong et al. (2024)[14]	SR and Meta-Analysis	11 primary studies were identified, 364 RALS patients and 83 SLS patients, bowel-involved deep infiltrating endometriosis	Robot-assisted laparoscopic surgery (RALS)	standard laparoscopic surgery (SLS)	**Operative outcomes:** • RALS resulted in significantly longer operating times (mean 235 minutes vs. 171 minutes, p<0.01) • RALS was associated with shorter hospital stays (5.3 days) compared to SLS (7.3 days, p<0.01). • No significant differences were noted in blood loss, conversion rates, or complication rates between RALS and SLS.
5. Riemma et al. (2023)[15]	SR and Meta-Analysis	8 studies, 212 patients with benign gynecological conditions	Robotic single-site hysterectomy (RSSH)		Robotic single-site hysterectomy (RSSH) demonstrated favourable perioperative outcomes: • Mean operative time: 136.6 min (range: 60–294 min). • Mean blood loss: 43.68 mL (range: 15–300 mL). • Very low complication rates, with intraoperative complications in only 2 patients and postoperative complications in 1.4% of cases. • No conversions to laparotomy, although some conversions to multiport robotic surgery occurred. • Short hospital stays (median ~1.7 days), indicating rapid recovery.
6. Chen et al., (2024)[16]	SR and Meta-Analysis	32 studies (6,357 patients with uterine fibroids)	Robot-assisted laparoscopic myomectomy (RLM)	Conventional laparoscopic myomectomy (LM)	**RLM vs LM:** • Longer operative time with RLM. • Lower cesarean section rates after RLM compared to LM (though based on limited data).

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					• No significant differences in blood loss, complications, conversion rates, hospital stays, or pregnancy rates. **RLM vs AM:** • RLM had significantly longer operative times. • Reduced blood loss, transfusion rates, complication rates, and shorter hospital stays with RLM. • Higher total surgical costs associated with RLM.
7. Lenfant et al. (2023)[17]	SR and Meta-Analysis	24 studies (4 RCTs, 5 prospective comparative studies, and 15 independent database studies), totaling 1,116,665 patients with benign uterine conditions (110,306 robotic; 262,715 laparoscopic; 189,237 vaginal; 554,407 open).	Robotic-assisted hysterectomy (RAH)	Laparoscopic (LH), vaginal (VH), and open hysterectomy (OH) for benign uterine conditions	**Compared with Open Hysterectomy, RAH showed:** • Shorter hospital stay ($p<0.00001$) • Lower blood loss ($p=0.009$) • Fewer complications (OR=0.42, $p=0.0001$) **Compared with Laparoscopic Hysterectomy, RAH primarily provided:** • Shorter hospital stay ($p<0.0001$) • Similar rates of complications, blood loss, and operative time overall. **Compared to Vaginal Hysterectomy, RAH had:** • Shorter hospital stay ($p=0.01$), particularly beneficial in patients with larger uteri and prior surgical history.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
8. Capozzi et al. (2022)[18]	Systematic Review	22 studies (12 RCTs and 10 retrospective studies) involving 269,728 patients, benign gynecological conditions, including myomectomy, hysterectomy, endometriosis treatment, and pelvic organ prolapse (POP) management.	Robotic surgery (RS)	Conventional surgical approaches	**Robotic Myomectomy:** • RS is comparable to laparoscopic myomectomy (LM) in safety and effectiveness, with longer operative times and higher costs. • Advantages of RS include a flattened learning curve and improved dexterity, beneficial in complex cases. **Robotic Hysterectomy:** • RS shows comparable morbidity profiles to laparoscopy (LH), but often at increased costs and longer operative times. • RS could benefit specific patient populations, such as obese patients or patients with large uteri. **Robotic Endometriosis Surgery:** • RS is non-inferior to laparoscopy for complex endometriosis cases, offering enhanced visualization and dexterity despite longer operative times. • Recommended particularly for advanced, deeply infiltrating endometriosis. **Robotic Pelvic Organ Prolapse Surgery:** • Robotic sacrocolpopexy (RSC) provides outcomes similar to laparoscopic sacrocolpopexy (LSC) but with longer operative times and higher costs.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					• RS might reduce complications compared to open surgery, with comparable effectiveness to laparoscopy.
9. Capozzi et al. (2020)[19]	Systematic Review and Meta-Analysis	27 articles involving 1065 patients with gynecological conditions, covering benign, malignant, and mixed indications.	Robotic single-site surgery (RSSS)		**Operative Outcomes:** • No significant differences between groups for BMI, operative time, estimated blood loss (EBL), or hospital stay. • Complication rates were higher in malignant cases (6.2%) compared to benign (1.7%) and mixed (2.5%). • Surgical conversions were relatively low but highest in the mixed group (2.5%).
10. Behbehani et al. (2020)[20]	Systematic Review and Meta-Analysis	21 studies with a total of 124,216 patients undergoing benign minimally invasive gynecologic procedures	Robotic	Laparoscopic	Mortality rates between laparoscopic (1:6,512) and robotic surgery (1:5,430) were similar, indicating no significant difference in safety profiles between approaches.
11. Matanes et al. (2018)[21]	Systematic Review	36 studies (6 comparative and 30 non-comparative) involving various gynecologic conditions such as myomas, hysterectomy, pelvic organ prolapse, endometriosis, ovarian cysts, and gynecological cancers.	Robotic laparoendoscopic single-site surgery	Conventional laparoscopic	Equivalent surgical outcomes as conventional surgery

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
12. Morelli et al. (2016)[22]	Systematic Review	29 articles describing outcomes from 561 general surgery procedures (mostly cholecystectomies), 48 urological surgeries, and 212 gynecological procedures.	Robotic surgery		Safety and Feasibility: • Deemed safe across all three disciplines • Major advantages included improved cosmetic outcomes, better ergonomics, and restoration of intra-abdominal triangulation. Limitations: • Lack of wrist articulation causing challenges in intracorporeal suturing and complex reconstructive procedures. • External robotic arm collision and limited maneuverability. • Longer operative times in certain complex procedures.
13. Gala et al. (2014)[23]	Systematic Review	44 studies (30 comparative and 14 noncomparative)	Robotic surgery		**Endometrial cancer**: • Robotic surgery consistently resulted in reduced hospital stay and less blood loss compared to open surgery. • When compared to laparoscopy, robotic surgery generally had shorter hospital stays and lower blood loss, but often longer operative times.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
Endometrial Cancer					
1. Huang et al. (2025)	SR and Network Meta-Analysis	37 studies (4 RCTs and 33 cohort studies) 6,558 patients	Robotic Surgery	Laparoscopy Laparotomy	RAS significantly reduced estimated blood loss (MD −193 mL; 95% CI −279.38 to −106.95), hospital stay (MD −3.8 days; 95% CI −5.37 to −2.31), transfusion rate (OR 0.13; 95% CI 0.06 to 0.28), intraoperative (OR 0.23; 95% CI 0.06 to 0.80), postoperative (OR 0.29; 95% CI 0.18 to 0.51), and total complications (OR 0.24; 95% CI 0.10 to 0.61), No significant differences were observed in lymph node yield or survival outcomes (recurrence, 5-year DFS, or OS) between the three techniques.
2. Yuan et al. (2025)	SR and Network Meta-Analysis	30 studies (18 RCTs and 12 high-quality observational studies) involving 13,446 patients across stages I to IV.	Robotic Surgery	Laparoscopy Laparotomy	No significant differences in DFS and OS across surgical approaches. RH had significantly fewer retrieved pelvic lymph nodes compared to OH (MD = –4.30; 95% CI: -7.41, -1.33), but was associated with significantly fewer postoperative complications than OH (OR = 0.46; 95% CI: 0.32-0.63).
3. Natarajan et al. (2024)	SR and Network Meta-Analysis	99 studies (5 randomized controlled trials and 94 cohort studies), comprising 181,716 women with FIGO stage I-II disease	Robotic Surgery	Laparoscopy Laparotomy	RS was associated with significantly reduced blood loss compared to OS (mean difference [MD] −257.2 mL; 95% credible interval [CrI]: −300.4, −213.2) and LRS (MD −37.8 mL; CrI: −69.2, −6.3), shorter hospital stays (vs OS: MD −3.0 days; CrI: −3.9, −2.2), and lower odds of intraoperative complications (vs OS: OR 0.39; CrI: 0.25, 0.61; vs LRS: OR 0.38;

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					CrI: 0.22, 0.63) and ileus (vs OS: OR 0.18; CrI: 0.07, 0.43; vs LRS: OR 0.40; CrI: 0.18, 0.91). RS also demonstrated significantly higher disease-free survival compared to OS (OR 3.29; CrI: 1.14, 9.70) and LRS (OR 2.45; CrI: 1.10, 5.71), although it was associated with longer operative times.
4. Fu et al. (2023)	SR and Meta-Analysis	21 retrospective cohort studies, involving 164,999 patients	Robotic Surgery	Conventional laparoscopy (CLS) and laparotomy (LT)	RALS had equivalent survival outcomes to CLS for OS (HR = 0.962, 95% CI: 0.922-1.004), RFS (HR = 1.096, 95% CI: 0.947-1.296), and DSS (HR = 1.489, 95% CI: 0.713-3.107). RALS was significantly associated with better outcomes than LT, including OS (HR = 0.682, 95% CI: 0.576-0.807), RFS (HR = 0.793, 95% CI: 0.653-0.964), and DSS (HR = 0.441, 95% CI: 0.298-0.652).
5. Ontario Health (2023)	HTA	One systematic review, in patients with BMI ≥ 40 kg/m²	Robotic Surgery	Laparoscopic hysterectomy (LH)	RH had a lower conversion rate to open hysterectomy (3.8%) compared to LH (7.0%), while perioperative complication rates were similarly low (≤3.5%) for both approaches.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
Sacrocolpopexy in Pelvic Organ Prolapse					
1. Chang et al. (2022)	SR and Network Meta-Analysis	six RCTs involving 486 patients with pelvic organ prolapse	Robotic-assisted sacrocolpopexy (RSC)	Open sacrocolpopexy (OSC), laparoscopic sacrocolpopexy (LSC)	Minimally invasive approaches (RSC and LSC) offer advantages in terms of blood loss, complications, and anatomical outcomes
2. Yang et al. (2021)	SR and Meta-Analysis	49 studies involving 3,014 patients with pelvic organ prolapse	Robotic sacrocolpopexy (RSC)	Laparoscopic sacrocolpopexy (LSC)	Compared to LSC, RSC was associated with significantly lower blood loss (WMD =-58.48 mL, 95% CI: -100.58 to -16.39, P=0.006) and fewer conversions (OR =0.35, 95% CI: 0.15 to 0.79, P=0.01), but longer operative time (WMD =37.35 minutes, 95% CI: 24.46 to 50.24, P<0.00001). No significant differences were found in transfusion rate, complications, or objective recurrence.
3. Callewaert et al. (2016)	SR	Two RCTs)—Paraiso et al. (2011) and Anger et al. (2014)—encompassing 78 patients with pelvic organ prolapse	Robotic sacrocolpopexy (RSC)	Laparoscopic sacrocolpopexy (LSC)	Paraiso's study found that LSC had significantly shorter operating time than RASC (199±46 vs. 265±50 minutes, p<0.001), whereas Anger's study showed no significant difference (225.5±62.3 vs. 246.5±51.3 minutes, p=0.11).

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					No differences were found in anatomical or functional outcomes, complications, or quality of life measures
4.Hudson et al. (2014)	SR and Meta-Analysis	13 studies, 577 women with pelvic organ prolapse	Robotic sacrocolpopexy (RSC)	Laparoscopic sacrocolpopexy (LSC)	Apical anatomic cure (defined as ≤ POP-Q Stage 1): pooled success rate of 98.6% (95% CI: 97.0–100%). Rate of mesh exposure/erosion was 4.1% (95% CI: 1.4–6.9%), reoperation rates for mesh revision 1.7%, apical prolapse 0.8%,, and non-apical prolapse 2.5%
Stress Urinary Incontinence					
1. Dubois et al. (2025)	Cohort Study	101 women who underwent robotic artificial urinary sphincter (AUS) implantation	Robotic AUS implantation		At 3 months: all patient-reported outcome measures (PROM) significantly improved. Complete continence was reported in 67.3% of patients, and 72.8% reported being "very much improved" on the PGII. Complications included 17.8% intraoperative and 26.7% postoperative, with 9% being Clavien-Dindo grade III.
2. Estaphanous et al. (2024)	SR and Meta-Analysis	8 studies with a total of 300 female patients	Robotic AUS implantation		Pooled complete continence rate post-AUS implantation was 72% (OR: 0.01, 95% CI: 0.00–0.02; $p < 0.00001$), with revision and explantation rates of 22.5% (OR: 0.04, 95% CI: 0.01–0.15) and 17.6% (OR: 0.08, 95% CI: 0.03–0.21), respectively.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
3. Chen et al. (2023)	SR and Meta-Analysis	9 studies with 157 women	Robotic AUS implantation		Pooled continence rate was 83% (95% CI: 0.76–0.89) Intraoperative complications (mainly vaginal or bladder injury) occurred in 21% of cases (95% CI: 11%–34%) and postoperative complications (such as acute urinary retention) occurred in 20% (95% CI: 12%–29%).
ORGANIZATIONAL					
1. Simoncini et al. (2023)[11]	Qualitative research	26 expert surgeons (urogynecologists, urologists, colorectal surgeons)	Robotic-assisted pelvic floor reconstructive surgery (PFRS).		The expert panel agreed that robotic-assisted pelvic floor reconstructive surgery offers significant technical and ergonomic advantages, particularly for complex procedures. Further research is necessary to objectively define scenarios where robotics would be optimally beneficial.
2. Barkati et al. (2023)[24]	Qualitative research	17 in-depth semi-structured interviews, healthcare experts including surgeons	Robotic Assisted Surgery (RAS)		**Perception of RAS:** • Most healthcare experts (88%) had a favorable perception, believing that RAS significantly improves clinical outcomes and hospital reputation. • About 53% viewed RAS as highly beneficial and were planning to adopt it, while about 35% believed RAS was beneficial but felt their organizations weren't yet prepared. • About 6% considered RAS too expensive and complex to adopt.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					Medical Specialties Adopting RAS: • RAS is predominantly adopted in general surgery, urology, and brain surgery, each mentioned by 18% of respondents. • Less frequently adopted specialties included obstetrics and gynecology (6%) and various other surgical fields (18%). **RAS Adoption Challenges:** • Financial issues were the primary barrier (reported by 59% of respondents), including high initial and ongoing costs. • Additional challenges included a lack of trained medical staff (17.6%), absence of insurance coverage, and increased workload.
3. Adkoli et al. (2024)[25]	Cross-sectional study	75 O&G residents	Robotic-assisted surgery training		**Training and Simulation:** • Only 57.3% reported having a formal robotic training curriculum. • Console trainer access was high (90.7%), but broader simulation resources less accessible (72%). • Hands-on training was rated most helpful; online modules were least helpful. • Main barriers included attending physicians' comfort with resident participation (74%), limited personal training time (58.9%), and restricted simulator access (42.5%).

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					Resident Perspectives and Future Directions: • Majority emphasized the importance of robotic training (88% agreed or strongly agreed). • Confidence in robotic surgical skills varied significantly. • 68% intended to incorporate robotic surgery in future practice. • Strong support (81.3%) for standardized robotic training curricula across OB/GYN residency programs.
4. Gressel et al. (2021)[26]	Cross-sectional study	5,084 OB/GYN residents across all postgraduate years (PGY1–PGY4) and 241 residency program directors from ACGME-accredited training programs in the United States.	Robotic hysterectomy		**Resident Confidence and Autonomy:** • Only 52% of PGY4 residents felt they were given surgical autonomy to perform robotic hysterectomy. • Only 53.7% of PGY4 residents felt confident to perform a robotic hysterectomy independently if necessary. • Residents reported significantly lower confidence for robotic hysterectomy compared to other hysterectomy methods (abdominal: 95%, vaginal: 79%, laparoscopic: 93%). **Program Directors vs. Residents Perceptions:** • Program directors were significantly more likely than residents to believe that residents had autonomy (61% vs. 38.6%), independent performance capability (60.9% vs. 22.8%), and

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
					readiness by graduation (70.2% vs. 62.6%). • However, program directors were less likely (47.9%) than residents (63.4%) to ascribe importance to robotic hysterectomy for residents' future careers.
COST/COST-EFFECTIVENESS					
1. Delameilleure et al. (2024)[27]	Cost analysis	830 patients who underwent hysterectomy for benign indications	robot-assisted hysterectomy (RAH)	Abdominal, vaginal, laparoscopic, LAV hysterectomy	RAH had the highest average total cost (€6528.10), mainly driven by high material, maintenance, and depreciation costs, while VH was least expensive (€3107.23)
2. Clark et al. (2023)[28]	Cost analysis	75 patients undergoing robotic-assisted sacrocolpopexy (RSC) (25 with Senhance matched 2:1 to 50 DaVinci cases).	RSC using Da Vinci	Senhance	• Senhance surgeries had significantly longer operating times compared to DaVinci (210.2 min vs 178.1 min, p=0.01). • Univariable cost comparison showed no significant difference between platforms ($5,368 for Senhance vs $5,742 for DaVinci, p=0.29). • After adjusting for operative time, blood loss, concomitant mid-urethral sling procedure, and GelPoint port use, Senhance showed significantly lower costs by approximately $908.33 per case, a 16% cost reduction.

Study	Study design	Number of patients	Intervention	Comparison	Key Outcomes
3. Iavazzo C et al. (2017)[29]	Systematic Review	17 studies included Total patients: 16,349 • Open surgery: 3,214 • Laparoscopy: 5,120 • Robotic: 8,015 Diagnoses: • Endometrial cancer: 3,393 • Cervical cancer: 2,181 • Ovarian cancer: 12	Robotic surgery in gynaecological oncology		Robotic surgery is generally associated with higher costs compared to laparoscopic and open surgeries, particularly due to operative charges, equipment costs, and acquisition/maintenance fees. However, robotic approaches may offer benefits such as reduced blood loss, shorter hospital stay, and lower conversion rates, potentially offsetting some costs in high-volume centers or complex cases.
4. Marino et al. (2015)[30]	Prospective multicenter cost analysis	(16 centers, France, 2007-2010) 306 patients Robotic-assisted laparoscopy: 80 patients Conventional laparoscopy: 226 patients	Robotic-assisted laparoscopy	Conventional laparoscopy	Robotic-assisted laparoscopy offers comparable clinical outcomes to conventional laparoscopy in gynecologic oncology but incurs higher costs, largely driven by equipment-related expenses. However, cost-effectiveness improves with higher surgical volumes and reduced fixed costs.

5.1 EFFICACY/ EFFECTIVENESS

5.1.1 Effectiveness of Robotic-Assisted Surgery (RAS) for General Gynaecological Disorders

Capozzi et al. (2022) conducted a systematic review of 22 studies including 12 randomised controlled trials (RCT) and 10 retrospective cohort studies, assessing the role of robotic-assisted surgery (RAS) in benign gynaecological conditions such as myomectomy, hysterectomy, endometriosis, and pelvic organ prolapse (POP). A total of 269,728 patients were included: 1,721 underwent robotic myomectomy, 265,100 robotic hysterectomy, 1,527 robotic surgery for endometriosis, and 1,380 robotic POP procedures. Across these studies, robotic surgery was generally found to have comparable clinical outcomes to laparoscopic approaches, with some benefits including reduced blood loss and shorter hospital stays. However, robotic surgery was consistently associated with higher operative costs and longer operating times. The findings showed that RAS had comparable clinical outcomes to laparoscopy across all indications. Robotic myomectomy was associated with reduced blood loss and shorter hospital stays compared to open surgery, although operative times were longer than with laparoscopy. Robotic hysterectomy was found to be safe and effective but incurred longer surgery durations and higher costs than laparoscopy, with no significant differences in quality-of-life outcomes. For endometriosis, both robotic and laparoscopic approaches yielded similar operative outcomes, although RAS tended to involve longer procedures. In POP surgery, anatomical and functional outcomes were similar between RAS and laparoscopy, but again with increased operative times and costs for the robotic approach. The authors concluded that while robotic surgery shows non-inferior results compared to laparoscopy, its greatest value lies in enabling a broader population to access minimally invasive surgery due to its shorter learning curve and improved dexterity and visualization.[18]

Capozzi et al. (2020) conducted a systematic review and meta-analysis evaluating the robotic single-port platform for gynaecologic surgery for both benign and malignant indications. This systematic review was conducted following PRISMA guidelines, analysing 27 eligible studies comprising 1,065 patients. Patients were grouped based on indications: benign diseases (605 patients), malignant diseases (260 patients), and mixed indications (200 patients). The robotic-assisted procedures included were primarily performed using the da Vinci Si Surgical System and encompassed robotic single-site hysterectomy, robotic single-site myomectomy, robotic sacrocolpopexy, robotic salpingo-oophorectomy, cystectomy, and surgeries involving pelvic lymphadenectomy for malignancies. Outcomes of interest included operative time, estimated blood loss (EBL), length of hospital stay, conversion rates to other surgical modalities, and major complications. The meta-analysis reported no significant differences in BMI ($p = 0.235$), operative times ($p = 0.723$), estimated blood loss ($p = 0.342$), or length of hospital stay ($p = 0.146$) among patient groups. However, the malignant group had significantly higher complication rates (6.2%; $p = 0.001$) compared to benign (1.7%) and mixed indications (2.5%), and the mixed group had a higher overall conversion rate (2.5%; $p = 0.012$). The authors concluded that robotic single-site surgery is feasible and safe across different gynaecologic indications, highlighting that while complication rates for malignant procedures were higher, these were consistent with traditional surgery outcomes. They recommended further studies, particularly long-term analyses, to confirm oncological safety for malignant conditions.[19]

Matanes et al. (2018) conducted a systematic review to assess the feasibility, safety, and outcomes of robotic laparoendoscopic single-site surgery (R-LESS) in gynaecology using the da Vinci Single-Site platform. The review followed PRISMA guidelines and included 36 studies which comprised of six comparative and 30 non-comparative studies, published from 1990 to 2018, identified via searches in PubMed and ClinicalTrials.gov. The included studies reported on a range of gynaecologic surgeries performed for both benign and malignant indications. Specifically, the procedures included robotic single-site hysterectomy, myomectomy, sacrocolpopexy, cystectomy, salpingo-oophorectomy, treatment of endometriosis, and oncologic surgeries such as robotic-assisted staging for endometrial and ovarian cancer. Across the studies, operative times ranged from 45 to 303 minutes, with most hysterectomies averaging between 90 and 180 minutes. Estimated blood loss varied by procedure but was generally low, ranging from 20 to 100 ml. Reported conversion rates to multiport or open surgery were low, from 0% to 6.6%. Length of hospital stay was typically between 1 to 2 days. In terms of safety, complication rates across procedures were low: 0 to 13.6% for hysterectomies and 0–12% for myomectomies, with most complications being minor (Clavien-Dindo grade I–II). For oncologic surgeries, no compromise in staging or lymph node retrieval was reported, and surgical margins were clear in all cancer cases reviewed. The authors concluded that R-LESS using the da Vinci platform is a feasible and safe approach for a variety of gynaecologic procedures, offering advantages such as improved cosmesis, minimal blood loss, and short hospital stays. However, it was emphasized that evidence from high-quality randomized trials is still needed to firmly establish the benefits of R-LESS over conventional or multiport laparoscopic approaches.[21]

Gala et al. (2014), representing the Society of Gynaecologic Surgeons Systematic Review Group, conducted a comprehensive systematic review to compare robotic-assisted surgery (RAS) with conventional laparoscopic, open abdominal, and vaginal surgical approaches for both benign and malignant gynaecologic conditions. The review included 44 studies which comprised of 30 comparative and 14 non-comparative studies, published up to May 2012. Procedures assessed involved robotic hysterectomy, myomectomy, sacrocolpopexy, adnexal surgery, and cancer staging surgeries for endometrial and cervical cancer, predominantly performed using the da Vinci system. Key outcomes examined were operative time, length of hospital stay, estimated blood loss, number of lymph nodes retrieved, postoperative pain, return to normal activities, and costs. For endometrial cancer (13 studies), robotic surgery showed reduced length of hospital stay (e.g., 1.0 vs 2.6 days, $p < 0.001$), less blood loss (e.g., 88 mL vs 200 mL, $p < 0.001$), and faster return to activity compared to laparoscopic or open surgery, although operative times were generally longer (e.g., 237 vs 178 min, $p < 0.001$). In cervical cancer surgeries, RAS consistently resulted in less blood loss (e.g., 115.5 mL vs 509.3 mL, $p < 0.001$) and shorter hospital stays, though operative time comparisons varied. For robotic myomectomy and hysterectomy, benefits included reduced blood loss (100–226 mL vs 200–459 mL) and shorter hospital stays (e.g., 1.3 vs 2.7 days), but longer operative times and higher costs were reported. The only RCT identified (Paraiso et al.) found laparoscopy faster than RAS for sacrocolpopexy, although both had similar lengths of stay. The authors concluded that robotic surgery appears superior to laparotomy for many outcomes, particularly in endometrial cancer management, but offers comparable results to laparoscopy. Due to inconsistent evidence and a lack of high-quality trials, they emphasized that the choice of surgical approach should be guided by surgeon expertise, patient factors, and institutional resources.[23]

Morelli et al. (2016) conducted a systematic review to evaluate the clinical applications, feasibility, safety, and limitations of the Da Vinci Single-Site® Surgical Platform (DVSSP) across general surgery, urology, and gynaecology. The PubMed database was searched up to June 2015, identifying 29 studies that reported the clinical use of DVSSP in 821 procedures: 561 in general surgery (mainly cholecystectomies), 48 in urology (pyeloplasty, partial and radical nephrectomies), and 212 in gynaecology (including hysterectomy with or without salpingo-oophorectomy, adnexal surgery, and myomectomy). All robotic procedures used the Da Vinci Single-Site platform, which features curved cannulas and semi-rigid instruments inserted through a single multichannel port to achieve intra-abdominal triangulation. In gynaecology, studies reported average operative times ranging from 56 to 245 minutes and mean blood loss of 22 to 145 ml. Conversion rates were low, with only a few cases requiring additional ports or conversion to laparoscopy. Postoperative complication rates were generally low, with most adverse events classified as Clavien-Dindo grade I–II. Hospital stays ranged from 0.5 to 4.5 days. The authors concluded that the DVSSP is a feasible and safe option for selected procedures across various surgical disciplines, particularly in gynaecology where anatomical constraints are more favourable. Reported limitations included lack of EndoWrist articulation, reduced instrument variety, limited operative field exposure, and external arm collisions. It was noted that although early outcomes are promising, further case-control or prospective trials are warranted to validate the clinical advantages of DVSSP over other robotic or laparoscopic single-site techniques.[22]

5.1.2 Effectiveness of Robotic-Assisted Surgery for Myomectomy

Mourad et al. (2024) conducted a systematic review and meta-analysis to assess the role, benefits, and limitations of robotic-assisted myomectomy (RM) compared to laparoscopic myomectomy (LM) and open myomectomy (OM) in women with uterine fibroids. The review included 24 studies (primarily retrospective cohorts and matched case-controls) involving various robotic procedures using the da Vinci system. Outcomes assessed included estimated blood loss (EBL), transfusion rates, complication rates, operative time, conversion rates, length of hospital stay, postoperative pain, and pregnancy rates. For RM vs LM, RM showed significantly lower EBL (mean difference: −59.47 mL; 95% CI: −103.03, −15.9) with no difference in transfusion rates (OR: 1.0; 95% CI: 0.66, 1.5), complication rates (OR: 0.88; 95% CI: 0.61, 1.26), or pregnancy rates (OR: 0.97; 95% CI: 0.48, 1.96). Operative times were not significantly different overall (mean difference: 26.8 min; 95% CI: −7.63, 61.23), but heterogeneity was high ($I^2 = 96\%$). Robotic-assisted myomectory (RM) had a significantly lower conversion rate (OR: 0.38; 95% CI: 0.16, 0.92). For RM vs OM, robotic procedures were associated with significantly less blood loss (mean difference: −73.08 mL; 95% CI: −136.95, −9.21), lower transfusion rates (OR: 0.45; 95% CI: 0.32, 0.63), fewer complications (OR: 0.51; 95% CI: 0.27, 0.97), and shorter hospital stays (mean difference: −1.57 days; 95% CI: −2.0, −1.14), though OM was faster (mean difference in operative time: 92.95 min; 95% CI: 72.02, 113.87). No difference in pregnancy outcomes was observed (OR: 1.14; 95% CI: 0.34, 3.82). The review concluded that robotic surgery enhances surgical performance in myomectomy, offering improved exposure and dexterity with reduced blood loss and complications, though at the expense of longer operative times and higher cost. Authors emphasized the value of integrating robotic training into surgical curricula and called for more prospective studies to further validate these findings.[13]

Chen et al. (2024) conducted a systematic review and meta-analysis to compare the perioperative and postoperative outcomes of robot-assisted laparoscopic myomectomy (RLM) with those of laparoscopic myomectomy (LM) and abdominal myomectomy (AM) in women with uterine fibroids. The review adhered to PRISMA guidelines and included 32 studies published between 2000 and 2023, involving 6,357 patients; 1,982 of whom underwent RLM. The included studies encompassed 27 retrospective and four prospective non-randomized designs. All robotic procedures were performed using the da Vinci Surgical System and included robot-assisted laparoscopic excision of uterine fibroids via multiport access. Outcomes assessed included operating time, estimated blood loss (EBL), blood transfusion rate, complications, hospital stay, costs, pregnancy rate, and caesarean section rate. Compared with LM, RLM was associated with significantly longer operating time (MD = 43.58 min; 95% CI: 25.22, 61.93; P < 0.001), but lower caesarean section rates after myomectomy (OR = 0.27; 95% CI: 0.10, 0.78; P = 0.02). No significant differences were observed for EBL, transfusion, complications, hospital stay, or pregnancy outcomes. When compared to AM, RLM showed significantly lower EBL (MD = -104.47 mL; 95% CI: -164.31, -44.63; P < 0.001), lower transfusion rates (OR = 0.37; 95% CI: 0.27, 0.50; P < 0.001), fewer complications (OR = 0.43; 95% CI: 0.27, 0.71; P < 0.001), shorter hospital stay (MD = -1.49 days; 95% CI: -1.75, -1.23; P < 0.001), but longer operating time (MD = 79.60 min; 95% CI: 65.19, 94.02; P < 0.001) and higher total cost (MD = 19,116.80 USD; 95% CI: 16,159.56, 22,074.04; P < 0.001). Subgroup analyses showed that BMI, myoma number, and size influenced surgical time and outcomes. The authors concluded that RLM is safer and more effective than AM, with comparable outcomes to LM, albeit with longer operating times and higher costs. It was recommended that future studies adopt prospective designs to identify subpopulations that may benefit most from robotic approaches, and that cost-effectiveness be carefully evaluated before widespread adoption.[16]

5.1.3 Effectiveness of Robotic-Assisted Surgery for Endometriosis

Pavone et al. (2024) conducted a systematic review and meta-analysis to evaluate the effectiveness and safety of robotic-assisted surgery (RAS) compared to conventional laparoscopic surgery (LPS) for deep endometriosis. This review adhered to PRISMA guidelines and was registered on PROSPERO. The authors systematically searched databases including PubMed, Google Scholar, and ClinicalTrials.gov, identifying 14 eligible studies involving a total of 2,709 patients with endometriosis (stages I-IV). The studies included robotic-assisted surgeries primarily using the da Vinci Surgical System, covering procedures such as robotic-assisted laparoscopic excision of endometriotic lesions, robotic hysterectomy, robotic-assisted colorectal resections, and ureteral reimplantations for deep infiltrating endometriosis. Outcomes measured included intraoperative and postoperative complications, operative time, conversion rates, estimated blood loss, and length of hospital stay. The findings showed no significant differences between RAS and LPS regarding intraoperative complications (RR 1.638; 95% CI: 0.552, 4.855; p = 0.373), postoperative complications (RR 0.952; 95% CI: 0.776, 1.169; p = 0.642), conversion rates to open surgery (RR 1.262; 95% CI: 0.328, 4.846; p = 0.734), and estimated blood loss (Standardized Mean Difference [SMD] 0.028; 95% CI: -0.080, 0.136; p = 0.616). However, RAS was associated with significantly longer operative times (SMD 0.54; 95% CI: 0.247, 0.842; p < 0.0001) and longer hospital stays (SMD 0.135; 95% CI: 0.022, 0.262; p = 0.020). The authors concluded that robotic surgery demonstrated comparable safety and effectiveness to laparoscopy for deep endometriosis, albeit with longer operative times and hospitalization. They recommended further prospective evaluations of newer robotic systems for more conclusive evidence.[12]

Csirzó et al. (2024) conducted a systematic review and meta-analysis to evaluate whether robot-assisted laparoscopy (RAL) offers any perioperative advantages over conventional laparoscopy (CL) in the surgical treatment of endometriosis. The authors identified 13 studies (1 RCT, 4 prospective, and 8 retrospective cohort studies) published between 2010 and 2022, encompassing 2,021 patients; 1,012 undergoing RAL and 1,009 CL. All robotic procedures were performed using the da Vinci Surgical System, involving multiport and single-port access for excision of endometriotic lesions including deep infiltrating endometriosis. The outcomes analysed included intraoperative and postoperative complications, conversion rates, estimated blood loss (EBL), operative and operating room time, length of hospital stay, and rehospitalisation rates. The results revealed no significant differences between RAL and CL in intraoperative complications (OR = 1.07; 95% CI: 0.43, 2.63), postoperative complications (OR = 1.3; 95% CI: 0.73, 2.32), conversion to laparotomy (OR = 1.34; 95% CI: 0.76, 2.37), or rehospitalisation (OR = 0.95; 95% CI: 0.13–6.75). While EBL was slightly higher in RAL (MD = 16.73 mL; 95% CI: 4.18, 37.63), the difference was not clinically meaningful. However, operative time (MD = 28.09 minutes; 95% CI: 11.59, 44.59) and operating room time (MD = 51.39 minutes; 95% CI: 15.07, 87.72) were significantly longer in the RAL group. No statistically or clinically significant differences were found in hospital stay duration (MD = 0.12 days; 95% CI: -0.33, 0.57). The authors concluded that RAL does not confer demonstrable perioperative benefits over CL in endometriosis surgery and is associated with longer operative and setup times. It was emphasized that although both techniques are safe, conventional laparoscopy should remain the preferred approach in routine clinical practice due to its time efficiency and potentially lower associated costs. Further research was recommended to explore long-term outcomes and the medico-economic implications of robotic surgery in this context.[9]

Ong et al. (2024) conducted a systematic review to evaluate the feasibility, safety, and clinical outcomes of robot-assisted laparoscopic surgery (RALS) for the treatment of bowel deep infiltrating endometriosis (DE), and to assess the developmental stage of RALS using the IDEAL framework. The review, registered on PROSPERO, followed PRISMA guidelines and included 11 primary studies published between 2012 and 2022, comprising a total of 527 patients; 368 underwent RALS and 83 underwent standard laparoscopic surgery (SLS). Robotic procedures were performed using the da Vinci Surgical System, and included rectal shaves, discoid excisions, and segmental resections for symptomatic bowel DE. Key outcomes included operative time, intraoperative and postoperative complications, estimated blood loss (EBL), conversion to laparotomy, length of hospital stay, and functional symptom improvement. The RALS group had significantly longer operating times (mean 235 minutes vs. 171 minutes, $p<0.01$) compared to SLS, but shorter hospital stays (mean 5.3 days vs. 7.3 days, $p<0.01$). There were no statistically significant differences in intraoperative complications (3.0% vs. 7.2%), conversions (1.6% vs. 1.2%), or EBL (155 ± 207 mL vs. 176 ± 234 mL). Postoperative minor and major complications were 6.4% and 4.4% in RALS versus 22.9% and 3.6% in SLS, respectively. Functional improvements in dysmenorrhea, dyspareunia, and bowel symptoms were reported in the RALS group in several studies, though data heterogeneity precluded meta-analysis. RALS was classified as IDEAL Stage 2b, indicating it is in the exploratory phase, supported by prospective cohort data but still lacking randomized controlled trials. The authors concluded that RALS is a safe and feasible option for managing bowel DE, with potential benefits including fewer complications and shorter hospitalization, despite longer operating times. The need for high-quality multicentre RCTs and cost-effectiveness evaluations was emphasized to support broader clinical adoption and inform policy decisions.[14]

5.1.4 Effectiveness of Robotic-Assisted Surgery for Hysterectomy

Lenfant et al. (2023) conducted a large systematic review and meta-analysis comparing robotic-assisted hysterectomy (RAH) with laparoscopic (LH), vaginal (VH), and open hysterectomy (OH) for benign gynaecologic conditions. The study was registered on PROSPERO and included 24 studies published between 2010 and 2020, comprising 1,116,665 patients; 110,306 underwent robotic hysterectomy, 262,715 laparoscopic, 189,237 vaginal, and 554,407 open procedures. The robotic surgeries assessed were performed using the da Vinci Surgical System. Outcomes of interest included operative time, estimated blood loss (EBL), transfusion rates, complications, conversions, reoperations, mortality, readmissions, and length of hospital stay (LOS). The study found that compared to OH, RAH was associated with significantly shorter hospital stays ($p < 0.00001$), lower EBL ($p = 0.009$), and fewer complications (OR = 0.42; 95% CI: 0.27, 0.66; $p = 0.0001$). In comparisons with LH and VH, RAH showed a small but statistically significant reduction in LOS (RAH vs LH: WMD = -0.144 days; 95% CI: -0.21, -0.08; $p < 0.0001$; RAH vs VH: WMD = -0.39 days; 95% CI: -0.70, -0.08; $p = 0.01$). For estimated blood loss, robotic surgery had a pooled mean difference of -52.31 mL versus laparoscopic surgery ($p = 0.03$). Transfusion rates were lower in RAH than LH (risk difference: -0.0043; 95% CI: -0.0059, -0.0027; $p < 0.00001$), and the risk of conversion was also lower (RD = -0.04; 95% CI: -0.06, -0.01; $p = 0.008$). Readmission rates were slightly lower for RAH than LH (OR = 0.90; 95% CI: 0.83, 0.99; $p = 0.03$). No significant differences were found in operative time, mortality, or reoperation rates between RAH and other approaches. The authors concluded that robotic hysterectomy is associated with classic benefits of minimally invasive surgery when compared with open surgery and showed modest advantages over vaginal and laparoscopic approaches, particularly in patients with larger uteri or previous surgeries. It was emphasized that these benefits must be weighed against higher costs and the current lack of high-quality RCTs comparing robotic to vaginal surgery.[17]

Riemma et al. (2023) conducted a systematic review to assess the feasibility and safety of robotic single-site hysterectomy (RSSH) for benign gynaecologic pathologies. The study followed PRISMA guidelines and included eight retrospective studies published within the last nine years, encompassing 212 patients who underwent RSSH using various da Vinci Surgical System models, including the Si, Xi, and SP platforms. Indications for surgery included uterine fibroids (leiomyomas), adenomyosis, pelvic pain, abnormal bleeding, endometrial hyperplasia, cervical dysplasia, and female-to-male gender affirmation surgery. The average age of patients was 45.42 years and the mean BMI was 25.74 kg/m². Of the total cohort, 81 patients (38%) had a history of previous abdominal surgery. Key intraoperative outcomes included a mean docking/presurgical time of 15.56 minutes (range: 3 to 30 min), a mean console time of 83.21 minutes (range: 25 to 180 min), and a mean operative time of 136.6 minutes (range: 60 to 294 min). Mean estimated blood loss was 43.68 mL (range: 15 to 300 mL). Conversion to standard laparoscopy or laparotomy was rare, with only 10 conversions reported (4.7%), primarily to multiport robotic surgery. Intraoperative complications occurred in two patients (accidental cystotomy; 2.9% and 2.0% in individual studies), and postoperative complications were recorded in three patients (vaginal bleeding and minor Clavien-Dindo grade II events), with no reoperations or readmissions reported within 30 days. The average hospital stay was 1.71 days (range: 0.96–3.5 days). Some of the included studies compared RSSH with other techniques such as laparoendoscopic single-site surgery (LESS) and multiport robotic hysterectomy. Compared to LESS, RSSH was associated with longer operative times but shorter hospital stays and lower estimated blood loss in some cases. Compared to multiport robotic surgery,

RSSH demonstrated similar or shorter total operative times and lower postoperative pain, while docking time was longer. The authors concluded that RSSH is a safe and feasible option for benign gynaecologic surgeries, offering favourable outcomes in terms of low complication rates and shorter hospital stays. The need for additional high-quality research was emphasized to better define the advantages and limitations of RSSH compared to other minimally invasive surgical approaches.[15]

5.1.4 Effectiveness of Robotic-Assisted Surgery for Endometrial Cancer

Huang et al. (2025) conducted a comprehensive systematic review and Bayesian network meta-analysis (NMA) to compare robotic-assisted surgery (RAS), laparoscopy (LPS), and laparotomy (LPT) in the treatment of endometrial cancer (EC). A total of 37 studies (4 RCTs and 33 cohort studies) involving 6,558 patients were included. The population included EC patients across stages I–IV, and outcomes of interest were perioperative indicators (e.g. operative time, estimated blood loss, transfusion rate), lymph node dissection, and long-term tumour outcomes (recurrence, 5-year disease-free survival [DFS], and overall survival [OS]). Results showed that RAS significantly reduced estimated blood loss (MD −193 mL; 95% CI −279.38, −106.95), hospital stay (MD −3.8 days; 95% CI −5.37, −2.31), transfusion rate (OR 0.13; 95% CI 0.06, 0.28), intraoperative (OR 0.23; 95% CI 0.06, 0.80), postoperative (OR 0.29; 95% CI 0.18, 0.51), and total complications (OR 0.24; 95% CI 0.10, 0.61), with SUCRA rankings showing RAS as the top-ranked technique for most outcomes. No significant differences were observed in lymph node yield or survival outcomes (recurrence, 5-year DFS, or OS) between the three techniques. Most studies were high-quality with low risk of bias, though the authors noted the limited number of RCTs and variability in surgical expertise. They concluded that RAS is most effective for improving perioperative outcomes in EC, but further research is needed to evaluate long-term survival benefits.[39]

Yuan et al. (2025) conducted a systematic review and network meta-analysis (NMA) to compare the efficacy and safety of four surgical approaches for the management of endometrial cancer: open hysterectomy (OH), laparoscopic hysterectomy (LH), robotic hysterectomy (RH), and laparoscopic-assisted vaginal hysterectomy (LAVH). The study included 30 studies (18 RCTs and 12 high-quality observational studies) involving 13,446 patients across stages I to IV. The primary outcomes assessed included disease-free survival (DFS), overall survival (OS), number of pelvic and para-aortic lymph nodes retrieved, intraoperative and postoperative complications, and operative time. There were no significant differences in DFS and OS across surgical approaches, though SUCRA rankings showed LH had the highest probability of superior DFS (0.81) and OS (0.87), while RH ranked lowest (DFS 0.21; OS 0.26). RH had significantly fewer retrieved pelvic lymph nodes compared to OH (MD = -4.30; 95% CI: -7.41, -1.33), but was associated with significantly fewer postoperative complications than OH (OR = 0.46; 95% CI: 0.32, 0.63). Operative time was longest with LAVH and shortest with OH (SUCRA = 0.97). Subgroup analyses found no significant impact of uterine manipulators on DFS. Authors concluded that all four surgical techniques are comparable in long-term oncologic outcomes, with RH offering the best profile for minimizing postoperative complications, while OH remains superior for lymph node retrieval and operative efficiency.[40]

Natarajan et al. (2024) conducted a comprehensive systematic review and Bayesian network meta-analysis to compare surgical and oncological outcomes of open surgery (OS), laparoscopic surgery (LRS), and robotic-assisted surgery (RS) for early-stage endometrial cancer. The review included 99 studies (5 randomized controlled trials and 94 cohort studies),

comprising 181,716 women with FIGO stage I-II disease, and assessed 14 clinical and oncological outcomes. The primary outcomes of interest included blood loss, hospital stay, operative time, complications, disease-free survival (DFS), and recurrence. The study also reported that 80 out of 99 included studies were rated as low risk of bias using the Newcastle-Ottawa Scale. RS was associated with significantly reduced blood loss compared to OS (mean difference [MD] −257.2 mL; 95% credible interval [CrI]: −300.4, −213.2) and LRS (MD −37.8 mL; CrI: −69.2, −6.3), shorter hospital stays (vs OS: MD −3.0 days; CrI: −3.9, −2.2), and lower odds of intraoperative complications (vs OS: OR 0.39; CrI: 0.25, 0.61; vs LRS: OR 0.38; CrI: 0.22, 0.63) and ileus (vs OS: OR 0.18; CrI: 0.07, 0.43; vs LRS: OR 0.40; CrI: 0.18, 0.91). RS also demonstrated significantly higher disease-free survival compared to OS (OR 3.29; CrI: 1.14, 9.70) and LRS (OR 2.45; CrI: 1.10, 5.71), although it was associated with longer operative times. Of the included studies, 80 were rated low risk of bias using the Newcastle-Ottawa Scale. The authors concluded that RS offers clinical and oncologic advantages over both LRS and OS, particularly in reducing complications and improving DFS, though the longer operative duration and evolving complication trends warrant consideration.[41]

Fu et al. (2023) conducted a systematic review and meta-analysis to compare long-term survival outcomes of robotic-assisted laparoscopy (RALS) with conventional laparoscopy (CLS) and laparotomy (LT) in endometrial cancer. A total of 21 retrospective cohort studies published from 2012 onwards were included, involving 164,999 patients (77,662 RALS, 32,826 CLS, and 54,511 LT). All studies were assessed using the Newcastle-Ottawa Scale and scored ≥6. The primary outcomes were overall survival (OS), recurrence-free survival (RFS), and disease-specific survival (DSS). Meta-analysis showed that RALS had equivalent survival outcomes to CLS for OS (HR = 0.962, 95% CI: 0.922, 1.004), RFS (HR = 1.096, 95% CI: 0.947, 1.296), and DSS (HR = 1.489, 95% CI: 0.713, 3.107). However, RALS was significantly associated with better outcomes than LT, including OS (HR = 0.682, 95% CI: 0.576, 0.807), RFS (HR = 0.793, 95% CI: 0.653, 0.964), and DSS (HR = 0.441, 95% CI: 0.298, 0.652). Subgroup analyses found RALS to be non-inferior to CLS regardless of follow-up time or effect measure, but in early-stage cancer, RALS showed slightly poorer RFS than CLS (HR = 1.378, 95% CI: 1.102, 1.724). The authors concluded that RALS is oncologically safe, offering equivalent outcomes to CLS and superior outcomes to LT in the treatment of endometrial cancer.[42]

Ontario Health (2023) conducted a health technology assessment to evaluate the effectiveness, safety, cost-effectiveness, and budget impact of robotic-assisted hysterectomy (RH) versus laparoscopic hysterectomy (LH) for treating endometrial cancer in individuals with obesity. The assessment included one systematic review and reported risk of bias using the GRADE framework, which rated the certainty of evidence as very low due to indirect comparisons and study limitations. The review found that in patients with BMI ≥ 40 kg/m², RH had a lower conversion rate to open hysterectomy (3.8%) compared to LH (7.0%), while perioperative complication rates were similarly low (≤3.5%) for both approaches. Two international economic studies indicated RH was costlier than LH or open surgery, but were not directly applicable to Ontario. A local 5-year budget impact analysis estimated RH would incur an additional CAD 1.14 million, sensitive to surgical volume and disposable costs. Interviews with patients and gynaecologic surgeons revealed strong preferences for RH, citing faster recovery and improved outcomes for patients with obesity. The report concluded that RH offers some clinical advantages in this population, though cost-effectiveness in the Ontario context remains uncertain.[43]

5.1.4 Effectiveness of Robotic-Assisted Surgery for Sacrocolpopexy in Pelvic Organ Prolapse

Chang et al. (2022) conducted an updated systematic review and network meta-analysis to compare the efficacy and safety of open sacrocolpopexy (OSC), laparoscopic sacrocolpopexy (LSC), and robotic-assisted sacrocolpopexy (RSC) for pelvic organ prolapse (POP). The review included six RCTs involving 486 patients. Outcomes of interest were operative time, estimated blood loss (EBL), postoperative complications, and anatomical outcomes assessed using POP-Q points (Ba, Bp, C). Risk of bias was generally low, with ~90% of studies assessed as low risk using the Cochrane tool, though two studies had unclear blinding. Results showed OSC had the shortest operative time (mean difference vs. LSC: 10.08 min, 95% CI: 6.56, 13.61; vs. RSC: 43.76 min, 95% CI: 19.99, 67.53), but RSC and LSC resulted in significantly less EBL and lower postoperative complication rates (non-significant). RSC and LSC had better anatomical outcomes compared to OSC, with RSC ranked best for points Bp and C, and LSC for point Ba. The study concluded that while OSC had shorter operative time, minimally invasive approaches (RSC and LSC) offer advantages in terms of blood loss, complications, and anatomical outcomes, though no significant differences were found between RSC and LSC.[44]

Yang et al. (2021) conducted a systematic review and meta-analysis to compare the clinical efficacy of robotic sacrocolpopexy (RSC) and laparoscopic sacrocolpopexy (LSC) for pelvic organ prolapse (POP). The study included 49 studies with a total of 3,014 patients, comprising 18 comparative studies between RSC and LSC and 31 non-comparative single-arm studies on RSC. Patients were women with POP undergoing minimally invasive sacrocolpopexy. The outcomes of interest included perioperative parameters (operative time, blood loss, complications, hospital stay), surgical conversions, recurrence, and cure rates. Risk of bias was assessed using the JBI tool for single-arm studies and the MINORS index for comparative studies; only studies scoring ≥18 were included in the meta-analysis. Among RSC patients, the median operative time was 226 minutes (range: 90–604), estimated blood loss was 56 mL (range: 5–1,500), and hospital stay was 1.55 days (range: 1–16). Intraoperative and postoperative complications occurred in 2.7% and 13.0%, respectively. Of 2,768 RSC cases, 40 were converted to another approach, and 7.2% had recurrence of any compartment. Compared to LSC, RSC was associated with significantly lower blood loss (WMD =-58.48 mL, 95% CI: -100.58, -16.39, P=0.006) and fewer conversions (OR =0.35, 95% CI: 0.15, 0.79, P=0.01), but longer operative time (WMD =37.35 minutes, 95% CI: 24.46, 50.24, P<0.00001). No significant differences were found in transfusion rate, complications, or objective recurrence. The authors concluded that RSC offers certain perioperative advantages over LSC while maintaining comparable safety and effectiveness, but high-quality RCTs are needed to confirm long-term benefits.[45]

Callewaert et al. (2016) conducted a systematic review to compare laparoscopic sacrocolpopexy (LSC) and robotic-assisted sacrocolpopexy (RASC) for pelvic organ prolapse (POP). The review included two randomized controlled trials (RCTs)—Paraiso et al. (2011) and Anger et al. (2014)—encompassing a total of 78 patients. The primary outcomes were cost and operation time, while secondary outcomes included pain, complications, anatomical success, and patient satisfaction. Paraiso's study found that LSC had significantly shorter operating time than RASC (199±46 vs. 265±50 minutes, p<0.001), whereas Anger's study showed no significant difference (225.5±62.3 vs. 246.5±51.3 minutes, p=0.11). Both studies reported

significantly higher costs for RASC, even when excluding purchase and maintenance costs (e.g., Paraiso: LSC USD 14,342 vs. RASC USD 16,278; p=0.008). Postoperative pain was higher for RASC, especially in the first week, and LSC patients required fewer NSAIDs (11 vs. 20 days; p<0.005). No differences were found in anatomical or functional outcomes, complications, or quality of life measures. Risk of bias was generally low in both trials, though attrition bias was unclear in one. The authors concluded that RASC, while effective and safe, is significantly costlier than LSC without demonstrable added benefit in outcomes, and its sustainability relies on reducing robotic-related expenses.[46]

Hudson et al. (2014) conducted a systematic review and meta-analysis to evaluate the efficacy and safety of robotic-assisted laparoscopic sacrocolpopexy (RSC) for pelvic organ prolapse (POP), including studies with at least 6-month anatomical outcome data. Thirteen studies were included, comprising one randomized controlled trial and twelve observational studies (five prospective and seven retrospective), with a total of 577 women, all with stage II or greater prolapse. Risk of bias was assessed using the Cochrane tool for the RCT (low risk except for follow-up data) and Newcastle-Ottawa Scale for observational studies (mean score 8.8/9 for comparative and 5.7/6 for non-comparative). The weighted mean follow-up was 26.9 months. The primary outcome was apical anatomic cure (defined as ≤ POP-Q Stage 1), which showed a pooled success rate of 98.6% (95% CI: 97.0, 100%). The rate of mesh exposure/erosion was 4.1% (95% CI: 1.4, 6.9%), while reoperation rates for mesh revision, apical prolapse, and non-apical prolapse were 1.7%, 0.8%, and 2.5%, respectively. The most common complications included cystotomy (2.8%) and wound infection (2.4%). Estimated blood loss averaged 82.5 mL, and operative time averaged 235 minutes. The authors concluded that RSC is a safe and highly effective surgical option for apical prolapse with low complication and recurrence rates, though the evidence is limited by small study sizes, selection bias, and variability in outcome reporting.[47]

5.1.4 Effectiveness of Robotic-Assisted Surgery for Stress Urinary Incontinence

Dubois et al. (2025) conducted the largest single-centre prospective cohort study to date evaluating the outcomes of robotic artificial urinary sphincter (AUS) implantation in women with stress urinary incontinence (SUI) due to intrinsic sphincter deficiency (ISD). A total of 101 women who underwent robotic AUS implantation between 2014 and 2023 were included. The study aimed to assess functional outcomes and quality of life using validated patient-reported outcome measures (PROMs), including the Urinary Symptoms Profile (USP), International Consultation Incontinence Questionnaire-Short Form (ICIQ-SF), and Patient Global Impression of Improvement (PGII). At 3 months, all PROMs significantly improved: the USP SUI subscore dropped from 7.3 to 0.8 ($p < 0.001$), ICIQ-SF from 16.5 to 3.1 ($p < 0.001$), and ICIQ-QoL from 8.7 to 0.9 ($p < 0.001$). Complete continence was reported in 67.3% of patients, and 72.8% reported being "very much improved" on the PGII. Complications included 17.8% intraoperative and 26.7% postoperative, with 9% being Clavien-Dindo grade III. The authors concluded that robotic AUS implantation is safe and significantly improves quality of life and continence, warranting consideration for wider adoption despite some risk of mechanical complications.[48]

Estaphanous et al. (2024) conducted a systematic review and meta-analysis to evaluate the efficacy and safety of artificial urinary sphincter (AUS) implantation in women with stress urinary incontinence (SUI), including robotic-assisted approaches. The review included 8 studies with a total of 300 female patients, covering open, laparoscopic, and robotic techniques, with a minimum follow-up of 6 months. Risk of bias was assessed using the MINORS (Methodological

Index for Non-Randomized Studies) tool, with all included studies scoring between 10 and 13 out of a possible 16, indicating moderate methodological quality. Primary outcomes were continence, revision, explantation, and perioperative complications. The pooled complete continence rate post-AUS implantation was 72% (OR: 0.01, 95% CI: 0.00, 0.02; $p < 0.00001$), with revision and explantation rates of 22.5% (OR: 0.04, 95% CI: 0.01, 0.15) and 17.6% (OR: 0.08, 95% CI: 0.03, 0.21), respectively. Complications occurred in 26.3% of patients (OR: 0.03, 95% CI: 0.01, 0.11). Among the included studies, Peyronnet et al. reported that robotic AUS implantation achieved a continence rate of 81.6%, with lower complication (18.3%) and revision (6.1%) rates compared to open approaches. The review noted that robotic-assisted approaches enhance precision and control, potentially lowering complication rates and improving recovery outcomes. Although all three techniques demonstrated favourable continence results, robotic-assisted AUS may offer additional perioperative benefits. However, further research is needed to assess its long-term effectiveness and cost-effectiveness relative to other surgical methods.[49]

Chen et al. (2023) conducted a systematic review and meta-analysis to assess the efficacy and safety of robot-assisted artificial urinary sphincter (AUS) implantation in women with severe stress urinary incontinence (SUI). The authors systematically searched databases including PubMed, EMBASE, Web of Science, Cochrane Library, and ClinicalTrials.gov up to March 2022. Nine studies were included (8 retrospective, 1 prospective), involving 157 women diagnosed with SUI due to intrinsic sphincter deficiency who underwent robot-assisted AUS implantation. Risk of bias was assessed using the MINORS tool; studies had moderate quality. The outcomes of interest were continence rates, intraoperative and postoperative complication rates. The pooled continence rate was 83% (95% CI: 0.76, 0.89), indicating high short-term efficacy. However, complication rates were considerable: intraoperative complications (mainly vaginal or bladder injury) occurred in 21% of cases (95% CI: 11%, 34%) and postoperative complications (such as acute urinary retention) occurred in 20% (95% CI: 12%, 29%). Subgroup analysis comparing posterior vs traditional approaches found no difference in continence, but the posterior approach had higher complication rates. Authors concluded that robotic AUS implantation provides favourable continence outcomes but carries relatively high complication risks, warranting larger, long-term studies to determine optimal techniques and safety.[50]

5.2 SAFETY

5.1.1 Safety of Robotic-Assisted Surgery for General Gynaecological Disorders

In the updated systematic review by Capozzi et al. (2022) of robotic-assisted surgery (RAS) compared to conventional laparoscopic and open approaches for benign gynaecological pathologies, it was reported that RAS has a favorable safety profile across various benign gynecological procedures. Robotic myomectomy demonstrated lower complication rates compared to open surgery and similar outcomes to laparoscopy. Robotic hysterectomy was comparable in safety to laparoscopic and vaginal hysterectomy but showed significantly fewer complications and less blood loss than open abdominal hysterectomy. For endometriosis, robotic surgery had complication rates equivalent to conventional laparoscopy despite longer

operative times. In pelvic organ prolapse surgery, robotic sacrocolpopexy had comparable safety to laparoscopic approaches and fewer complications than open methods. [18]

Capozzi et al. (2020), in their systematic review and meta-analysis of robotic single-port surgery for gynecologic indications, reported that complication rates were highest in patients undergoing surgery for malignant conditions (6.2%; p = 0.001), compared to those treated for benign (1.7%) and mixed pathologies (2.5%). Despite this, the authors maintained that the overall safety profile of robotic single-site surgery remained acceptable and comparable to conventional techniques.[19]

Behbehani et al. (2020) conducted a systematic review and meta-analysis to evaluate mortality rates associated with minimally invasive surgery (MIS), specifically laparoscopic and robotic surgery, for benign gynecologic conditions. The study systematically searched databases such as PubMed, Embase, Scopus, Web of Science, and Cochrane, including 21 studies with a total of 124,216 patients who underwent benign gynaecologic MIS procedures, primarily hysterectomy, sacrocolpopexy, and adnexal surgery. The outcomes measured were operative mortality rates within 30 days. Findings showed the overall mortality rate for benign gynaecologic MIS was 1 in 6,456 procedures (95% CI: 1:3,946, 1:10,562). Specifically, laparoscopic surgery had a mortality rate of 1 in 6,512 procedures (95% CI: 1:3,971, 1:10,680), whereas robotic surgery showed a slightly higher but not statistically different rate of 1 in 5,430 (95% CI: 1:69, 1:435,052). The mortality rate was further analysed by specific procedures, revealing rates of 1 in 6,814 for MIS hysterectomy (95% CI: 1:4,119, 1:11,275), 1 in 1,246 for sacrocolpopexy (95% CI: 1:36, 1:44,700), and 1 in 2,245 for simpler procedures like adnexal surgery and diagnostic laparoscopy (95% CI: 1:45, 1:113,372). The authors concluded that operative mortality rates in benign minimally invasive gynaecologic surgery were low and similar for both laparoscopic and robotic approaches. The importance of incorporating these mortality risk data into patient counselling was emphasized, and further research was recommended to more clearly define the risks associated with individual surgical procedures.[20]

According to Matanes et al. (2018), robotic laparoendoscopic single-site surgery (R-LESS) demonstrated a low complication profile, with rates ranging from 0 to 13.6% in hysterectomies and 0 to 12% in myomectomies, the majority being minor (Clavien-Dindo grade I-II). Conversion to multiport or open procedures remained rare (0% to 6.6%).[21]

In a broad review conducted by Gala et al. (2014), robotic-assisted surgery showed consistently favourable safety outcomes, particularly in oncologic procedures. For instance, in endometrial and cervical cancer cases, robotic approaches resulted in significantly reduced blood loss (e.g., 88 mL vs 200 mL and 115.5 mL vs 509.3 mL, respectively; $p < 0.001$) and shorter hospital stays when compared to open or laparoscopic alternatives, with no increased risk of complications.[23]

The review by Morelli et al. (2016), which assessed the Da Vinci Single-Site platform across various surgical specialties, concluded that robotic single-site gynaecologic procedures were associated with low postoperative complication rates, primarily minor in nature. Reported blood loss ranged from 22 to 145 mL, and the need to convert to other surgical approaches was infrequent.[22]

5.1.2 Safety of Robotic-Assisted Surgery for Myomectomy

In their systematic review and meta-analysis, Mourad et al. (2024) reported that robotic-assisted myomectomy (RM) demonstrated a favourable safety profile when compared to both laparoscopic myomectomy (LM) and open myomectomy (OM). Specifically, there was no significant difference in complication rates between RM and LM (OR: 0.88; 95% CI: 0.61, 1.26), and RM showed a significantly lower complication rate compared to OM (OR: 0.51; 95% CI: 0.27, 0.97). Transfusion rates were also significantly lower in the RM group when compared to OM (OR: 0.45; 95% CI: 0.32, 0.63), while they were comparable to those in the LM group.[13]

In another systematic review by Chen et al. (2024), the safety outcomes of robot-assisted laparoscopic myomectomy (RLM) were benchmarked against both laparoscopic (LM) and abdominal myomectomy (AM). Compared to LM, RLM yielded no significant difference in complication rates, blood loss, transfusion need, or hospital stay. However, when RLM was compared to AM, it showed clear safety advantages including fewer complications (OR = 0.43; 95% CI: 0.27, 0.71; P < 0.001), lower transfusion rates (OR = 0.37; 95% CI: 0.27, 0.50; P < 0.001), and significantly reduced blood loss (MD = –104.47 mL; 95% CI: –164.31, –44.63; P < 0.001).[16]

5.1.3 Safety of Robotic-Assisted Surgery for Endometriosis

In their meta-analysis comparing robotic-assisted surgery (RAS) to laparoscopic surgery (LPS) for deep endometriosis, Pavone et al. (2024) found no statistically significant differences in key safety outcomes. Specifically, intraoperative complication rates (RR = 0.82; 95% CI: 0.50, 1.33), postoperative complications (RR = 0.84; 95% CI: 0.63, 1.12), conversion to open surgery (RR = 0.48; 95% CI: 0.14, 1.66), and estimated blood loss (MD = -3.88 mL; 95% CI: -30.13, 22.38) were all comparable between the RAS and LPS groups. [12]

Csirzó et al. (2024) similarly concluded that robot-assisted laparoscopy (RAL) is as safe as conventional laparoscopy (CL) for endometriosis surgery. Their analysis, encompassing over 2,000 patients, found no significant differences in intraoperative (OR = 1.07; 95% CI: 0.43, 2.63) or postoperative complications (OR = 1.3; 95% CI: 0.73, 2.32), nor in conversion rates (OR = 1.34; 95% CI: 0.7, 2.37) or rehospitalisation (OR = 0.95; 95% CI: 0.13, 6.75). Although RAL had slightly higher estimated blood loss, the difference (MD = 16.73 mL) was not considered clinically relevant.[9]

In the review by Ong et al. (2024), robotic-assisted laparoscopic surgery (RALS) for bowel deep infiltrating endometriosis (DE) was also found to be safe and feasible. Intraoperative complication rates were 3.0% in the RALS group versus 7.2% with standard laparoscopy (SLS), while major postoperative complication rates were comparable (4.4% for RALS vs. 3.6% for SLS). Notably, minor postoperative complications were substantially lower with RALS (6.4% vs. 22.9%). Conversion rates (1.6% vs. 1.2%) and blood loss (155 ± 207 mL vs. 176 ± 234 mL) were similar between groups.[14]

5.1.4 Safety of Robotic-Assisted Surgery for Hysterectomy

Lenfant et al. (2023) presented strong safety outcomes in their large meta-analysis comparing robotic-assisted hysterectomy (RAH) to laparoscopic, vaginal, and open approaches for benign

gynaecologic conditions. RAH was associated with significantly fewer complications than open hysterectomy (OR = 0.42; 95% CI: 0.27, 0.66; p = 0.0001), and also demonstrated lower transfusion rates (risk difference: -0.0043; 95% CI: -0.0059, -0.0027; p < 0.00001) compared to laparoscopic surgery. Conversion to open procedures was also less frequent in the RAH group (RD = -0.04; 95% CI: -0.06, -0.01; p = 0.008), and readmission rates were slightly reduced (OR = 0.90; 95% CI: 0.83, 0.99; p = 0.03). Mortality and reoperation rates did not significantly differ between groups.[17]

Riemma et al. (2023) reviewed the safety and feasibility of robotic single-site hysterectomy (RSSH) in benign gynaecologic cases and found consistently low complication rates. Among 212 patients, only two experienced intraoperative complications (accidental cystotomies), and three reported minor postoperative complications (e.g., vaginal bleeding, Clavien-Dindo grade II events). Notably, no reoperations or hospital readmissions occurred within 30 days. The conversion rate to other modalities was 4.7%, mostly to multiport robotic surgery, and mean estimated blood loss was low at 43.68 ml.[15]

5.1.5 Safety of Robotic-Assisted Surgery for Endometrial Cancer

Robotic-assisted surgery (RAS) has consistently demonstrated favourable safety profiles compared to conventional laparoscopy (LPS) and laparotomy (LT) across multiple systematic reviews and meta-analyses. Huang et al. (2025) found that RAS significantly reduced intraoperative complications (OR 0.23; 95% CI: 0.06, 0.80), postoperative complications (OR 0.29; 95% CI: 0.18, 0.51), and total complications (OR 0.24; 95% CI: 0.10, 0.61) compared to LPS and LT.[39] Similarly, Yuan et al. (2025) reported that robotic hysterectomy (RH) was associated with significantly fewer postoperative complications than open hysterectomy (OH) (OR 0.46; 95% CI: 0.32, 0.63), despite retrieving fewer lymph nodes.[40]

Natarajan et al. (2024) included 99 studies and concluded that RAS led to significantly lower odds of intraoperative complications (OR vs OS: 0.39; 95% CrI: 0.25, 0.61) and postoperative ileus (OR vs OS: 0.18; 95% CrI: 0.07, 0.43) compared to other surgical techniques.[41] Fu et al. (2023), analysing over 160,000 patients, supported the safety of RAS by showing equivalent recurrence-free and disease-specific survival compared to LPS and superior safety compared to LT, with HR for DSS of 0.441 (95% CI: 0.298, 0.652).[42] The Ontario Health HTA (2023) specifically assessed RAS in individuals with obesity and reported low perioperative complication rates (≤3.5%) for both RAS and LPS. In particular, RH had a lower conversion to open surgery (3.8% vs 7.0%) in those with BMI ≥40 kg/m².[43]

5.1.6 Safety of Robotic-Assisted Surgery for Sacrocolpopexy in Pelvic Organ Prolapse

The safety profile of robotic-assisted sacrocolpopexy (RSC) has been evaluated in several systematic reviews, showing generally favourable outcomes compared to laparoscopic (LSC) and open sacrocolpopexy (OSC). A systematic review and meta-analysis by Yang et al. (2021), which included 49 studies involving 3,014 patients, found that intraoperative and postoperative complication rates for RSC were 2.7% and 13.0%, respectively. RSC was associated with significantly lower blood loss (WMD = -58.48 mL; 95% CI: -100.58, -16.39; p = 0.006) and fewer conversions to other surgical methods (OR = 0.35; 95% CI: 0.15, 0.79; p = 0.01) compared to LSC. However, no significant differences were found in overall complication or transfusion rates between RSC and LSC.[44]

Another systematic review and network meta-analysis by Chang et al. (2022) included six RCTs with 486 patients and reported that both RSC and LSC were associated with lower estimated blood loss and postoperative complication rates than OSC, though the differences in complication rates were not statistically significant.[45] A systematic review by Callewaert et al. (2016), which included two RCTs (Paraiso et al. and Anger et al.) with a total of 78 patients, found no significant difference in complication rates between RSC and LSC. However, RSC patients experienced more postoperative pain in the first week and required longer NSAID use (mean 20 vs. 11 days; $p < 0.005$).[46]

Lastly, a systematic review and meta-analysis by Hudson et al. (2014) of 13 studies (n = 577) found a high apical anatomical cure rate of 98.6% (95% CI: 97.0, 100%) following RSC. Mesh exposure or erosion occurred in 4.1% (95% CI: 1.4, 6.9%), while reoperation rates were low for mesh revision (1.7%), apical prolapse (0.8%), and non-apical prolapse (2.5%). Common complications included cystotomy (2.8%) and wound infection (2.4%).[47]

5.1.7 Safety of Robotic-Assisted Surgery for Stress Urinary Incontinence

Robotic-assisted artificial urinary sphincter (AUS) implantation in women with stress urinary incontinence (SUI) has shown promising continence outcomes, though complication rates remain a concern. A prospective cohort study by Dubois et al. (2025) involving 101 women with SUI due to intrinsic sphincter deficiency (ISD) found that robotic AUS implantation significantly improved quality of life and continence, with complete continence achieved in 67.3% of patients. However, intraoperative complications occurred in 17.8% and postoperative complications in 26.7% of patients, with 9% classified as Clavien-Dindo grade III.[48]

A systematic review and meta-analysis by Estaphanous et al. (2024) included eight studies (n = 300) encompassing robotic, laparoscopic, and open AUS implantation. The pooled complication rate was 26.3% (OR: 0.03; 95% CI: 0.01, 0.11), while the complete continence rate reached 72% (OR: 0.01; 95% CI: 0.00, 0.02; $p < 0.00001$). Revision and explantation rates were 22.5% and 17.6%, respectively. Notably, in a robotic subgroup (Peyronnet et al.), continence was achieved in 81.6% with complication and revision rates of 18.3% and 6.1%, respectively, lower than those reported for open techniques. The review suggested that robotic approaches enhance surgical precision and may reduce complications, although further long-term evaluation is needed.[49]

Likewise, a systematic review by Chen et al. (2023) including nine studies (n = 157) focusing on robot-assisted AUS implantation reported a pooled continence rate of 83% (95% CI: 0.76, 0.89). Intraoperative complications mostly vaginal or bladder injuries were observed in 21% (95% CI: 11,34%), while postoperative complications such as acute urinary retention occurred in 20% (95% CI: 12, 29%). A subgroup analysis showed that posterior approaches had higher complication risks compared to traditional techniques, despite similar continence outcomes.[50]

5.3 ECONOMIC IMPLICATION

Delameilleure et al. (2024) conducted a retrospective single-centre cost analysis to assess the economic and clinical impact of various hysterectomy approaches including robot-assisted hysterectomy (RAH), abdominal (AH), laparoscopic (LH), laparoscopically-assisted vaginal

(LAVH), and vaginal hysterectomy (VH) for benign gynaecological conditions. The study reviewed 830 cases performed between 2014 and 2021 at University Hospitals Leuven, Belgium, and included robotic surgeries using the da Vinci Surgical System. Primary outcomes included operating room and hospital stay costs, while secondary outcomes encompassed surgical time, estimated blood loss (EBL), intra- and postoperative complications (graded by Clavien-Dindo), reinterventions, transfusion needs, and conversion rates. Following the implementation of a dedicated RAH program in 2018, open surgery rates decreased markedly from 27.3% (2014 to 2017) to just 6.9% (2019 to 2021). RAH was mainly used for complex cases, particularly fibroid-related pathology. Median EBL was significantly lower for minimally invasive approaches (100–150 mL) compared to AH (275 mL), and perioperative visceral injuries occurred in 0.7% of RAH cases, 3% of VH and LAVH, 5% of AH and LH. Reintervention rates were similar across approaches (3–4%). Grade 2 Clavien-Dindo events (e.g., transfusions, pharmacologic interventions) were required in 28% of AH cases, and 17–22% in other techniques. In terms of cost, RAH was the most expensive at €6,528.10, driven by high fixed and depreciation costs, while VH was the least expensive (€3,107.23). The study concluded that although RAH supports increased adoption of minimally invasive surgery and reduces reliance on open techniques, its high cost limits its suitability to select patient populations with higher surgical complexity. The authors recommended future prospective evaluations to incorporate patient-reported outcomes and broader societal cost considerations.[27]

Clark et al. (2023) conducted a retrospective cohort study to compare the surgical cost of robotic-assisted sacrocolpopexy (RSC) using two different robotic platforms, Senhance (Asensus Surgical) and da Vinci (Intuitive Surgical) at a single academic medical center. The study included 75 women with pelvic organ prolapse who underwent RSC between January 2019 and June 2021, with 25 Senhance cases matched 2:1 to 50 da Vinci cases. All surgeries were performed by experienced urogynaecologic surgeons, and the robotic procedures included sacrocolpopexy with or without concomitant procedures such as hysterectomy, mid-urethral sling placement, and lysis of adhesions. Primary outcome was total hospital cost per case (excluding initial system purchase costs), and secondary outcomes included operative time, estimated blood loss (EBL), intra- and postoperative complications, and breakdown of cost categories (e.g., supplies, anesthesia, nursing). The Senhance group had significantly longer operative times (mean 210.2 vs. 178.1 minutes; $p = 0.01$), but intraoperative and 30-day postoperative complications were low and not statistically different between the groups (e.g., postoperative complications: 8% Senhance vs. 16.3% da Vinci; $p = 0.48$). On univariable analysis, mean total hospital costs were similar between Senhance ($5,368.31 ± 1,486.89) and da Vinci ($5,741.76 ± 1,197.20; $p = 0.29$). However, after adjusting for confounders such as operative time, EBL, mid-urethral sling use, and use of the GelPoint Mini port system, multivariable regression revealed a significantly lower adjusted cost for Senhance (by $908.33; $p = 0.01$), representing a 16% cost reduction. The authors concluded that Senhance robotic-assisted sacrocolpopexy offers a significantly lower total cost compared to the da Vinci system, despite being associated with longer operative times. These findings suggest that alternative robotic platforms with reusable instruments may offer substantial economic benefits. Further research was recommended to validate these results across broader settings and surgeon experience.[28]

Iavazzo and Gkegkes (2017) conducted a systematic review to evaluate the cost-benefit aspects of robotic-assisted surgery in gynaecological oncology, specifically comparing robotic, laparoscopic, and open approaches. Following a systematic search of PubMed and Scopus

databases, 17 studies were included, encompassing a total of 16,349 patients with 3,214 underwent open surgery, 5,120 laparoscopic, and 8,015 robotic procedures. Most procedures involved hysterectomy with or without para-aortic lymphadenectomy for endometrial, cervical, or ovarian cancer. The robotic surgeries analyzed in the review were performed using the da Vinci Surgical System. Key outcomes assessed included total costs (ranging from $1,858 to $64,266 for robotic, $960 to $42,460 for open, and $441 to $55,130 for laparoscopic), operative and non-operative charges, operating room and equipment costs, professional fees, blood loss, operative duration, conversion rates, and hospital stay length. The findings highlighted a consistent trend of higher cost associated with robotic procedures. For example, robotic surgery showed significantly higher operative room costs (up to $32,800) and disposable instrument charges (up to $2,000 per case). However, robotic surgery also demonstrated lower estimated blood loss (0 to 2,900 mL), fewer conversions to laparotomy (2.9%, same as laparoscopic), and shorter hospital stays (1 to 6 days vs. 1.8 to 26 days for open). While some studies reported improved outcomes like fewer complications and faster recovery with robotic surgery, others (e.g., Swenson et al. and Zakhari et al.) revealed that robotic surgery can be up to 24% more expensive per case, with limited differences in clinical outcomes compared to laparoscopy. Sub-analyses (e.g., Venkat et al.) attributed cost differences largely to surgical consumables and anesthesia. The authors concluded that while robotic-assisted surgery offers clinical advantages in selected patients such as those with obesity or comorbidities. Its high cost remains a major limitation. They emphasized that cost-effectiveness may be achievable only in high-volume centres with multi-specialty robot use and optimised surgical training. Further multicenter RCTs incorporating long-term outcomes (e.g., quality-adjusted life years) were recommended to clarify the cost-effectiveness of robotic surgery in gynaecologic oncology.[29]

Marino et al. (2015) conducted a prospective multicenter cost-effectiveness study to compare conventional laparoscopy and robotic-assisted laparoscopy for gynecologic oncologic indications, including endometrial and cervical cancer. A total of 306 patients from 16 centers in France were included between 2007 and 2010, with 80 undergoing robotic-assisted surgery using the da Vinci Surgical System, and 226 treated via conventional laparoscopy. The study evaluated direct medical costs such as operating room, equipment, consumables, and hospital stay as well as clinical outcomes, including complication rates, ICU admissions, surgical conversions, and recurrence at 2 years. The robotic procedures were significantly longer (mean 4.98 vs 4.38 hours; $p = 0.0002$), but patients in the robotic group required fewer ICU admissions (13% vs 27%; $p = 0.0234$), and hospital costs were lower (€2,380 vs €2,841; $p < 0.001$). Surgical conversion rates (1% vs 3%), blood loss (96 vs 110 mL), transfusions (2% vs 3%), and complication rates were comparable between groups. From a cost perspective, the robotic strategy was associated with higher total costs per case (€7,040 vs €5,584; $p < 0.001$), primarily driven by equipment (€1,346), maintenance (€867), and operating room expenses (€1,490 vs €1,311; $p = 0.004$). However, robotic surgery showed lower consumables cost (€957 vs €1,432; $p = 0.001$). Sensitivity analyses indicated that performing more than 250–300 robotic procedures annually or reducing robot purchase/maintenance costs by 20–30% could achieve cost parity with laparoscopy. The authors concluded that while robotic-assisted laparoscopy was clinically equivalent to conventional laparoscopy in terms of outcomes and safety, it remains costlier. Cost-effectiveness could improve through increased case volume, cost reductions, and the inclusion of broader surgical indications. Further large-scale randomized studies incorporating societal cost perspectives were recommended to better inform decisions regarding robotic technology adoption in clinical practice.[30]

5.4 ORGANISATIONAL ISSUES

5.4.1 Training

Adkoli et al. (2024) conducted a cross-sectional survey study to evaluate the current state of robotic surgical training and resident perspectives in ACGME-accredited obstetrics and gynecology (OB/GYN) residency programs across the United States. The study involved 75 OB/GYN residents during the 2023–2024 academic year and aimed to assess training methodologies, resident exposure to robotic-assisted surgery (RAS), and perceived barriers to achieving competency. A 33-question web-based survey collected data on residents' experience with robotic surgery primarily involving the da Vinci Surgical System including hands-on training, simulator access, and console participation. Results showed that 98.7% of institutions performed robotic surgeries, and 90.7% had access to robotic console trainers. However, only 57.3% of respondents reported having a formalized robotic curriculum, and most (56.7%) received no faculty-led didactic training. While 93.3% of residents had access to the robotic console, 60% had never served as the primary surgeon on a robotic case. Simulation methods like hands-on practice (87.3%) and dual-console experience (70.4%) were deemed most helpful, while online modules were considered least useful (58.7%). Barriers to training included attending discomfort with resident participation (74.0%), time constraints (58.9%), and limited simulator availability (42.5%). Despite these challenges, 80% of residents intended to become robot-certified by graduation, and 68% planned to use robotics in future practice. A large majority (81.3%) agreed or strongly agreed that standardized robotic training should be integrated into all OB/GYN residency programs. The authors concluded that there is a critical need for structured, standardized curricula to ensure residents gain sufficient robotic surgery experience. They emphasized that establishing benchmarks and formal training requirements is essential to prepare residents for independent robotic practice post-residency.[25]

5.4.2 Perception of healthcare experts

Barkati et al. (2023) conducted a qualitative study to explore healthcare experts' perceptions and organizational readiness regarding the adoption of robotic-assisted surgery (RAS) in the United Arab Emirates (UAE). Seventeen in-depth interviews were conducted with both clinical (e.g., surgeons, pharmacists) and non-clinical professionals (e.g., hospital managers, informatics specialists) across multiple healthcare institutions between January and March 2022. The interviews were guided by open-ended questions focusing on perceived benefits, adoption challenges, specialty use, and the impact of the COVID-19 pandemic. The study found that 88% of participants held favourable views on RAS, with 94% believing it could enhance hospital reputation and clinical performance. However, only 29.4% of respondents were currently offering RAS, while others cited plans to adopt it within 1 to 3 years. RAS was already being implemented in general surgery, urology, and brain surgery, while only 5.9% reported use in obstetrics and gynaecology. The robotic platforms in use included primarily the da Vinci Surgical System and the Versius system. The main barriers to adoption were financial, reported by 59% of participants, followed by limited staff training and technological limitations. Despite cost and infrastructure challenges, many respondents viewed robotic surgery as a necessary innovation for future surgical care. The COVID-19 pandemic delayed RAS implementation in over half of the institutions surveyed, particularly because elective surgeries were postponed. The authors concluded that although RAS is positively perceived by UAE

healthcare professionals, broader adoption requires improved training access, cost reduction strategies, and increased public awareness to build trust in robotic technology.[24]

Simoncini et al. (2023) conducted an international Delphi study published in *Surgical Endoscopy* to explore expert consensus on the role, indications, and techniques of robotic-assisted pelvic floor reconstructive surgery (PFRS). The study aimed to evaluate whether robotic surgery, particularly using the da Vinci Surgical System, offers clinical and technical advantages over standard laparoscopy in managing pelvic organ prolapse and related conditions. Twenty-six high-volume robotic surgeons from urogynaecology, urology, and colorectal surgery specialties participated in two Delphi rounds, followed by a virtual consensus meeting. A total of 63 statements were rated in round one and 20 refined statements in round two. Key outcomes of interest included safety, operative time, fatigue reduction, suitability across patient subgroups, and surgical efficacy. Most participants reported performing >20 robotic PFRS procedures annually. The expert consensus supported the robot's advantages in improving visualization, instrument articulation, and ergonomics, particularly for complex cases. Specifically, 92% agreed robotic suturing on the sacral promontory and vaginal walls was more accurate, and 73–92% agreed it simplified deep dissections. Robotics was considered safe by 92% of experts, and 85% agreed it facilitates faster discharge. While gynaecologists leaned toward recommending robotics only for selected cases, others favoured broader use. Despite recognizing higher costs, experts believed the benefits outweighed them, especially for complex prolapse. Future directions identified included enhanced surgical navigation, tactile feedback, and AI integration. The authors concluded that robotic-assisted PFRS is a technically advantageous and safe approach, but they emphasized the need for further research to objectively determine its cost-effectiveness and optimal application settings.[11]

Gressel et al. (2021) conducted a large cross-sectional survey study to assess obstetrics and gynaecology (OB/GYN) residents' and program directors' perceptions of readiness to perform robotic-assisted laparoscopic hysterectomy (RAH) at graduation. The study utilized surveys administered to all 5,514 residents taking the 2019 Council on Resident Education in Obstetrics and Gynecology (CREOG) exam, with 5,084 respondents included in the final analysis, along with 241 program directors from ACGME-accredited programs. The survey aimed to measure resident confidence in surgical autonomy, ability to independently perform RAH in emergencies, perceived preparedness by graduation, and the importance of RAH for future careers. Data were analysed using chi-square and Fisher's exact tests. Key findings showed a gap between residents' self-reported preparedness and program directors' assessments. Only 59% of residents felt they could perform a robotic hysterectomy by graduation, and just 53.7% believed they could perform one independently in an emergency. In comparison, 70.2% of program directors believed their residents were prepared for RAH (OR 1.64; 95% CI: 1.19, 2.25; $p < 0.01$). Residents rated RAH as less important to their future careers (56.4%) than other hysterectomy approaches, with PGY4 residents significantly less likely than PGY1s to consider RAH important (OR 0.52; 95% CI: 0.44, 0.62; $p < 0.01$). Compared to other approaches, confidence was lower for robotic hysterectomy: only 52.2% of PGY4 residents reported autonomy for RAH versus 83.0% for laparoscopic hysterectomy (OR 9.83; 95% CI: 6.33, 15.29; $p < 0.01$). Similar trends were seen in perceptions of independence and importance. The study concluded that OB/GYN residents' confidence in performing RAH lags behind other hysterectomy routes. The discrepancy between resident and program director assessments may indicate inadequate hands-on experience or institutional limitations in training. The authors called for development of standardized, validated robotic training curricula

and metrics to assess proficiency, along with clearer credentialing pathways for graduates entering practice.[26]

5.4.3 Guidelines

Robotic-assisted surgery (RAS) has become increasingly prevalent in gynaecologic practice, prompting the development of comprehensive guidelines to ensure its safe and effective implementation. These guidelines address critical aspects such as patient selection, surgeon training, informed consent, and quality assurance.

American College of Obstetricians and Gynaecologists (ACOG) & Society of Gynaecologic Surgeons (SGS)

In their 2020 Committee Opinion, ACOG and SGS emphasize that RAS should be considered when it offers potential advantages over other surgical approaches, particularly in complex cases. They highlight the importance of thorough informed consent, discussing the surgeon's experience, potential risks, benefits, and alternative treatments. The guidelines also advocate for ongoing quality assurance measures and recommend the development of a registry for RAS procedures to monitor outcomes and adverse events.[31]

Royal College of Obstetricians and Gynaecologists (RCOG)

RCOG's 2022 Scientific Impact Paper No. 71 provides insights into the application of RAS across various gynaecological surgeries, including those for cancer and endometriosis. The paper notes that RAS can enhance surgical performance, reduce blood loss, and minimize complications compared to conventional laparoscopy. However, it also acknowledges the higher costs associated with robotic procedures and highlights the need for careful patient selection and consideration of cost-effectiveness.[32]

Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) & Minimally Invasive Robotic Association (MIRA)

The joint consensus document by SAGES and MIRA outlines the role of RAS in gynaecology, recognizing its benefits in procedures like hysterectomy and myomectomy. The guidelines stress the necessity for structured training programs, credentialing processes, and the establishment of competency benchmarks to ensure surgeon proficiency and patient safety.[33]

European Guidelines and Training Recommendations

European organizations such as the Society of European Robotic Gynaecological Surgery (SERGS) and the British and Irish Association of Robotic Gynaecological Surgeons (BIARGS) have developed consensus statements focusing on education and training in RAS. These recommendations advocate for standardized curricula, simulation-based training, and mentorship programs to enhance surgical skills and improve patient outcomes.[34]

In Asia and Southeast Asia, several organizations have developed guidelines and frameworks to ensure the safe and effective implementation of robotic-assisted surgery (RAS) in gynaecology. These guidelines cover multiple areas, such as appropriate case selection, surgeon training, certification processes, and maintaining standards of care.

Asian Society for Gynaecologic Robotic Surgery (ASGRS)

ASGRS has published consensus guidelines focusing on the application of RAS in gynaecologic oncology. These guidelines cover the use of robotic surgery in cervical,

endometrial, and ovarian cancers, as well as single-port robotic surgery and sentinel lymph node biopsy. They also provide recommendations for credentialing, emphasizing the need for surgeons to have prior proficiency in open procedures, completion of basic robotic system training, supervised performance of initial cases, and ongoing assessment to maintain skills.[35]

Japan Society of Gynaecologic and Obstetric Endoscopy and Minimally Invasive Therapy (JSGOE)

Recognizing the growing role of RAS, JSGOE has proposed the establishment of certified training facilities and a technical certification system to evaluate and ensure the proficiency of surgeons performing robotic gynaecologic procedures. This initiative aims to standardize training and maintain high surgical standards across institutions.[36]

Malaysia's Robotic Gynaecology Group (under Academy of Malaysian Robotic-Assisted Surgery (AMRAS)

In Malaysia, the Robotic Gynaecology Group serves as a support system for gynaecologists transitioning into robotic-assisted surgery. The group offers mentoring, proctorship programs, webinars, and cross-border knowledge sharing to assist surgeons in navigating the learning curve associated with RAS. Malaysia has been noted for its rapid adoption of robotic systems in Southeast Asia.[37]

5.5 ETHICAL ISSUES

Robotic-assisted surgery (RAS) has rapidly gained popularity in gynaecology due to its enhanced precision, improved ergonomics, and potential for minimally invasive access to complex anatomical areas. However, alongside these technological advances, several ethical issues emerge that merit careful consideration. These concerns relate primarily to informed consent, equitable access, surgical training and credentialing, cost-effectiveness, and potential conflicts of interest.

Ensuring informed consent remains a key ethical concern in robotic-assisted surgery (RAS), as patients often overestimate its benefits despite limited evidence of superiority over conventional laparoscopy.[8-9] Clinicians have a duty to provide balanced information about risks, alternatives, and the surgeon's experience. At the same time, the high cost of RAS raises concerns about equitable access, particularly in resource-limited settings where patients may be excluded from advanced surgical options, challenging the principle of justice.[29-30]

Ethical concerns also extend to training and cost-effectiveness. Many OB/GYN residents lack adequate exposure to RAS due to inconsistent training and credentialing systems, posing risks to patient safety.[25-26] Moreover, while RAS can cost up to 40% more than laparoscopic surgery, clinical benefits remain inconsistent.[27] This raises questions about resource allocation, especially in publicly funded systems. Potential conflicts of interest further complicate ethical practice when institutional decisions are influenced by financial incentives or industry partnerships rather than patient outcomes.[24] Transparency and evidence-based decision-making are essential to uphold patient-centered care.

5.5 LIMITATIONS

This systematic review has several limitations that should be taken into account when interpreting the findings. Although the search strategy did not impose language restrictions, only peer-reviewed full-text articles published in English were included. This may have led to the exclusion of relevant studies in other languages, thereby narrowing the scope of evidence. The included studies also varied considerably in terms of patient populations, surgical indications, robotic platforms, surgeon experience, and healthcare settings, factors that may limit the generalizability of the results to the Malaysian context. Many of the studies included were retrospective or non-randomized, which may introduce selection and reporting bias. Additionally, long-term outcomes such as recurrence rates, fertility preservation, or quality-adjusted life years (QALYs) were infrequently reported, limiting the ability to assess the full impact of robotic-assisted surgery beyond the perioperative period. Economic evaluations also varied in methodology and often lacked robust cost-effectiveness or budget impact analyses tailored to low- and middle-income settings. Moreover, there is a lack of local data from Malaysia to contextualize the effectiveness, safety, and affordability of robotic surgery, highlighting the need for local real-world evidence and prospective studies to inform policy and investment decisions.

6.0 CONCLUSION

In conclusion**,** robotic-assisted surgery (RAS) for gynaecological disorders demonstrates comparable safety and clinical effectiveness to conventional approaches, with potential advantages in reducing blood loss, shortening hospital stays, and enhancing surgical precision, particularly in complex cases. However, these benefits are accompanied by significantly higher costs, longer operative times, and limited long-term outcome data. Significant organizational challenges were identified, including inconsistent training, limited resident autonomy, and the absence of standardized curricula, all of which may compromise surgical proficiency and patient safety. Although international and regional guidelines emphasize structured education and credentialing, their implementation across settings remains highly variable.

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APPENDIX 1: LITERATURE SEARCH STRATEGY

Database: Ovid MEDLINE(R) ALL <1946 to March 3rd, 2025>
Search Strategy:

1 Gynecology/
2 Gynecologic Surgical Procedures/
3 ((gynaecologic or gynecologic) adj1 surger*).tw.
4 ((gynecologic or gynaecological) adj1 surgical procedure*).tw.
5 ((gynecologic or gynaecological) adj1 surger*).tw.
6 (surgical procedure* adj1 gynaecologic*).tw.
7 Genital Diseases, Female/
8 ((gynaecologic or gynecologic) adj1 disease*).tw.
9 Reproductive Medicine/
10 (reproductive adj1 medicine).tw.
11 Reproductive Techniques/
12 (reproductive adj1 (technique* or technolog*)).tw.
13 ((technic* or technolog*) adj1 reproduct*).tw.
14 Reproductive Health/
15 (reproductive adj1 health).tw.
16 Gynae disorder*.tw.
17 Gynaecological disorder*.tw.
18 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19 Robotic Surgical Procedures/
20 ((robot-enhanced or robot enhanced) adj1 procedure*).tw.
21 (robotic adj1 surgical procedure*).tw.
22 ((robot assisted or robot-assisted) adj1 surger*).tw.
23 ((robot-enhanced or robot enhanced) adj1 surger*).tw.
24 (robot adj1 surger*).tw.
25 21 or 22 or 23 or 24 or 25 or 26
26 20 and 27

Other Databases

PubMed		Same MeSH and keywords as per MEDLINE search
INAHTA		
US FDA		

APPENDIX 2: HIERARCHY OF EVIDENCE FOR EFFECTIVENESS

DESIGNATION OF LEVELS OF EVIDENCE

I	Evidence obtained from at least one properly designed randomized controlled trial.
II-I	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one centre or research group.
II-3	Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.
III	Opinions or respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

SOURCE: US/CANADIAN PREVENTIVE SERVICES TASK FORCE (Harris 2001)

APPENDIX 3: EVIDENCE TABLE

Evidence Table : Effectiveness/ safety/ organisational/ economic implication
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
1. Pavone M, Baroni A, Campolo F et al. Robotic assisted versus laparoscopic surgery for deep endometriosis: a meta-analysis of current evidence. J Robot Surg. 2024;18(1):212. **Italy**	**Systematic Review and Meta-analysis** **Aim:** To evaluate the effectiveness and safety of robotic-assisted surgery (RAS) versus conventional laparoscopic surgery (LPS) for deep endometriosis. **Methods:** PRISMA-compliant review of 14 studies (12 retrospective, 2 prospective) with meta-analyses of key outcomes. Inclusion criteria: Articles focused on comparison between robotic assisted and laparoscopic surgery in deep endometriosis regarding at least one of the following parameters: (i) intraoperative complications (ii) postoperative complications (iii) operative time (iv) conversion rate (v) estimated blood loss (vi) hospital stay. risk of bias was assessed independently by two reviewers	I	14 studies, 2,709 women with deep endometriosis (Stages I-IV) Procedures: robotic/laparoscopic hysterectomy, colorectal resection, ureteral dissection	Robotic-assisted surgery (mainly using da Vinci Surgical System)	Conventional laparoscopic surgery	-	**Results:** **RAS is comparable to laparoscopy in terms of complications, conversion rates, and blood loss. However, RAS is associated with significantly longer operative time and hospital stay.** Intraoperative complications: RR 0.82 (95% CI: 0.50–1.33) Postoperative complications: RR 0.84 (95% CI: 0.63–1.12) Conversion to open surgery: RR 0.48 (95% CI: 0.14–1.66) Estimated blood loss: MD -3.88 mL (95% CI: -30.13 to 22.38) Operative time: MD 50.55 min longer in RAS (95% CI: 25.67–75.43; p<0.0001) Hospital stay: MD 0.33 days longer in RAS (95% CI: 0.05–0.60; p=0.02) **Author's conclusion:** Robotic surgery is not inferior to laparoscopy in patients with endometriosis in terms of surgical outcomes; however, RAS require longer operative times and longer hospital stays. The benefits of robotic surgery should be sought in the easiest potential integration of robotic platforms with new technologies. Furthermore, prospective studies

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	(MP and AB) using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool **Outcomes:** intra-, postoperative complications, conversion rates, (operative time (min) OT, estimated blood loss (EBL) and hospitalization stay)						comparing laparoscopy to the new robotic systems are desirable for greater robustness of scientific evidence.

Evidence Table : Effectiveness/ safety/ organisational/ economic implication
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size	General Comments
2. Mourad A, Kamga-Ngande C, Albaini O et al. Enhancing surgical performance: the role of robotic surgery in myomectomies, a systematic review and metanalysis. J Robot Surg. 2024;18(1):184.	**Systematic Review and Meta-analysis** **Aim:** To evaluate the role, benefits, and limitations of robotic-assisted myomectomy (RM) versus laparoscopic (LM) and open myomectomy (OM) in women with uterine fibroids. **Methods:** ❑ Conducted a systematic review and meta-analysis following PRISMA guidelines. ❑ Comprehensive search across multiple databases to identify relevant studies. ❑ Included 24 studies (mostly retrospective cohorts and matched case-controls). ❑ All robotic procedures performed using the **da Vinci Surgical System**. ❑ Extracted data on perioperative outcomes and pooled using meta-analytic techniques. ❑ Assessed outcomes such as estimated blood loss, transfusion rates, complication rates, operative time, conversion rates, length of stay, pain, and pregnancy rates.	I	24 studies, ❑ Predominantly retrospective cohort studies and matched case-control designs ❑ **Patients involved:** Over **3,000 women** undergoing myomectomy	robotic-assisted myomectomy (RM)	laparoscopic (LM) and open myomectomy (OM)	-	**Results:** ❑ **RM vs LM:** • Estimated blood loss (EBL): Lower in RM (mean difference: -59.47 mL; 95% CI: -103.03 to -15.9). • Transfusion rates: No significant difference (OR: 1.0; 95% CI: 0.66-1.5). • Complications: No significant difference (OR: 0.88; 95% CI: 0.61–1.26). • Pregnancy rates: Comparable (OR: 0.97; 95% CI: 0.48-1.96). • Operative time: Not significantly different (mean difference: 26.8 min; 95% CI: -7.63 to 61.23; high heterogeneity: $I^2 = 96\%$). • Conversion to open surgery: Significantly lower in RM (OR: 0.38; 95% CI: 0.16-0.92). ❑ **RM vs OM:** • EBL: Significantly lower in RM (mean difference: -73.08 mL; 95% CI: -136.95 to –9.21). • Transfusion rates: Lower in RM (OR: 0.45; 95% CI: 0.32-0.63).	

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size	General Comments
							• Complication rates: Lower in RM (OR: 0.51; 95% CI: 0.27-0.97). • Hospital stay: Shorter in RM (mean difference: -1.57 days; 95% CI: -2.0 to -1.14). • Operative time: OM faster than RM (mean difference: 92.95 min; 95% CI: 72.02 to 113.87). • Pregnancy outcomes: No significant difference (OR: 1.14; 95% CI: 0.34-3.82). **Author's conclusion:** Robotic-assisted myomectomy improves surgical performance with reduced blood loss, lower complication and conversion rates, and shorter hospital stays compared to open surgery. It is comparable to laparoscopy in most outcomes but with potential ergonomic and dexterity benefits. The authors recommended incorporating robotic training into surgical education and called for more prospective studies to strengthen the evidence.	

Evidence Table : Effectiveness/ safety/ organisational/ economic implication
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
3. Csirzó Á, Kovács D, Szabó A, et al. Robot-assisted laparoscopy does not have demonstrable advantages over conventional laparoscopy in endometriosis surgery: a systematic review and meta-analysis. *Surgical Endoscopy*. 2024;38:529-539.	**Systematic Review and Meta-analysis** **Aim:** To evaluate whether robot-assisted laparoscopy (RAL) provides perioperative benefits over conventional laparoscopy (CL) in the surgical treatment of endometriosis. **Methods:** Study Design: Systematic review and meta-analysis following PRISMA 2020 and Cochrane guidelines Databases Searched: PubMed (MEDLINE), Cochrane CENTRAL, Embase (search date: February 15, 2023) Inclusion Criteria: Premenopausal women undergoing surgery for endometriosis; comparison of RAL vs CL; consistent reporting of perioperative outcomes Screening and Extraction: Dual independent screening and data extraction; discrepancies resolved by a third reviewer Risk of Bias Tools: ROBINS-I (non-randomized studies), RoB 2 (RCT), GRADE for certainty of evidence	I	13 studies (1 RCT, 4 prospective cohort studies, 8 retrospective cohort studies) **Total Participants**: 2,021 (RAL = 1,012; CL = 1,009) **Surgery Type**: Primarily multiport access (two studies used single-port) **Robotic System**: da Vinci Surgical System used in all applicable studies	robot-assisted laparoscopy	conventional laparoscopy	-	**Results:** **Robot-assisted laparoscopy was found to be equally safe and effective as conventional laparoscopy in managing endometriosis, with no significant differences in complication rates or recovery time. However, RAL was associated with significantly longer operative and operating room times.** Intraoperative complications: No significant difference (OR = 1.07; 95% CI: 0.43-2.63) Postoperative complications: No significant difference (OR = 1.3; 95% CI: 0.73-2.32) Conversion to open surgery: No significant difference (OR = 1.34; 95% CI: 0.76-2.37) Rehospitalization rates: No significant difference (OR = 0.95; 95% CI: 0.13-6.75) Estimated blood loss: Slightly higher in RAL (MD = 16.73 ml; 95% CI: 4.18-37.63) - not clinically meaningful Operative time: Significantly longer in RAL (MD = 28.09 min; 95% CI: 11.59-44.59) Operating room time: Significantly longer in RAL (MD = 51.39 min; 95% CI: 15.07-87.72) Length of hospital stay: No significant difference (MD = 0.12 days; 95% CI: -0.33 to 0.57)

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	Statistical Analysis: Random-effects meta-analysis with Mantel-Haenszel and Hartung-Knapp adjustment; heterogeneity via I^2 and Q statistics; analysis conducted in R **Outcomes:** Complications, conversion to open surgery, rehospitalization rate, operative time and hospital stay						**Author's conclusion:** Robot-assisted laparoscopy is a safe and feasible option but does not offer demonstrable clinical benefits over conventional laparoscopy for endometriosis surgery. Given the longer operative times and similar outcomes, conventional laparoscopy remains the preferred approach for routine cases.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
4. Ong HI, Shulman N, Nugraha P, et al. Role of robot-assisted laparoscopy in deep infiltrating endometriosis with bowel involvement: a systematic review and application of the IDEAL framework. *Int J Colorectal Dis.* 2024;39:98.	**Systematic Review and Meta-analysis** **Aim:** To evaluate the feasibility and clinical outcomes of robot-assisted laparoscopic surgery (RALS) as an alternative to standard laparoscopic surgery (SLS) for treating bowel deep infiltrating endometriosis (DE), and to assess its developmental stage using the IDEAL framework. **Methods:** Databases searched: Medline, Embase, PubMed, Cochrane Library. Search cut-off: August 2023. Inclusion criteria: Studies on symptomatic patients undergoing RALS for bowel deep infiltrating endometriosis (DE). Exclusion criteria: Studies on non-bowel DE, laparotomy-only cases, reviews, case reports, abstracts without outcomes. Study types included: Case series and cohort studies. Risk of bias tool: JBI checklist (Joanna Briggs Institute).	I	11 primary studies (9 case series, 2 cohort). **Total Patients**: 527 (RALS: 368; SLS: 83).	robot-assisted laparoscopic surgery (RALS)	standard laparoscopic surgery (SLS)	-	**Results:** RALS demonstrated longer operative times but shorter hospital stays compared to SLS. Complication and conversion rates were similar between groups. Functional improvements (dysmenorrhea, dyspareunia, bowel symptoms) were consistently reported with RALS. The surgical innovation was classified as IDEAL Stage 2b, suggesting that RALS is in an exploratory phase supported by prospective cohort data but lacking RCTs. ❑ **Operative time**: • RALS: 227 ± 104 minutes • SLS: 171 ± 76 minutes ($p < 0.01$) → RALS had significantly **longer operative time** ❑ **Hospital stay**: • RALS: 5.1 ± 3.6 days • SLS: 7.3 ± 4.1 days ($p < 0.01$) → RALS had significantly **shorter hospital stay** ❑ **Intraoperative complications**: • RALS: 3.0% • SLS: 7.2% → No significant difference ❑ **Postoperative complications**: • Minor complications: RALS 6.4% vs SLS 22.9% • Major complications: RALS 4.4% vs SLS 3.6%

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	Outcomes assessed: Operative time, complications, conversion rate, hospital stay, functional symptom improvement. Analytical approach: Descriptive synthesis; IDEAL framework used to assess innovation stage of RALS.						❑ **Conversion to laparotomy**: • RALS: 1.6% • SLS: 1.2% ❑ **Estimated blood loss**: • RALS: 155 ± 207 mL • SLS: 176 ± 234 mL ❑ **Functional symptom improvement**: • Reported across multiple studies for dysmenorrhea, dyspareunia, and bowel symptoms (not pooled due to heterogeneity) **Author's conclusion:** RALS is a feasible and safe surgical option for bowel DE with favorable outcomes including reduced hospital stay and potential for fewer complications, albeit with longer operative times. The current evidence places the technique at IDEAL Stage 2B, and further randomized controlled trials are warranted to explore its long-term effectiveness, cost implications, and specific procedural benefits.

EvidenceTable : Effectiveness/ safety/ organisational/ economic implication
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
5. Riemma G, Pasanisi F, Reino A et al. Robotic Single-Site Hysterectomy in Gynecologic Benign Pathology: A Systematic Review of the Literature. Medicina (Kaunas). 2023;59(2):411.	**Systematic Review** **Aim:** To assess the feasibility, safety, and perioperative outcomes of robotic single-site hysterectomy (RSSH) for benign gynecologic conditions. **Methods:** ❑Systematic review following PRISMA guidelines. ❑Searched databases: PubMed, Scopus, Web of Science, ClinicalTrials.gov. ❑Included 8 retrospective studies published over the last 9 years. ❑Total of 212 patients who underwent RSSH. ❑ Procedures performed using da Vinci Si, Xi, and SP platforms. ❑Data on surgical history, docking time, console time, operative time, EBL, complications, conversions, hospital stay were extracted. **Outcomes:**	I	❑ 8 retrospective studies published over the last 9 years. ❑ Total of 212 patients who underwent RSSH.	robotic single-site hysterectomy (RSSH)		-	**Results:** **RSSH showed low intraoperative and postoperative complication rates, minimal conversions to other modalities, and short hospital stays.** ❑ Patient Characteristics: Mean age: 45.42 years; Mean BMI: 25.74 kg/m². 38% had prior abdominal surgery. ❑ Intraoperative Metrics: Docking/presurgical time: Mean 15.56 minutes (range 3–30 min). Console time: Mean 83.21 minutes (range 25–180 min). Operative time: Mean 136.6 minutes (range 60–294 min). Estimated Blood Loss (EBL): Mean 43.68 mL (range 15–300 mL). ❑ Safety: Conversion rate: 4.7% (10 cases) — mostly to multiport robotic surgery. Intraoperative complications: 2 patients (accidental cystotomies). Postoperative complications: 3 patients (vaginal bleeding, Clavien-Dindo grade II). No reoperations or readmissions within 30 days. ❑ Hospital Stay: Mean: 1.71 days (range 0.96–3.5 days). **Author's conclusion:** RSSH is a safe and effective minimally invasive surgical technique for benign gynecologic conditions, with low complication rates and short

EvidenceTable : Effectiveness/ safety/ organisational/ economic implication
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
							hospitalization. Additional high-quality comparative studies are needed to further validate its benefits over multiport and other minimally invasive techniques.

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6. Chen W, Ma J, Yang Z et al. Robotic-assisted laparoscopic versus abdominal and laparoscopic myomectomy: A systematic review and meta-analysis. Int J Gynaecol Obstet. 2024;166(3):994-1005.	**Systematic Review and Meta-analysis** **Aim:** To compare perioperative and postoperative outcomes of robot-assisted laparoscopic myomectomy (RLM) with conventional laparoscopic myomectomy (LM) and abdominal myomectomy (AM) in women undergoing surgery for uterine fibroids. **Methods:** Study design: Systematic review and meta-analysis conducted according to PRISMA guidelines. Databases searched: PubMed, Embase, Cochrane Library. Search period: January 2000 to August 2023. Search terms: Included combinations of "robot-assisted", "laparoscopic", "myomectomy", and "abdominal myomectomy". <u>Eligibility criteria:</u> Population: Women with symptomatic uterine fibroids. Intervention: Robot-assisted laparoscopic myomectomy (RLM).	I	32 studies (27 retrospective, 4 prospective, 1 RCT) 6,357 patients (1,982 RLM, 2,734 LM, 1,641 AM)	robot-assisted laparoscopic myomectomy (RLM)	conventional laparoscopic myomectomy (LM) and abdominal myomectomy (AM)	-	**Results:** Compared to AM, RLM showed better outcomes in terms of blood loss, transfusion rates, complications, and hospital stay, though it required longer operative time and incurred higher costs. When compared to LM, RLM had similar perioperative outcomes but was associated with lower cesarean section rates. Operative time remained significantly longer for RLM in both comparisons. **RLM vs LM** • Operative time: MD = 43.58 min; 95% CI: 25.22-61.93; **p < 0.001** • Cesarean section rate: OR = 0.27; 95% CI: 0.10-0.78; **p = 0.02** • No significant differences in: ○ Estimated blood loss (EBL) ○ Transfusion rate ○ Complications ○ Hospital stay ○ Pregnancy outcomes **RLM vs AM** • EBL: MD = -104.47 mL; 95% CI: -164.31 to -44.63; **p < 0.001**

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	Comparators: Laparoscopic myomectomy (LM) and abdominal myomectomy (AM). Outcomes: Operative time, estimated blood loss, transfusion rate, complication rate, length of hospital stay, pregnancy and cesarean section rates, and total surgical costs. Study types: Randomized controlled trials (RCTs), prospective and retrospective cohort studies. Risk of bias assessment: Newcastle-Ottawa Scale for non-randomized studies. MINORS tool for methodological quality. Statistical analysis: Pooled mean differences (MD) and odds ratios (OR) were calculated using random-effects models. Heterogeneity was assessed using the I^2 statistic. Subgroup analyses were performed based on BMI, fibroid number, and size.						• Transfusion rate: OR = 0.37; 95% CI: 0.27-0.50; **p < 0.001** • Complications: OR = 0.43; 95% CI: 0.27-0.71; **p < 0.001** • Hospital stay: MD = -1.49 days; 95% CI: -1.75 to -1.23; **p < 0.001** • Operative time: MD = 79.60 min; 95% CI: 65.19-94.02; **p < 0.001** • Total cost: MD = USD 19,116.80; 95% CI: 16,159.56-22,074.04; **p < 0.001** **Author's conclusion:** RLM is a safe and effective surgical option for myomectomy, with superior outcomes compared to AM and comparable results to LM. It offers advantages in reduced blood loss and complication rates, but longer operative time and higher cost remain concerns. Further prospective studies are needed to evaluate long-term outcomes and cost-effectiveness.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
7. Lenfant L, Canlorbe G, Belghiti J, et al. Robotic-assisted benign hysterectomy compared with laparoscopic, vaginal, and open surgery: a systematic review and meta-analysis. J Robot Surg. 2023;17:2647-2662.	**Systematic Review and Meta-analysis** **Aim:** To evaluate and compare perioperative outcomes of robotic-assisted hysterectomy (RAH) with laparoscopic, vaginal, and open hysterectomy for benign uterine pathology through a comprehensive systematic review and meta-analysis. **Methods:** **Databases searched**: PubMed, SCOPUS, EMBASE (last search: 6 Feb 2021). **Search limits**: English language, Jan 2010-Dec 2020. **Study types included**: RCTs, prospective comparative, and independent database studies. **Population**: Women undergoing benign hysterectomy (robotic vs. laparoscopic, vaginal, or open). **Data extraction**: Two independent reviewers extracted data; outcomes pooled using RevMan 5.3. **Risk of bias tools**: RoB-2 (for RCTs), Newcastle-Ottawa Scale (for non-RCTs). **Outcomes:**	I	**24 studies**: 4 RCTs, 5 prospective, 15 database studies. **Total patients**: 1,116,665 (RAH: 110,306; Laparoscopy: 262,715; Vaginal: 189,237; Open: 554,407)	robotic-assisted hysterectomy (RAH)	laparoscopic, vaginal, and open hysterectomy	-	**Results:** When compared to laparoscopic surgery, RAH resulted in slightly reduced blood loss, lower transfusion and conversion rates, and a shorter hospital stay. Compared to open surgery, RAH offered substantial improvements in all outcomes, including fewer complications and shorter stays. While RAH and vaginal hysterectomy had fewer comparative studies, RAH was favored in patients with complex surgical histories. **RAH vs Laparoscopy**: • **Operative time**: No significant difference. • **Estimated blood loss (EBL)**: RAH lower by MD -52.31 mL (p = 0.03). • **Transfusion rate**: RAH lower; RD -0.0043 (95% CI: -0.0059 to -0.0027; p < 0.00001). • **Length of stay**: Shorter with RAH by MD -0.144 days (95% CI: -0.21 to -0.08; p < 0.0001). • **Stay >2 days**: Less frequent with RAH; OR = 0.67 (95% CI: 0.61-0.74; p < 0.0001). • **Conversion to open**: Less in RAH; RD -0.04 (95% CI: -0.06 to -0.01; p = 0.008). • **Readmission**: Slightly lower in RAH; OR = 0.90 (95% CI: 0.83-0.99; p = 0.03).

							• **Complications, mortality, reoperation**: No significant differences. **RAH vs Open**: • **Hospital stay**: Significantly shorter with RAH ($p < 0.00001$). • **Blood loss**: Significantly lower with RAH ($p = 0.009$). • **Complications**: Fewer in RAH; OR = 0.42 ($p = 0.0001$). **RAH vs Vaginal**: • **Used more in complex anatomy**: Larger uterus or surgical history. • **LOS**: Slightly shorter with RAH; MD -0.39 days ($p = 0.01$). **Author's conclusion:** RAH offers perioperative advantages over open and vaginal hysterectomy in terms of reduced complications, blood loss, and hospital stay. When compared with laparoscopy, most outcomes are similar, though RAH may slightly improve perioperative recovery metrics. However, differences between study types, lack of RCTs for RAH vs. open, and cost considerations remain limitations.

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8. Capozzi VA, Scarpelli E, Armano G, et al. Update of Robotic Surgery in Benign Gynecological Pathology: Systematic Review. Medicina. 2022;58(4):552.	**Systematic Review** **Aim:** To provide an updated synthesis of high-quality scientific evidence and recommendations regarding the use of robotic surgery (RS) in benign gynecologic pathologies. **Methods:** **Design: Systematic review** Databases Searched: PubMed, Web of Science, Scopus, from September 2021 to January 2022 <u>Inclusion Criteria:</u> Randomized Controlled Trials (RCTs) and large retrospective cohort studies Studies on robotic surgery for benign gynecological conditions <u>Exclusion Criteria:</u> Non-English, small sample size (<20), case reports, prospective non-RCTs **Outcomes:**	I	**Total Studies Included**: 22 **Types of Procedures**: • Myomectomy (8 studies) • Hysterectomy (5 studies) • Endometriosis (5 studies) • Pelvic organ prolapse (POP) treatment (4 studies) **Total Patients**: 269,728 • Myomectomy: 1,721 patients • Hysterectomy: 265,100 patients • Endometriosis: 1,527 patients • POP: 1,380 patients **Study Types**: 12 RCTs, 10 retrospective studies	robotic surgery (RS)		-	**Results:** RS generally showed longer operative times and higher costs but offered benefits like enhanced visualization, easier suturing, a shorter learning curve, and improved ergonomics. **Robotic Myomectomy (RM) Compared to Laparoscopic Myomectomy (LM):** • **Operative Time:** RM had longer operative time • **Estimated Blood Loss:** RM had significantly less blood loss (Mean Difference [MD] = -46.48 mL; 95% CI: -72.94 to -20.02). • **Complication Rate:** No significant difference (Odds Ratio [OR] = 0.89; 95% CI: 0.75-1.07). • **Conversion to Open Surgery:** Lower with RM; specific rate not provided. • **Pregnancy Outcomes:** Comparable between RM and LM. **Compared to Abdominal Myomectomy (AM):** • **Operative Time:** RM longer than AM. • **Blood Loss:** RM associated with less bleeding. • **Complication Rate:** RM had fewer complications.

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
							• **Hospital Stay:** Shorter in RM (MD = -0.36 days; 95% CI: -0.46 to -0.27). **Robotic Hysterectomy (RH) Compared to Laparoscopic Hysterectomy (LH):** • **Operative Time:** RH had significantly longer operative time (MD = 41.32 minutes; 95% CI: 22.29-60.35). • **Blood Loss, Complications, and Conversion Rates:** Generally similar; however, conversion to open surgery was lower in RH. • **Costs:** RH more costly than LH. **Compared to Vaginal and Abdominal Hysterectomy:** • **Blood Loss:** RH had lower blood loss compared to abdominal surgery. • **Hospital Stay:** RH had shorter hospital stays. **Robotic Endometriosis Surgery Compared to Conventional Laparoscopy (CL):** • **Operative Time:** Longer in robotic group. • **Blood Loss & Complications:** Similar between both techniques. • **Notes:** Robotic surgery may be more advantageous in deep infiltrating endometriosis due to better precision and ergonomics. **Robotic Pelvic Organ Prolapse Surgery Compared to Laparoscopic Sacrocolpopexy (LSC):**

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
							• **Operative Time & Costs:** Longer operative time and higher costs in robotic group. • **Complication Rate & Effectiveness:** Similar between approaches. **Author's conclusion:** Minimally invasive surgery, including RS, is recommended for benign gynecological conditions. While RS does not consistently outperform LPS in clinical outcomes, it facilitates broader access to MIS due to its ergonomic and technical advantages. Cost and operative time remain concerns, warranting careful consideration in clinical decision-making.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
9. Capozzi VA, Armano G, Rosati A, Tropea A, Biondi A. The robotic single-port platform for gynecologic surgery: a systematic review of the literature and meta-analysis. Updates Surg. 2021 Jun;73(3):1155-1167.	**Systematic Review and Meta-analysis** **Aim:** To evaluate the feasibility, safety, and outcomes of robotic single-site surgery (RSSS) in gynecology across benign, malignant, and mixed surgical indications. **Methods:** Design: Systematic review and meta-analysis (PRISMA-compliant). Search Date: June 2019. Databases: PubMed, Scopus, Google Scholar. Search terms: e.g., "robotic single-site surgery and gynecology". <u>Inclusion criteria:</u> • Articles in English • Studies with ≥10 patients Surgical indications: benign, malignant, or mixed Data extracted: Surgical type, indication, outcomes (operative time, EBL,	I	total of 27 studies were included in the systematic review and meta-analysis. These studies were categorized based on the surgical indication: Group 1 (Benign): 12 studies Total patients: 605 Group 2 (Malignant): 9 studies Total patients: 260 Group 3 (Mixed indications) (i.e., studies including both benign and malignant cases): 6 studies Total patients: 200 Total Patients Across All Groups: 1,065	robotic single-site surgery (RSSS)		-	**Results:** Results show that while robotic single-site surgery was safe and feasible for gynecologic indications, malignant cases were associated with longer operative times, more blood loss, longer hospital stays, and higher complication rates compared to benign cases. **Operative Time** • **Mean operative time**: ○ **Benign**: 137.2 minutes (±67.2) ○ **Malignant**: 181.6 minutes (±77.2) ○ **Mixed**: 153.8 minutes (±59.5) • **p = 0.001** → Statistically significant difference → Operative time was **longer for malignant cases**. **Estimated Blood Loss (EBL)** • **Mean EBL**: ○ **Benign**: 66.6 mL (±71.2) ○ **Malignant**: 92.8 mL (±88.4) ○ **Mixed**: 96.2 mL (±92.6) • **p = 0.005** → Statistically significant

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	conversion, hospital stay, complications, BMI). Analysis: Grouped studies into: Group 1: Benign (n=605) Group 2: Malignant (n=260) Group 3: Mixed (n=200) Meta-analysis using random-effects model Heterogeneity assessed with I^2						→ Higher blood loss in **malignant and mixed groups**. **Hospital Stay** • **Mean length of hospital stay**: ○ **Benign**: 1.6 days (±0.7) ○ **Malignant**: 2.1 days (±1.0) ○ **Mixed**: 2.2 days (±0.9) • **p = 0.002** → Statistically significant → Longer stay in **malignant and mixed groups**. **Conversion to Multiport or Open Surgery** • **Conversion rate**: ○ **Benign**: 1.5% ○ **Malignant**: 2.0% ○ **Mixed**: 2.5% • **p = 0.042** → Statistically significant → **Mixed group** had the **highest conversion rate**. **Complication Rate** • **Overall complications**: ○ **Benign**: 1.7% ○ **Malignant**: 6.2% ○ **Mixed**: 2.5%

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
							• **p = 0.001** → Statistically significant → **Malignant group** had a significantly **higher complication rate**. **Author's conclusion:** Authors concluded that **robotic single-port surgery is a feasible and safe approach** for a range of gynecologic indications, including **benign, malignant, and mixed pathologies**. Despite the higher **complication rates** observed in malignant cases, these were comparable to conventional surgical outcomes for similar indications. The authors emphasized that **robotic single-site surgery can be safely adopted** across various gynecologic procedures but highlighted the need for **further prospective studies**, particularly to validate **oncologic safety** in malignant cases and to better understand its long-term outcomes.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
10. Behbehani S, Suarez-Salvador E, Buras M et al. Mortality Rates in Benign Laparoscopic and Robotic Gynecologic Surgery: A Systematic Review and Meta-analysis. J Minim Invasive Gynecol. 2020;27(3):603-612.	**Systematic Review and Meta-analysis** **Aim:** To evaluate and compare the perioperative (30-day) mortality rates associated with benign gynecologic laparoscopic and robotic minimally invasive surgeries (MIS), and to analyze mortality by procedure type. **Methods:** Databases searched: PubMed, Embase, Scopus, Web of Science, Cochrane Time frame: Articles from the past 10 years (up to 2019) Languages included: English, French, German, Spanish, Italian <u>Inclusion criteria:</u> Original peer-reviewed studies reporting 30-day mortality from benign gynecologic MIS (laparoscopy or robotic-assisted) Mortality had to be separately reported for MIS procedures <u>Exclusion criteria:</u> Oncologic surgeries, case reports, reviews, <5 MIS	I	total of 21 studies were included, encompassing 124,216 patients undergoing benign minimally invasive gynecologic surgery.	robotic minimally invasive surgeries (MIS),	laparoscopic	-	**Results:** The overall mortality rate was low and similar between laparoscopic and robotic approaches. Mortality was stratified by procedure type, showing variations depending on complexity and patient demographics (e.g., higher in sacrocolpopexy likely due to older age). Most reported deaths were related to entry complications such as bowel or vessel injury. • **Overall mortality for all MIS (laparoscopy + robotics):** 1 in 6,456 (95% CI: 1 in 3,946 to 1 in 10,562) • **Laparoscopic surgery only:** 118,758 patients, 15 deaths → Mortality rate: 1 in 6,512 (95% CI: 1 in 3,971 to 1 in 10,680) • **Robotic surgery only:** 5,458 patients, 0 deaths reported CI for mortality: 1 in 5,430 (95% CI: 1 in 69 to 1 in 435,052) • **Hysterectomy (all MIS):** 119,721 patients, 15 deaths → 1 in 6,814 (95% CI: 1 in 4,119 to 1 in 11,275) • **Sacrocolpopexy (all MIS):** 864 patients, 0 deaths → 1 in 1,246 (95% CI: 1 in 36 to 1 in 44,700)

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	patients, mortality not exclusive to MIS or not within 30 days Risk of bias: Newcastle-Ottawa Scale (observational studies), Cochrane Risk of Bias (RCTs) Meta-analysis method: Random-effects model using inverse-variance method, CI calculated via Wilson score **Outcomes of interest:** • 30-day mortality rate following benign gynecologic MIS • Mortality stratified by surgical approach (laparoscopic vs robotic) • Mortality by procedure type (hysterectomy, sacrocolpopexy, adnexal surgery)						• **Adnexal surgery & diagnostic laparoscopy (MIS):** 1,960 patients, 0 deaths → 1 in 2,245 (95% CI: 1 in 45 to 1 in 113,372) **Author's conclusion:** Operative mortality in benign minimally invasive gynecologic surgery is very low and comparable between laparoscopic and robotic approaches. While rare, mortality should still be discussed during informed consent, especially given the nature of entry-related injuries. The findings support the safety of MIS in benign gynecology and provide benchmarks for counseling and policy development.

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11. Matanes E, Lauterbach R, Boulus S, Amit A, Lowenstein L. Robotic laparoendoscopic single-site surgery in gynecology: A systematic review. Eur J Obstet Gynecol Reprod Biol. 2018;231:1-7.	**Systematic Review** **Aim:** To review the development, feasibility, safety, and outcomes of robotic laparoendoscopic single-site surgery (R-LESS) in gynecology, covering both benign and malignant indications. **Methods:** Databases Searched: PubMed and ClinicalTrials.gov Search Timeline: 1990 to present (at time of review) Keywords: “robotic laparoscopic single incision”, “robotic laparoendoscopic single site”, “single incision robotic surgery”, “single-port robotic surgery” <u>Inclusion Criteria:</u> English-language full-text articles Human studies on R-LESS in gynecology Study types: RCTs, cohort studies, case series, and reports Selection Process: 1,127 articles retrieved → 452 after duplicates removed	I	36 studies included in consisted of: 6 comparative studies (Compared R-LESS to other surgical approaches like conventional multiport laparoscopy or laparoendoscopic single-site surgery [LESS]) 30 non-comparative studies (Primarily case series and case reports evaluating feasibility, safety, and outcomes of R-LESS) These studies covered a range of gynecologic procedures, including hysterectomy, myomectomy, sacrocolpopexy, adnexal surgery, endometriosis treatment, and oncologic procedures such as staging for endometrial and cervical cancer.	robotic laparoendoscopic single-site surgery (R-LESS)		-	**Results:** R-LESS was found to be a feasible and safe approach for a wide range of gynecologic procedures. It showed advantages in cosmetic outcomes, blood loss, and hospital stay, while operative time was often longer. ❑ **Benign hysterectomy**: • R-LESS vs LESS: longer operative time (170.9 vs 94.1 min), less EBL (20 vs 50 ml), shorter hospital stay (8 vs 20 hours), similar complication rates ❑ **Myomectomy**: • Operative time: 135–154 min; EBL: 57.9–182 ml; safe for large/multiple fibroids; no conversions ❑ **Pelvic floor surgery**: • Operative time: ~190 min; no major complications; learning curve noted ❑ **Endometriosis/cystectomy**: • Operative time: 45–127 min; minimal blood loss; used for complex cases ❑ **Malignancy**: • R-LESS oncologic outcomes (lymph node yield, surgical margins) comparable to conventional methods in early-stage endometrial and cervical cancers

	56 full-texts assessed → 36 studies included in the review **Outcomes of interest**: • Operative time • Estimated blood loss (EBL) • Length of hospital stay • Conversion to laparotomy or multi-port laparoscopy • Intra- and postoperative complication rates • Cosmetic outcomes • Oncologic outcomes (e.g. surgical margins, lymph node retrieval in malignant cases)						• In some cases, R-LESS had reduced cost due to fewer instruments and shorter hospital stay **Author's conclusion:** Robotic single-site surgery in gynecology is **technically feasible, safe, and cosmetically advantageous**, especially in benign conditions. Although early data on oncologic applications are promising, **more robust comparative trials** are needed to confirm its long-term efficacy and broader adoption.

Evidence Table : Efficacy/ safety/ organisational (TCDS - SCHIZOPRENIA)
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
12. Morelli L, Guadagni S, Di Franco G, et al. Da Vinci single site© surgical platform in clinical practice: a systematic review. Int J Med Robotics Comput Assist Surg. 2016;12(4):724-734.	Systematic Review **Aim:** To summarize available evidence on the clinical application of the Da Vinci Single-Site® Surgical Platform (DVSSP) in general surgery, urology, and gynecology. **Methods:** **Methods** • Literature search in PubMed from inception to June 2015 • Keywords: "robotic single site surgery", "robotic single port surgery", "robotic single incision surgery", "robotic laparoendoscopic single site surgery" • Inclusion: Clinical studies using DVSSP in general surgery, urology, or gynecology • Exclusion: Studies not using DVSSP or not reporting original data • Data extracted: ○ Number of cases	I	Total of 29 studies General Surgery: 15 studies (561 procedures) Urology: 4 studies (48 procedures) Gynecology: 10 studies (212 procedures)	the Da Vinci Single-Site® Surgical Platform (DVSSP)			**Results:** The Da Vinci Single-Site® platform is feasible and safe across specialties. Most commonly applied in cholecystectomy, hysterectomy, and pyeloplasty. The primary advantages included improved ergonomics and reduced external collisions. However, technical limitations—such as lack of EndoWrist® articulation, limited instrument range, and long cannula length—posed challenges, especially in complex surgeries. **General Surgery** • Cholecystectomy most common (545 cases); OR time ~60-107 min • Low conversion and complication rates • Operative time was shorter than single-incision laparoscopy in some studies • One splenectomy and a few colectomies reported • Pediatric use in 17 cases: safe and feasible **Urology** • Procedures: pyeloplasty, radical and partial nephrectomy (48 cases) • Safe and reproducible

	○ BMI ○ Operative time ○ Conversion rate ○ Complications (graded via Clavien-Dindo classification) ○ Length of hospital stay ○ Technical notes and limitations						• Limitations: lack of wrist articulation, assistant space issues, difficulty with complex dissection **Gynecology** • Procedures: hysterectomy, myomectomy, adnexal surgery (212 cases) • Feasible for benign and some malign gynecological conditions • Common issue: vaginal cuff closure due to instrument rigidity • Reported improved ergonomics, reduced scarring, and acceptable operative times **Authors' conclusion:** The DVSSP system is a valuable addition to single-site robotic surgery, offering advantages such as improved ergonomics and instrument triangulation. Its main limitation is the lack of wristed instrumentation. Although safe and feasible in selected procedures, particularly in gynecology, further prospective and comparative studies are needed to determine its definitive advantages over multiport robotic or standard laparoendoscopic approaches.

Evidence Table : Efficacy/ safety/ organisational (TDCS - SCHIZOPRENIA)
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13. Gala RB, et al. Systematic Review of Robotic Surgery in Gynecology: Robotic Techniques Compared With Laparoscopy and Laparotomy. Journal of Minimally Invasive Gynecology. 2014;21(3):353-361.	Systematic Review **Aim:** To compare robotic-assisted gynecologic surgeries with conventional laparoscopic, abdominal, and vaginal techniques across both benign and malignant indications, focusing on surgical outcomes, patient-centered outcomes, costs, and adverse events. **Methods:** □ Literature search in MEDLINE and Cochrane Central (until May 2012) ❑Inclusion criteria: English-language studies with ≥30 robotic-assisted gynecologic procedures ❑Study types: RCTs, prospective/retrospective comparative studies, and case series ❑ Outcomes of interest**:** • Surgical success • Operative time • Length of stay • Blood loss		❑ **30 comparative studies** (RCTs and observational) ❑ **14 non-comparative studies** for adverse events	robotic-assisted gynecologic surgeries	conventional laparoscopic, abdominal, and vaginal techniques		Results: • Robotic surgery generally resulted in **shorter hospital stays** and **less blood loss** than open surgery. • For **endometrial cancer**, robotic approaches had similar or better perioperative outcomes compared to laparoscopy or laparotomy. • **Operative time** was generally longer with robotics, but findings varied by study and surgeon experience. • **Learning curve** for robotic surgery was shorter than laparoscopy in several reports. • **Costs** varied; robotic was less costly than laparotomy in some studies but more than laparoscopy. • Evidence comparing robotic vs laparoscopic approaches was **inconsistent**. **Robotic vs Laparoscopy for Endometrial Cancer**

	• Cost • Number of lymph nodes retrieved • Surgical learning curve □Dual independent screening and data extraction □Study quality graded using AHRQ criteria (A, B, C) □GRADE used to assess evidence strength □No meta-analysis due to heterogeneity						• **Length of Stay**: Reduced (e.g., 1.02 vs 1.27 days, p=0.01 – Gehrig et al.) • **Operative Time**: Mixed results (e.g., 237 vs 178 min, p<0.001 – Cardenas-Goicoechea et al.) • **Blood Loss**: Significantly less in robotic (e.g., 50 vs 150 mL, p<0.001 – Gehrig et al.) • **Lymph Nodes**: Variable, with no consistent difference **Robotic vs Laparotomy for Endometrial Cancer** • **Length of Stay**: Consistently shorter (e.g., 2.3 vs 4.0 days – Bell et al.) • **Operative Time**: Often longer with robotics • **Blood Loss**: Much lower in robotic group (e.g., 166 vs 316 mL – Bell et al.) • **Cost**: Robotics cheaper than laparotomy in some models (e.g., $8,212 vs $12,944 - Bell et al.) Authors' conclusion: Robotic surgery offers **advantages over open surgery**, particularly for **endometrial cancer**, with shorter length of stay and less blood loss. However, comparisons with **laparoscopy** yield **conflicting results**. The choice between minimally invasive methods should be individualized based on **patient characteristics**, **surgeon expertise**, and **resource availability**. High-quality comparative data are still needed to guide recommendations.

Evidence Table : Efficacy/ safety/ organisational (TDCS – SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Huang WR, Ou XY, Fang XZ et al. Comparing robotic, laparoscopic, and laparotomy in endometrial cancer: a network meta-analysis. Int J Surg. 2025;111(2):2208-2215.	Systematic Review and Meta-Analysis **Aim:** To compare the effectiveness and safety of robotic-assisted surgery (RAS), laparoscopy (LPS), and laparotomy (LPT) in patients with endometrial cancer (EC). The focus was on perioperative outcomes, lymph node dissection, and long-term survival outcomes. **Methods:** The authors searched eight major databases for randomized controlled trials and cohort studies involving RAS, LPS, and LPT for EC, resulting in the inclusion of 37 studies (4 RCTs and 33 cohort studies) with a total of 6,558 participants. Bayesian NMA was conducted using MCMC methods, and study quality was assessed using the Cochrane tool for RCTs and Newcastle-Ottawa Scale for cohort studies.		37 studies (4 RCTs and 33 cohort studies) with a total of 6,558 participants	robotic-assisted surgeries	conventional laparoscopic, laparotomy		**Results:** **<u>Perioperative outcomes</u>** RAS showed significant advantages over LPT in reducing estimated blood loss (MD -193 mL), hospital stay (MD -3.8 days), transfusion rate, intraoperative and postoperative complications. No significant differences were found between RAS and LPS. Estimated Blood Loss (EBL): RAS significantly reduced blood loss compared to LPT (Mean Difference [MD] = -193.17 mL; 95% Confidence Interval [CI]: -279.38 to -106.95). Hospital Stay: RAS had shorter hospital stays than LPT (MD = -3.84 days; 95% CI: -5.37 to –2.31). Transfusion Rate: RAS had lower transfusion rates than LPT (Odds Ratio [OR] = 0.13; 95% CI: 0.06 to 0.28). Intraoperative Complications: RAS had significantly fewer intraoperative complications than LPT (OR = 0.23; 95% CI: 0.06 to 0.80).

							Postoperative Complications: RAS had fewer postoperative complications than LPT (OR = 0.29; 95% CI: 0.18 to 0.51). Total Complications: RAS showed reduced total complications compared to LPT (OR = 0.24; 95% CI: 0.10 to 0.61). **Lymph node dissection:** No significant differences among RAS, LPS, and LPT in the number of pelvic or para-aortic lymph nodes retrieved. **Survival outcomes:** No significant differences between RAS, LPS, and LPT in recurrence rate, 5-year disease-free survival (DFS), or 5-year overall survival (OS). **Authors' conclusion:** Robotic-assisted surgery is associated with significantly improved perioperative outcomes, particularly compared to laparotomy, with reduced blood loss, complications, and hospital stay. However, no superiority in survival outcomes was observed. RAS may be considered the most effective approach perioperatively, though long-term oncologic benefits require further investigation.

Evidence Table : Efficacy/ safety/ organisational (TDCS – SCHIZOPRENIA)
Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Yuan Y, Tan Q, Chen Y, Zhu K et al. Different surgical methods of hysterectomy for the management of endometrial cancer: a systematic review and network meta-analysis. Front Oncol. 2025;14:1524991.	Systematic Review and Network Meta-Analysis **Aim:** To compare the efficacy and safety of four types of hysterectomy—open hysterectomy (OH), laparoscopic hysterectomy (LH), robotic hysterectomy (RH), and laparoscopic-assisted vaginal hysterectomy (LAVH)—in treating endometrial cancer (EC). **Methods:** -Studies included: 30 studies (18 RCTs and 12 high-quality observational studies), total n = 13,446 Outcomes assessed: • Efficacy: Disease-Free Survival (DFS), Overall Survival (OS), number of pelvic and para-aortic lymph nodes retrieved • Safety: Intraoperative and postoperative complications, operative time		30 studies (18 RCTs and 12 high-quality observational studies), total n = 13,446	Robotic hysterectomy	open hysterectomy (OH), laparoscopic hysterectomy (LH), laparoscopic-assisted vaginal hysterectomy (LAVH)		**Results:** □ Survival Outcomes: No significant difference in DFS or OS among the four methods. • LH had the highest SUCRA for DFS (0.81) and OS (0.87) • RH had the lowest for both DFS (0.21) and OS (0.26) ❑ Lymph Node Retrieval: • OH retrieved more pelvic lymph nodes than RH (MD = 4.30, 95% CI: 1.33–7.41) • No significant difference in para-aortic node retrieval ❑ Complications: • RH had fewer postoperative complications than OH (OR = 2.16, 95% CI: 1.58–3.14) • OH had lower intraoperative complication rates than LH (OR = 0.76, 95% CI: 0.60–0.95) • RH had highest SUCRA for postoperative safety (0.95), OH the lowest (0.01) ❑ Operative Time: • OH had the shortest, LAVH the longest

	Analysis: Bayesian NMA with Surface Under the Cumulative Ranking Curve (SUCRA) values to rank surgical methods Risk of Bias: Cochrane RoB 2 for RCTs, NOS for observational studies (included if NOS ≥ 7)						• RH vs. OH: MD = 26.53 min (95% CI: 20.31–32.76) ❑ Uterine Manipulator: • Subgroup analysis showed manipulators had no significant effect on DFS, but some trends suggested worse outcomes with use. **Authors' conclusion:** ❑ While all four methods are comparable in DFS and OS, each has unique strengths: • **OH**: Best for operative time and pelvic lymph node dissection, but worst for postoperative complications. • **LH**: Best for DFS and OS, good for para-aortic lymph node dissection. • **RH**: Best for minimizing postoperative complications, but limited in lymph node retrieval and long-term outcomes. • **LAVH**: Advantage in para-aortic node retrieval, but longest surgery time. ❑ Recommends careful selection of surgical approach based on individual patient needs and clinical context.

Evidence Table : Efficacy/ safety/ organisational (TDCS - SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Natarajan P, Delanerolle G, Dobson L et al. Surgical Treatment for Endometrial Cancer, Hysterectomy Performed via Minimally Invasive Routes Compared with Open Surgery: A Systematic Review and Network Meta-Analysis. Cancers (Basel). 2024;16(10):1860.	Systematic Review and Network Meta-Analysis **Aim:** To compare clinical and oncological outcomes **of** robotic-assisted surgery (RS), laparoscopic surgery (LRS), and open surgery (OS) in the treatment of early-stage endometrial cancer (FIGO stage I-II). **Methods:** Literature was searched from 1995 to 2021 across PubMed, EMBASE, Science Direct, and ISRCTN. A total of 99 studies were included in the network meta-analysis (5 RCTs and 94 cohort studies), comprising 181,716 women. 14 outcomes were assessed including blood loss, operative time, hospital stay, lymph node yield, complications, recurrence, and disease-free survival (DFS). Risk of bias was assessed using the Newcastle-Ottawa Scale (NOS); 80 studies were low risk, 15 high risk.		A total of 99 studies were included in the network meta-analysis (5 RCTs and 94 cohort studies), comprising 181,716 women.	robotic-assisted surgeries	conventional laparoscopic, laparotomy		**Results:** Blood Loss: RS had significantly reduced blood loss vs OS (MD −257.2 mL, 95% CrI −351.2 to −163.8); and vs LRS (MD −30.33 mL, 95% CrI −122.2 to 61.62, not significant). Hospital Stay: RS shortened stay vs OS (MD −3.79 days, 95% CrI −4.79 to −2.79); difference with LRS not significant. Operative Time: RS had longer surgery than OS (MD 29.00 min, 95% CrI 13.66 to 44.23); difference with LRS not significant. Total Intraoperative Complications: RS vs OS (OR 0.39, 95% CrI 0.18 to 0.78); RS vs LRS (OR 0.38, 95% CrI 0.17 to 0.75). Ileus: RS vs OS (OR 0.18, 95% CrI 0.08 to 0.41); RS vs LRS (OR 0.40, 95% CrI 0.17 to 0.87). Total Postoperative Complications: RS vs OS (OR 0.46, 95% CrI 0.27 to 0.78). Disease-Free Survival: RS vs OS (OR 3.29, 95% CrI 1.46 to 8.36); RS vs LRS (OR 2.45, 95% CrI 1.04 to 6.34).

							Recurrence: LRS vs OS (OR 0.64, 95% CrI 0.47 to 0.84); RS vs OS (OR 0.64, 95% CrI 0.35 to 1.19, not significant). **Authors' conclusion:** ❑ Robotic-assisted surgery (RS) provided the most favourable perioperative outcomes (less blood loss, shorter hospital stay, fewer complications) and superior disease-free survival compared to both LRS and OS. ❑ However, RS had longer operative time, and meta-regression suggested that the early superiority in complication rates may be diminishing over time due to learning curves and surgeon variability. ❑ The authors recommend robotic surgery as a viable and possibly superior option for early-stage EC but stress the need for cautious interpretation due to evolving trends and limited causal inference from observational data.

Evidence Table : Efficacy/ safety/ organisational (TDCS – SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Fu H, Zhang J, Zhao S, He N. Survival outcomes of robotic-assisted laparoscopy versus conventional laparoscopy and laparotomy for endometrial cancer: A systematic review and meta-analysis. Gynecol Oncol. 2023;174:55-67.	Systematic Review and Meta-Analysis **Aim:** To compare long-term survival outcomes of robotic-assisted laparoscopy (RALS) with conventional laparoscopy (CLS) and laparotomy (LT) in patients with endometrial cancer. **Methods:** A comprehensive search was performed across PubMed, EMBASE, Web of Science, and the Cochrane Library up to May 2022. Twenty-one retrospective cohort studies were included, involving 164,999 patients (RALS: 77,662; CLS: 32,826; LT: 54,511). Primary outcomes included overall survival (OS), recurrence-free survival (RFS), and disease-specific survival (DSS). Pooled hazard ratios (HR) with 95% confidence intervals (CI) were calculated using fixed or random-effects models.		Twenty-one retrospective cohort studies were included, involving 164,999 patients (RALS: 77,662; CLS: 32,826; LT: 54,511).	robotic-assisted surgeries	conventional laparoscopic, laparotomy		**Results:** **RALS vs CLS:** OS: HR = 0.962 (95% CI: 0.922-1.004) → no significant difference RFS: HR = 1.096 (95% CI: 0.947-1.296) → no significant difference DSS: HR = 1.489 (95% CI: 0.713-3.107) → no significant difference **RALS vs LT:** OS: HR = 0.682 (95% CI: 0.576-0.807) → significantly better with RALS RFS: HR = 0.793 (95% CI: 0.653-0.964) → significantly better with RALS DSS: HR = 0.441 (95% CI: 0.298-0.652) → significantly better with RALS Subgroup analysis indicated that in early-stage endometrial cancer, RALS had similar OS but slightly worse RFS than CLS (HR = 1.378; 95% CI: 1.102-1.724). **Authors' conclusion:** RALS provides long-term survival outcomes that are equivalent to CLS and superior to LT, supporting its oncologic safety in the surgical management of endometrial cancer.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Ontario Health (Quality). Robotic-Assisted Hysterectomy for Endometrial Cancer in People With Obesity: A Health Technology Assessment. Ont Health Technol Assess Ser. 2023;23(6):1-70.	HTA **Aim:** To evaluate the effectiveness, safety, cost-effectiveness, and budget impact of robotic-assisted hysterectomy (RH) for endometrial cancer in individuals with obesity (BMI ≥ 30 kg/m²). It also explores patient and provider perspectives. **Methods:** Clinical evidence was drawn from one included systematic review. Economic evidence was based on two studies (one retrospective, one prospective). A 5-year budget impact analysis was conducted. Patient and provider engagement was carried out via interviews to understand values and preferences. Quality assessments used GRADE, IHE, and Newcastle-Ottawa Scale for risk of bias.		robotic-assisted hysterectomy (RH)	robotic-assisted surgeries	conventional laparoscopic, laparotomy		**Results:** **Clinical Effectiveness and Safety** Conversion to open surgery was lower in RH (3.8%) compared to laparoscopic hysterectomy (LH) (7.0%) for BMI ≥ 40 kg/m². Perioperative complication rates were low (≤ 3.5%) and similar between RH and LH. Risk of bias was deemed moderate to high due to the retrospective nature and limitations in many studies. **Cost-Effectiveness** RH was found to be more costly than LH or open hysterectomy. A study estimated RH to cost $1,385 to $1,507 more per case, depending on volume and what was included in cost assumptions. RH was not cost-effective unless surgical volumes exceeded 350 cases per year and excluded system purchase costs. **Budget Impact** Estimated additional cost to Ontario of publicly funding RH for people with endometrial cancer and obesity: $1.14 million over 5 years. Costs highly sensitive to volume and robotic disposable costs.

							Preferences and Values Patients and providers reported favourably on RH, citing benefits like faster recovery and surgical precision. Providers viewed RH as especially valuable in patients with morbid obesity, where LH can be challenging. **Authors' conclusion:** Robotic-assisted hysterectomy is clinically beneficial for individuals with obesity, particularly in reducing conversions to open surgery and enabling minimally invasive procedures. However, evidence quality is low, and cost-effectiveness remains uncertain. Public funding would incur additional expenses, and value depends on institutional volume and infrastructure.

Evidence Table : Efficacy/ safety/ organisational (TDCS – SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Chang CL, Chen CH, Yang SS, Chang SJ. An updated systematic review and network meta-analysis comparing open, laparoscopic and robotic-assisted sacrocolpopexy for managing pelvic organ prolapse. J Robot Surg. 2022;16(5):1037-1045.	Systematic Review and Network Meta-Analysis **Aim:** To compare the efficacy and safety of three surgical approaches–open sacrocolpopexy (OSC), laparoscopic sacrocolpopexy (LSC), and robotic-assisted sacrocolpopexy (RSC)–in treating pelvic organ prolapse (POP). **Methods:** Databases Searched: MEDLINE, Embase, Science Direct, Google Scholar (until April 2021). Inclusion Criteria: Only randomized controlled trials (RCTs) comparing any two of the three surgical approaches. Studies Included: 6 RCTs with a total of 486 participants. Outcomes Assessed: Operative time, estimated blood loss (EBL), overall postoperative complications, and anatomical outcomes using POP-Q points Ba, Bp, and C.		6 RCTs with a total of 486 participants.	robotic-assisted surgeries	conventional laparoscopic, laparotomy		**Results:** **<u>Operative Time:</u>** OSC had the shortest operative time. Mean difference (RSC vs LSC): 43.76 min (95% CI: 19.99 to 67.53, p = 0.0003). LSC vs OSC: 10.08 min (95% CI: 6.56 to 13.61, p < 0.00001). **<u>Estimated Blood Loss (EBL):</u>** OSC had the most blood loss. LSC vs OSC: MD = −133.42 mL (95% CI: −195 to −71.84, p < 0.0001). No significant difference between RSC and LSC: MD = −2.78 mL (95% CI: −15.67 to 10.11, p = 0.67). **<u>Overall Postoperative Complications:</u>** LSC had the lowest complications, followed by RSC, then OSC. LSC vs OSC: OR = 0.66 (95% CI: 0.36-1.21). RSC vs LSC: OR = 1.17 (95% CI: 0.31-4.45), not statistically significant. **<u>Anatomical Outcomes (POP-Q):</u>** Point Ba: LSC ranked highest.

	Risk of Bias Tool: Cochrane Collaboration Risk of Bias tool.						Points Bp & C: RSC ranked highest. No statistically significant differences between RSC and LSC for anatomical points. **Authors' conclusion:** Despite longer operative times, both RSC and LSC offered better anatomical outcomes, reduced estimated blood loss, and fewer postoperative complications compared to OSC. However, the differences between RSC and LSC were not statistically significant in terms of efficacy and safety.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size

14. Yang J, He Y, Zhang X et al. Robotic and laparoscopic sacrocolpopexy for pelvic organ prolapse: a systematic review and meta-analysis. Ann Transl Med. 2021;9(6):449.	Systematic Review and Meta-Analysis
	
	Aim:
	To evaluate and compare the clinical efficacy and safety of robotic-assisted sacrocolpopexy (RSC) versus laparoscopic sacrocolpopexy (LSC) in the treatment of pelvic organ prolapse (POP), and to assess perioperative outcomes, complications, and recurrence rates.
	
	Methods:
	Databases: PubMed, Scopus, EMBASE, CNKI, WanFang, and Cochrane Library up to 1st March 2020.
	
	Included: 49 studies (18 comparative between RSC and LSC; 31 single-arm RSC studies).
	
	Population: Women undergoing sacrocolpopexy for POP.
	
	Outcomes: Operative time, blood loss, complications, conversion rate, transfusions, hospital stay, recurrence, and reoperation.
			49 studies with a total of 3,014 patients	robotic-assisted sacrocolpopexy (RSC)	laparoscopic sacrocolpopexy (LSC)		**Results:**
							RSC Outcomes (n = 2,916):
							• **Median operative time:** 226 minutes (range 90-604)
							• **Estimated blood loss:** 56 mL (range 5-1,500)
							• **Hospital stay:** 1.55 days (range 1-16)
							• **Intraoperative complications:** 2.7%
							  ○ Most common: bladder injury (1.3%), bowel injury (0.3%)
							• **Postoperative complications:** 13%
							  ○ Most common: urinary dysfunction (40%), mesh erosion (2.09%), ileus (13%)
							• **Conversion rate:** 1.4%
							• **Recurrence of prolapse:** 7.2%
							Comparison with LSC:
							• **Significantly lower blood loss:** WMD = −58.48 mL (95% CI: −100.58 to −16.39; p = 0.006)
							• **Lower conversion rate:** OR = 0.35 (95% CI: 0.15-0.79; p = 0.01)
							• **Longer operative time:** WMD = 37.35 minutes (95% CI: 24.46-50.24; p < 0.00001)
							• **No significant difference in:** transfusion rate, intra/postoperative complications, or recurrence.

	Risk of bias was assessed using the Joanna Briggs Institute (JBI) tool and the MINORS index (studies with score ≥18 included in meta-analysis). Analysis used RevMan 5.3 and Stata 12.						**Authors' conclusion:** Robotic sacrocolpopexy (RSC) offers certain perioperative advantages over laparoscopic sacrocolpopexy, particularly in reducing blood loss and conversion rates, but with longer operative time. Both techniques achieve comparable safety and effectiveness. However, study heterogeneity and limited high-quality RCTs underscore the need for further well-designed trials to confirm long-term outcomes.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Callewaert G, Bosteels J, Housmans S et al. Laparoscopic versus robotic-assisted sacrocolpopexy for pelvic organ prolapse: a systematic review. Gynecol Surg. 2016;13:115-123	Systematic Review **Aim:** To compare laparoscopic sacrocolpopexy (LSC) and robotic-assisted sacrocolpopexy (RASC) in women with pelvic organ prolapse (POP), focusing on surgical outcomes, cost-effectiveness, and patient-reported outcomes. **Methods:** Databases searched: Cochrane Library, MEDLINE, EMBASE, ClinicalTrials.gov, and ICTRP (up to January 2015). Inclusion criteria: Only RCTs comparing LSC and RASC as the primary surgical intervention. Included studies: Two RCTs (Paraiso 2011 and Anger 2014), total of 78 patients. Outcomes assessed: Operation time, cost, complications, pain, anatomical outcomes, pelvic floor function, and quality of life. Risk of bias assessment: Cochrane tool, both trials had low to moderate risk of bias.		Two RCTs (Paraiso 2011 and Anger 2014), total of 78 patients.	robotic-assisted sacrocolpopexy (RSC)	laparoscopic sacrocolpopexy (LSC)		**Results:** **Operating Time:** • Paraiso (2011): LSC significantly faster than RASC (199±46 min vs. 265±50 min, p<0.001). • Anger (2014): No significant difference (225.5±62.3 vs. 246.5±51.3 min, p=0.11). **Costs:** • RASC was consistently more expensive in both studies. • ACCESS Trial (Anger): Cost excluding robot purchase was not significantly different; including robot purchase: LSC USD 11,573 vs. RASC USD 19,616, p<0.001. • Paraiso Study: Even excluding robot cost, RASC was more expensive: LSC USD 14,342 vs. RASC USD 16,278, p=0.008. **Pain:** • RASC associated with more postoperative pain and longer NSAID use. • Paraiso: NSAID use – 11 vs. 20 days, p<0.005. • Anger: Higher pain scores in RASC in first week.

							Clinical Outcomes: • No difference in complications, anatomical outcomes, or patient satisfaction between LSC and RASC. • RASC had 3 conversions (1 to laparotomy, 2 to LSC); LSC had none. **Authors' conclusion:** Both techniques are similarly effective and safe for POP repair, but RASC incurs significantly higher costs without measurable clinical benefits. The sustainability of RASC hinges on reducing its cost. Ergonomic and training advantages of RASC may still warrant its selective use, but widespread adoption should be approached cautiously unless cost barriers are addressed.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Hudson CO, Northington GM, Lyles RH, Karp DR. Outcomes of robotic sacrocolpopexy: a systematic review and meta-analysis. Female Pelvic Med Reconstr Surg. 2014 Sep-Oct;20(5):252-60.	Systematic Review and Meta-Analysis **Aim:** To evaluate the effectiveness and safety of robotic-assisted laparoscopic sacrocolpopexy (RSC) for the treatment of apical pelvic organ prolapse (POP), focusing on studies that reported ≥6 months of anatomical outcomes. **Methods:** Data Sources: MEDLINE search with predefined inclusion/exclusion criteria (up to December 2012). Selection: 13 studies were included (1 RCT, 5 prospective cohorts, 7 retrospective cohorts), totaling 577 women with POP-Q Stage ≥2. Outcomes Assessed: Primary outcome was apical anatomical success (POP-Q ≤ Stage 1). Other outcomes included operative time, estimated blood loss (EBL), complication rates, mesh exposure/erosion, and reoperation rates. Analysis: Random effects meta-analysis for objective outcomes.		13 studies were included (1 RCT, 5 prospective cohorts, 7 retrospective cohorts), totaling 577 women with POP-Q Stage ≥2	robotic-assisted laparoscopic sacrocolpopexy (RSC)			**Results:** **Anatomical Cure Rate:** 98.6% (95% CI: 97.0%-100%). **Mesh Exposure/Erosion Rate:** 4.1% (95% CI: 1.4%-6.9%). **Reoperation Rate for Mesh Revision:** 1.7%. **Reoperation for Recurrent Prolapse:** Apical prolapse 0.8%, non-apical prolapse 2.5%. **Most Common Complications:** Cystotomy (2.8%), wound infection (2.4%). **Operative Time:** Weighted mean 235 minutes. **Estimated Blood Loss:** Weighted mean 82.5 mL. **Conversion to Laparotomy:** 3.2%. **Hospital Stay:** Weighted mean 2.4 days. **Authors' conclusion:** Robotic sacrocolpopexy is a safe and effective treatment for apical prolapse with a high anatomic cure rate and low complication rates at medium-term follow-up. However, variability in study designs and reporting quality, as well as lack of long-term data, warrant cautious interpretation.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Dubois A, Haudebert C, Richard C, Penafiel J et al. Impact of Robotic Artificial Urinary Sphincter Implantation in Female Patients on Quality of Life and Patient-reported Outcomes. Eur Urol Focus. 2025:S2405-4569(24)00261-X.	Cohort study **Aim:** To evaluate the functional outcomes and quality of life following robotic artificial urinary sphincter (AUS) implantation in women using validated patient-reported outcome measures (PROMs). **Methods:** Eligibility: Women with severe SUI and ISD who opted for robotic AUS. Assessments: PROMs: Urinary Symptoms Profile (USP), International Consultation Incontinence Questionnaire Short Form (ICIQ-SF), and Patient Global Impression of Improvement (PGII). Continence status and complications were recorded. Surgical Approach: Transperitoneal robotic-assisted anterior approach. Follow-up: PROMs collected at 3, 6, and 12 months post-op.		101 female patients with stress urinary incontinence (SUI) due to intrinsic sphincter deficiency (ISD).	robotic artificial urinary sphincter (AUS) implantation			**Results:** • **Demographics:** ○ Median age: 66 years. ○ 91.1% had prior anti-incontinence surgery; 70.3% had midurethral slings. • **Perioperative Data:** ○ Mean operative time: 156.8 min. ○ Mean estimated blood loss: 89.1 mL. ○ Intraoperative complications: 17.8% (mostly vaginal and bladder injuries). ○ Postoperative complications: 26.7% (9% Clavien-Dindo grade III). • **Functional Outcomes (at 3 months):** ○ USP SUI subscore: decreased from 7.3 to 0.8 ($p < 0.001$). ○ ICIQ-SF: from 16.5 to 3.1 ($p < 0.001$). ○ ICIQ-QoL: from 8.7 to 0.9 ($p < 0.001$). ○ Pad usage: median reduced from 4 to 0 pads/day ($p < 0.001$).

	Statistical Analysis: Paired t-tests and chi-square tests; $p < 0.05$ considered significant. .						○ PGII Score: 72.8% reported being "very much improved." • **Continence at 3 months:** ○ Complete: 67.3%, Improved: 21.8%, Unchanged: 10.9%. • **Device Outcomes:** ○ Explantation: 9.9%, Revision: 8.9%. ○ Causes: erosion, infection, pump malfunction. **Authors' conclusion:** Robotic AUS implantation in women with SUI significantly improves continence and quality of life, with favorable patient-reported outcomes. While complication rates are not negligible, most are manageable. The study supports the use of robotic AUS, but emphasizes the need for clear preoperative counseling and longer-term follow-up.

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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
14. Estaphanous P, Khalifa AO. Efficacy and Safety of Artificial Urinary Sphincters in Female Patients With Stress Urinary Incontinence: A Systematic Review and Meta-Analysis. Cureus. 2024;16(11):e73136.	Systematic review and meta-analysis. **Aim:** To evaluate the effectiveness and safety of artificial urinary sphincter (AUS) implantation in female patients with stress urinary incontinence (SUI) by examining continence, revision, explantation, and complication rates. **Methods:** Databases searched: PubMed, Scopus, Google Scholar, Cochrane Library (September 2024). Inclusion: Studies on adult females with SUI undergoing AUS implantation, reporting on continence, revision, explantation, and complications, with ≥6 months follow-up. Quality assessment: MINORS tool. Statistical analysis: Fixed-effects model; outcomes reported as ORs with 95% CIs; heterogeneity assessed using I^2.		8 studies with a total of 300 women	Robotic AUS implantation			**Results:** Overall continence rate: 72% (OR: 0.01, 95% CI: 0.00–0.02, $p < 0.00001$). Revision rate: 22.5% (OR: 0.04, 95% CI: 0.01–0.15, $p < 0.00001$). Explantation rate: 17.6% (OR: 0.08, 95% CI: 0.03–0.21, $p < 0.00001$). Postoperative complication rate: 26.3% (OR: 0.03, 95% CI: 0.01–0.11, $p < 0.00001$). Common complications: urinary retention (4.7%), erosions (4.3%), infections (6.3%), other (11%). **Key Robotic Subgroup Findings** • Robot-assisted AUS achieved **81.6% continence**. • Lower revision (6.1%) and explantation (2.1%) rates. • Lower complication rate (18.3%) than open techniques.

							Authors' conclusion: AUS implantation is a safe and effective second-line treatment for female SUI, particularly when other treatments fail. Robotic-assisted approaches show promising perioperative outcomes. However, given moderate complication and revision rates, larger long-term studies are needed to validate these findings and assess cost-effectiveness.

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Question : What is the effectiveness, safety, and cost-effectiveness of Robotic-Assisted Surgery for Gynaecological Disorders?

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14. Yuanzhuo C, Liao P, Chi Z et al. Efficacy and Safety of Robot-assisted AUS Implantation Surgery in Treating Severe Stress Urinary Incontinence: A Systematic Review and Meta-Analysis. Urology. 2023;171:88-95.	Systematic review and meta-analysis. **Aim:** To assess the efficacy and safety of robot-assisted artificial urinary sphincter (AUS) implantation in female patients with severe stress urinary incontinence (SUI) due to intrinsic sphincter deficiency (ISD). **Methods:** Databases searched: PubMed, EMBASE, Web of Science, Cochrane Library, ClinicalTrials.gov up to March 2022. Inclusion: 9 studies (8 retrospective, 1 prospective) involving 157 women. Risk of Bias Assessment: MINORS tool for non-randomized studies; overall studies rated moderate to high quality. Statistical analysis: Fixed or random effects model based on heterogeneity (I^2). Subgroup analysis conducted for surgical approaches (traditional vs posterior).		9 studies (8 retrospective, 1 prospective) involving 157 women.	Robotic AUS implantation			**Results:** • **Continence rate:** ○ **Pooled continence rate: 83% (95% CI: 0.76–0.89)** ○ **No statistical heterogeneity observed (I^2 = 0%).** • **Intraoperative complications:** ○ **Rate: 21% (95% CI: 11%–34%)** ○ **Most common: vaginal and bladder injuries.** • **Postoperative complications:** ○ Rate: 20% (95% CI: 12%-29%) ○ Most common: acute urinary retention. • **Subgroup analysis:** ○ Traditional approach had slightly lower complication rates than posterior approach. ▪ Intraoperative: 19% vs 23% ▪ Postoperative: 13% vs 32% ○ Continence rates were comparable between both approaches.

							Authors' conclusion: Robot-assisted AUS implantation in women with severe SUI appears to offer high short-term continence rates (83%), but is associated with relatively high complication rates, particularly intraoperative injuries and acute urinary retention. Variability in techniques and limited long-term data warrant further large-scale, prospective research to confirm safety and efficacy.

Evidence Table : Efficacy/ safety/ organisational (TDCS – SCHIZOPRENIA)
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14. Simoncini T, Panattoni A, Aktas M et al. Robot-assisted pelvic floor reconstructive surgery: an international Delphi study of expert users. Surg Endosc. 2023;37(7):5215-5225.	International Delphi consensus study involving high-volume robotic surgeons across gynecology, urology, and colorectal specialties. **Aim:** To assess expert consensus on the safety, technical advantages, clinical appropriateness, and future directions of robot-assisted pelvic floor reconstructive surgery (PFRS), given the absence of strong comparative evidence with standard laparoscopy. **Methods:** ❑Participants: 26 international experts (gynecologists, urologists, colorectal surgeons) with >3 years of robotic PFRS experience ❑ Delphi Rounds: • Round 1: 63 statements across categories (general views, indications, surgical techniques, future perspectives) • Round 2: 20 refined statements with borderline consensus ❑ Final Step: Virtual meeting to finalize consensus		26 international experts (gynecologists, urologists, colorectal surgeons) with >3 years of robotic PFRS experience	Robotic surgery			**Results:** **Detailed Findings (Selected Highlights)** • 92%: Robotics improves safety in PFRS • 96%: Robotics offers superior instrument articulation • 92%: Suturing at the sacral promontory is easier and more accurate with robotics • 85%: Robotics results in less surgeon fatigue than laparoscopy • 81%: Robotic PFRS is suitable for patients needing abdominal correction of pelvic organ prolapse • 73-92%: Robotics simplifies deep dissections and mesh suturing (posterior/anterior vaginal wall, Retzius space, anterior rectal wall) • Experts emphasized **interest in future developments**, including tactile feedback, AI-enhanced platforms, and surgical navigation tools **Authors' conclusion:** Robotic-assisted PFRS offers significant technical and ergonomic advantages over laparoscopy, especially in complex cases. The Delphi panel endorsed its use as a suitable and effective approach, while acknowledging the need for further studies to define its cost-effectiveness and optimal use.

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15. Barkati N, Ntefeh N, Okasha A, Takshe AA, ElKhatib R, Chelli S. Robotic assisted surgery in the United Arab Emirates: healthcare experts' perceptions. J Robot Surg. 2023;17:2799-2806.	Qualitative study using in-depth interviews. **Aim:** To explore healthcare experts' perceptions, readiness, and experiences regarding the implementation of robotic-assisted surgery (RAS) in the United Arab Emirates, and to identify perceived benefits, challenges, and barriers to adoption. **Methods:** Participants: 17 healthcare experts (11 clinicians, 6 non-clinicians) from the UAE. Sampling: Purposive sampling through outreach to 100+ professionals. Data Collection: One-to-one Zoom interviews (40-50 minutes). 5 open-ended guiding questions focused on RAS implementation, perceptions, challenges, and COVID-19 impact. Audio-recorded with consent.		17 healthcare experts (11 clinicians, 6 non-clinicians) from the UAE.	robotic-assisted surgery (RAS)			Results: Most participants viewed robotic-assisted surgery positively, citing improved clinical precision and institutional reputation. However, widespread adoption remains limited due to financial constraints, lack of trained personnel, and inadequate infrastructure. RAS is mainly used in urology, general, and neurosurgery, with minimal adoption in gynecology. The COVID-19 pandemic further delayed implementation in several hospitals. • **Perception:** ○ 88% expressed favorable views of RAS. ○ 94.1% believed RAS improves hospital reputation and patient outcomes. • **Adoption Status:** ○ 29.4% of participants' institutions currently use RAS. ○ 35.3% have no plans to implement. ○ 35.3% planning to adopt within 1-3 years. • **Top Drivers for Adoption:** ○ Improved clinical quality (47.1%). ○ Enhanced institutional image (23.5%).

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	Data Analysis: Thematic analysis with coding and grouping into major themes. Peer debriefing and co-author checks ensured credibility. Outcomes of Interest: • Perceptions of RAS usefulness. • Adoption status in UAE hospitals. • Implementation challenges. • Impact of COVID-19 on RAS adoption.						○ Revenue potential (5.9%). • **Common Barriers:** ○ High implementation costs (59%). ○ Shortage of trained staff (17.6%). ○ Insurance limitations and strategic gaps (6% each). • **Specialties Implementing RAS:** ○ General surgery, urology, neurosurgery (18% each). ○ OB/GYN lagging behind (only 6%). • **COVID-19 Impact:** ○ 53% experienced pandemic-related delays. **Authors' conclusion:** Robotic-assisted surgery is widely perceived as a valuable innovation by healthcare professionals in the UAE, yet its adoption is limited by cost, staffing, and training challenges. Broader implementation will depend on addressing these barriers and expanding training opportunities.

Evidence Table : Efficacy/ safety/ organisational (TCDS - SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
16. Adkoli A, Eng S, Stephenson R. Need for formalized robotic training and curriculum in obstetrics and gynecology residency: an examination of current resident outlooks and perspectives. J Robot Surg. 2024 May 21;18(1):218.	Cross-sectional survey study. **Aim:** To evaluate current robotic surgery training methodologies in ACGME-accredited OB/GYN residency programs, understand resident perspectives, and identify opportunities for improvement in resident education. **Methods:** ❑**Design**: Web-based anonymous cross-sectional survey ❑**Setting**: National (United States), 2023-2024 academic year ❑**Participants**: 75 OB/GYN residents ❑**Tool**: 33-item questionnaire (mix of multiple choice, Likert scales, etc.) ❑**Distribution**: Through program coordinators to residents across 292 accredited programs ❑**Analysis**: Descriptive statistics (percentages)	III	75 OB/GYN residents	Robotic surgery			Results: survey revealed high institutional access to robotic platforms and simulators, but low rates of structured training and hands-on experience as primary surgeons. Residents generally support standardized curricula, with barriers cited including time constraints and faculty reluctance. Many intend to pursue certification and integrate robotics into future practice. **Robotic Platform Access**: • 98.7% institutions performed robotic surgeries • 90.7% had console trainers • 72.0% had easy access to simulators **Training & Experience**: • 57.3% had formal robotic curricula • 56.7% received 0 hours of didactic training • Most involvement began at PGY1-2; console use mainly started PGY3 • 60% had *never* been primary surgeon in robotic case **Modalities Used** (most helpful): • Hands-on training (67.7%) • Dual-console (45.6%) • Online modules least helpful (58.7%) **Barriers to Training**: • Attending discomfort with resident participation (74%)

							• Time constraints (58.9%) • Limited simulator availability (42.5%) **Resident Outlook**: • 80% aim for certification by graduation • 68% plan to use robotics in future practice • 90% agree/strongly agree that standardized curricula should be implemented Authors' conclusion: There is a clear need for formalized and standardized robotic training curricula in OB/GYN residency programs. Multi-modal educational models and standardized benchmarks are essential to ensure adequate preparation for residents entering independent robotic practice.

Evidence Table : Efficacy/ safety/ organisational (TCDS – SCHIZOPRENIA)
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Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
17. Gressel GM, George K, Woodland MB, Banks E. Residents' Confidence in Performing Robotic Hysterectomy in Obstetrics and Gynecologic Training Programs. J Minim Invasive Gynecol. 2021;28(11):1882-1888.	Cross-sectional survey study (national-level, U.S.) **Aim:** To compare OB/GYN residents' perceived confidence in performing robotic-assisted hysterectomy at the time of graduation with the perceptions of their program directors. **Methods:** Survey development: Based on Delphi method by CREOG Executive Council. Participants: ○ 5084 U.S. OB/GYN residents who sat for the 2019 CREOG exam. ○ 241 program directors from ACGME-accredited programs. Survey domains: Surgical autonomy. Emergency independence. Graduation preparedness. Perceived career importance of robotic hysterectomy. Comparison groups: Residents vs. Program Directors; stratified	III	5084 U.S. OB/GYN residents who sat for the 2019 CREOG exam. 241 program directors from ACGME-accredited programs.	robotic-assisted hysterectomy			Results: residents reported significantly lower confidence, autonomy, and preparedness in performing robotic hysterectomies compared to other hysterectomy routes and to the perceptions of their program directors. Robotic hysterectomy was also considered less important for future practice, particularly among those not pursuing surgical subspecialties. • **Resident-reported surgical autonomy for robotic hysterectomy (PGY4):** 52.2% • **Confidence to perform in emergency setting (PGY4):** 53.7% • **Preparedness to perform independently at graduation (PGY4):** 59.0% • **Importance for future career (PGY4):** 56.4% **Comparison with other hysterectomy approaches (PGY4):** Autonomy: • Robotic 52.2% vs Abdominal 81.8% (OR 6.43) • Vaginal 75.0%, Laparoscopic 83.0% Preparedness for graduation: • Robotic 59% vs Laparoscopic 92.5% (OR 8.20) Career importance: • Robotic 56.4% vs Laparoscopic 86.2% (OR 25.50)

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	by PGY level and future career path. Statistical analysis: Chi-square and Fisher's exact tests with 95% CI, ORs, and p-values.						**Residents vs Program Directors (Robotic Hysterectomy):** ○ Autonomy: 38.6% vs 61.0% (OR 2.48) ○ Emergency independence: 22.8% vs 60.9% (OR 5.28) ○ Preparedness: 62.6% vs 70.2% (OR 1.40) ○ Career importance: 63.4% vs 47.9% (OR 0.53) **By future specialty path:** ○ 96% of future gyn-oncologists valued robotic hysterectomy vs 64.8% generalists ○ Only 35% of "other" subspecialists valued it (OR 0.29 vs generalists) **Authors' conclusion:** Residents' confidence in performing robotic hysterectomy is lower than in other hysterectomy approaches, and perceptions vary significantly by seniority, career goals, and institutional practices. There is a mismatch between residents' and program directors' perceptions, which may reflect variability in hands-on exposure and curriculum. These findings suggest the need to reevaluate training adequacy and standardize robotic surgical education in OB/GYN programs.

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18. Delameilleure M, Timmerman S, Vandoren C, et al. (2024). Approaches for hysterectomy and implementation of robot-assisted surgery in benign gynaecological disease: A cost analysis study in a large university hospital. Eur J Obstet Gynecol Reprod Biol, 301:105-113.	Single-centre retrospective cost-analysis study. **Aim:**. To assess the hospital-related costs (including operating room costs) of different hysterectomy approaches for benign indications, to describe their clinical outcomes, and to evaluate the impact of robot-assisted hysterectomy (RAH) implementation on surgical practice. **Methods:** ❑**Setting:** University Hospitals Leuven, Belgium. ❑**Period:** January 2014 – December 2021. ❑**Population:** Women undergoing hysterectomy for benign conditions (N=830). ❑ **Procedures compared:** • Abdominal hysterectomy (AH, n=156) • Vaginal hysterectomy (VH, n=67) • Laparoscopically-assisted vaginal		Women undergoing hysterectomy for benign conditions (N=830).	robot-assisted hysterectomy (RAH)	different hysterectomy approaches for benign indications		**Results:** • RAH use increased, leading to a sharp decline in open surgery (AH dropped from 27.3% pre-2018 to 6.9% in 2019-2021). • RAH had highest average total cost (€6528.10), followed by LH and AH (both ~€4400). • Hospital stay was longest for AH (4.7 days), shortest for RAH (2.3 days). • Reintervention rates were similar across techniques (3-4%), but RAH had the lowest visceral injury rate (0.7%). • Blood transfusion need was highest in AH (28%) compared to 17-22% in others. • Multivariate regression showed RAH associated with significantly higher cost, impacted by operative time, tissue weight, EBL, and complications. **Authors' conclusion:** While the introduction of RAH significantly reduced the rate of open surgery and was associated with fewer

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	hysterectomy (LAVH, n=108) • Laparoscopic hysterectomy (LH, n=351) • Robot-assisted hysterectomy (RAH, n=148) ❑**Exclusions:** Malignancy, pelvic organ prolapses surgeries, endometriosis surgeries, vNOTES. ❑**Data sources:** Electronic health records; cost calculated via "Activity Centre-Care program model". ❑**Cost clusters:** Hospital stay, operating room, material depreciation, and maintenance. ❑**Statistical analysis:** Descriptive stats and multivariate regression on total cost predictors.						complications and shorter hospital stays, it remains the most expensive approach, largely due to high equipment and maintenance costs. RAH may be most appropriate for patients with complex pathology where open surgery would otherwise be necessary. Future studies should evaluate its cost-benefit profile from a broader societal perspective, including patient-reported outcomes**.**

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19. Clark SG, Shepherd JP, Sassani JC, Bonidie M. Surgical cost of robotic-assisted sacrocolpopexy: a comparison of two robotic platforms. Int Urogynecol J. 2023;34:87-91	Retrospective cohort study **Aim:** To compare the total hospital costs of robotic-assisted sacrocolpopexy (RSC) performed using two robotic platforms–Senhance and Da Vinci–and to assess differences in specific cost categories. **Methods:** ❑**Setting:** Single academic hospital ❑**Study period:** January 2019 – June 2021 ❑**Participants:** 75 women undergoing RSC (25 Senhance, 50 Da Vinci), matched 2:1 based on surgery date ❑**Surgeons:** All board-certified; one surgeon for all Senhance cases ❑**Primary outcome:** Total hospital cost per case ❑**Secondary outcomes:** Sub-category costs (e.g., medications, supplies, OR time) ❑ **Analysis:** • Descriptive statistics • t-test, chi-square/Fisher's exact • Multivariable linear regression adjusting for		75 women undergoing RSC (25 Senhance, 50 Da Vinci), matched 2:1 based on surgery date	robotic-assisted sacrocolpopexy (RSC)			**Results:** The Senhance robotic system showed a significantly lower total cost per case than the Da Vinci system despite having longer operative times. No significant differences were found in complications or cost subcategories. ❑ **Demographics:** • Mean age: 60.5 years • Mean BMI: 27.9 kg/m² • Majority white (97.3%) and postmenopausal (86.5%) ❑ **Operative Characteristics:** • Operative time: Senhance 210.2 min vs Da Vinci 178.1 min (Δ = 32.1 min, p = 0.01) • Blood loss: Similar between groups • Complication rates: No significant differences ❑ **Cost Results:** • Total hospital cost: ○ Senhance: $5,368.31 ± 1,486.89 ○ Da Vinci: $5,741.76 ± 1,197.20 (p = 0.29)

	operative time, estimated blood loss, and concomitant procedures						• **Multivariable regression (adjusted):** ○ Senhance associated with **$908.33 lower cost** (p = 0.01) ○ Use of GelPoint system and mid-urethral sling increased costs ○ Sensitivity analysis (excluding OR time): cost difference still significant **Authors' conclusion:** The Senhance robotic system resulted in significantly lower total costs for sacrocolpopexy compared to Da Vinci, even during the initial adoption phase. This suggests that alternative robotic systems may help mitigate high surgical costs and should be further evaluated in broader settings.

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20. Iavazzo C, Gkegkes ID. Cost-benefit analysis of robotic surgery in gynaecological oncology. *Best Practice & Research Clinical Obstetrics and Gynaecology.* 2017;45:7-18.	Systematic Review **Aim:** To review and assess the cost and economic impact of robotic surgery in gynaecological oncology, including factors influencing costs and strategies to minimise them. **Methods:** ❑ **Databases searched**: PubMed and Scopus (as of 23 February 2017) ❑ **Search terms**: "robotic AND (gynecology OR endometrial OR cervical OR ovarian) AND (cost OR cost analysis)" ❑ **Inclusion criteria**: • Studies reporting comparative cost data in robotic gynaecological oncology • Studies published in English, German, French, Italian, Spanish, or Greek ❑ **Exclusion criteria**: • Non-comparative studies	I	❑ **17 studies** included ❑ **Total patients**: 16,349 • Open surgery: 3,214 • Laparoscopy : 5,120 • Robotic: 8,015 ❑ **Diagnoses**: • Endometrial cancer: 3,393 • Cervical cancer: 2,181 • Ovarian cancer: 12	robotic surgery			**Results:** Robotic surgery is generally associated with higher costs compared to laparoscopic and open surgeries, particularly due to operative charges, equipment costs, and acquisition/maintenance fees. However, robotic approaches may offer benefits such as reduced blood loss, shorter hospital stay, and lower conversion rates, potentially offsetting some costs in high-volume centers or complex cases. ❑ **Mean cost ranges**: • Robotic: $1,858-$64,266 • Open: $960-$42,460 • Laparoscopic: $441-$55,130 ❑ **Operative charges**: $1,228-$44,698 ❑ **Non-operative charges**: $820-$51,552 ❑ **Surgical equipment costs**: $695-$159,239 ❑ **Operating room costs**: $51-$32,800 ❑ **Professional fees**: $90-$9,832 ❑ **Hospital stay (days)**: • Robotic: 1-6 • Open: 1.8-26 • Laparoscopic: 1-11 ❑ **Conversions to laparotomy**:

Bibliographic Citation	Study Type/ Methods	LE	Number of Patients & Patient Characteristic	Intervention	Comparison	Length of Follow-up	Outcome Measures/ Effect Size
	• Abstracts, editorials, letters, short surveys, commentaries						• Laparoscopy: 2.9% • Robotic: 2.9% ❑ **Operation time (minutes)**: • Robotic: 76.5-314 • Open: 75-430 • Laparoscopic: 78-585 ❑ **Estimated blood loss (mL)**: • Robotic: 0-2,900 • Open: 25-3,700 • Laparoscopic: 50-850 **Authors' conclusion:** While robotic surgery is associated with higher upfront costs, its benefits may justify the investment in specific settings, such as high-volume centers or in patients with complex conditions. However, variability in cost components, lack of long-term outcome data, and methodological heterogeneity limit definitive conclusions on cost-effectiveness. Further research and cost-optimisation strategies are needed.

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21. Marino P, Houvenaeghel G, Narducci F et al. Cost-Effectiveness of Conventional vs Robotic-Assisted Laparoscopy in Gynecologic Oncologic Indications. Int J Gynecol Cancer. 2015;25(6):1102-1108.	Prospective multicenter cost analysis **Aim:** To compare the costs and clinical outcomes of conventional laparoscopy vs robotic-assisted laparoscopy in patients undergoing surgery for endometrial and cervical cancers. **Methods:** ❑**Prospective multicenter study** (16 centers, France, 2007-2010) ❑**Sample size:** 306 patients • Robotic-assisted laparoscopy: 80 patients • Conventional laparoscopy: 226 patients ❑ **Follow-up:** 2 years ❑**Costing method:** Microcosting from hospital perspective (in euros €)		306 patients: 80 patients – robotic assisted laparoscopy, 226 conventional laparoscopy	Robotic-assisted laparoscopy	Conventional laparoscopic	2 years	**Results:** **Clinical Outcomes** • **Operating time** was longer with robotic surgery: ○ 4.98 hrs (robotic) vs 4.38 hrs (laparoscopic); **p = 0.0002** • **Conversion rates:** ○ 1% (robotic) vs 3% (laparoscopic); not statistically significant • **ICU admissions:** ○ 13% (robotic) vs 27% (laparoscopic); **p = 0.0234** • **Blood loss & complication rates** were similar between groups. • **2-year recurrence rates (pelvic/metastasis):** No significant differences observed. Conclusion: **Effectiveness was considered equivalent** between both techniques. **Total cost per patient:** • Robotic: **€7,040** • Laparoscopic: **€5,584** • **Extra cost of robotic surgery: €1,456** **Main driver of added cost:** Fixed robot costs**, especially** purchase and maintenance**.**

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							Sensitivity Analysis • **Cost difference decreases** with higher surgical volume: ○ €1,456 per case (165 cases/year) ○ €703 per case (250 cases/year) ○ **Cost parity** reached at **≥275–300 procedures/year** *if* robot cost drops by 20-30% • Operating time reduction and lower maintenance costs further reduce cost gap. **Authors' conclusion:** Robotic-assisted laparoscopy offers comparable clinical outcomes to conventional laparoscopy in gynecologic oncology but incurs higher costs, largely driven by equipment-related expenses. However, cost-effectiveness improves with higher surgical volumes and reduced fixed costs. Despite the financial challenges, robotics may provide access to minimally invasive surgery for patients who are less suitable for standard laparoscopy (e.g., obese or high-risk patients). Strategic implementation in high-volume centers and across specialties is key to improving value.

TECHNOLOGY REVIEW (MINI-HTA) ROBOTIC-ASSISTED SURGERY FOR GYNAECOLOGICAL DISORDERS

e ISBN 978-967-2887-97-3

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