Technoleg Iechyd Cymru
Health Technology Wales

Evidence Appraisal Report [1]

Robot-assisted benign gynaecological surgery

Appraisal summary

Why did Health Technology Wales (HTW) appraise this topic?

Some non-cancerous (benign) gynaecological conditions may require surgical treatment, such as endometriosis, uterine fibroids and pelvic organ prolapse, amongst others. Hysterectomy (removal of the uterus) is the most frequently performed major gynaecological surgery. Other surgeries include myomectomy (removal of uterine fibroids), endometriosis surgery, and sacrocolpopexy (repair of vaginal prolapse).

These procedures may be performed as a robot-assisted surgery, by inserting a robotic surgical probe into a small laparoscopic ('keyhole') incision, controlled by the surgeon from an operating console a short distance from the patient. Alternative conventional approaches include open surgery through an incision in the abdomen, vaginal surgery, or as laparoscopic surgery without robot assistance.

Robot-assisted surgery widens the eligibility of a minimally-invasive approach to some patients who would ordinarily require an open approach. Experts report that wait-times for laparoscopic surgery can be a few years in NHS Wales for benign gynaecological conditions. They highlight that robot-assisted benign gynaecological surgery is not routinely available in NHS Wales, despite being widely available across the UK.

This topic was suggested to HTW by colleagues in the NHS.

What evidence did HTW find?

This report aims to identify and summarise evidence that addresses the following question: what is the clinical and cost effectiveness of robot-assisted benign gynaecological surgery compared to standard care?

Six systematic reviews of randomised controlled trials (RCTs) were identified which compared conventional laparoscopic surgery with robot-assisted hysterectomy, robot-assisted sacrocolpopexy and robot-assisted surgery for endometriosis. Most of the evidence compared robot-assisted hysterectomy or robot-assisted sacrocolpopexy with conventional laparoscopic surgery. The evidence comparing conventional laparoscopic surgery with robot-assisted surgery for endometriosis was limited. Limited evidence was identified comparing all types of robot-assisted surgery to open surgery or vaginal surgery. Most of the evidence identified was for short-term outcomes, with some long-term evidence found for post-operative complications,

[1] Cyfieithu dogfennau HTW wedi'u cyhoeddi o'r Saesneg i'r Gymraeg
Translation of published technical HTW documents from English into Welsh

recurrence, pain, quality of life, and patient satisfaction. Most systematic reviews either did not report the type of robot used or reported using the da Vinci robot system (Intuitive Surgical, Inc.), and is it unclear how generalisable these findings are to other types of robot systems.

Two systematic reviews of large comparative observational studies reported outcomes for robot-assisted myomectomy compared to conventional laparoscopic myomectomy or open myomectomy, but no evidence compared it to vaginal myomectomy.

Most of the outcomes showed no statistically significant difference between robot-assisted surgery and comparators. RCT and observational evidence found that robot-assisted surgery took longer than other surgical approaches. Evidence from the observational studies reported more favourable findings for robot-assisted surgery than the RCTs.

RCT evidence showed that the length of hospital stay was significantly shorter (by around seven hours) for those who had robot-assisted hysterectomy compared to conventional laparoscopic hysterectomy. Most RCT evidence indicated a significant improvement in short-term quality of life for robot-assisted hysterectomy compared to conventional laparoscopic hysterectomy or open hysterectomy, but a significantly lower short-term quality of life for robot-assisted surgery for endometriosis compared with conventional laparoscopic surgery. Some RCT evidence reported less blood loss with robot-assisted hysterectomy compared to conventional laparoscopic hysterectomy. There was also less blood loss and fewer complications with robot-assisted sacrocolpopexy than with comparator surgical approaches.

Surgeons performing hysterectomy or lymphadenectomy for malignant gynaecological conditions reported increased physical difficulty and perceived workload in conventional laparoscopic surgery compared with robot-assisted surgery. No RCT evidence was found for surgeon satisfaction. No relevant evidence was found for the subgroup analysis of pre- and post-menopause. We did not identify any evidence for use of robot-assisted surgery in people undergoing preventative surgery for increased familial risk of cancer.

Most of the outcomes are reported by the authors of the systematic reviews as having very low- to low-certainty, mainly due to high risk of bias from lack of blinding. The observational outcomes were largely from retrospective studies and therefore associated with a high risk of bias. There was a high degree of heterogeneity observed for many of the pooled results, indicating that there is a high degree of inconsistency between the reported results of individual studies.

Economic evidence was identified which compared robot-assisted surgery to alternative approaches in myomectomy, sacrocolpopexy and hysterectomy. The majority of the evidence was indicative of a higher economic burden when using robot-assisted surgery, however, no evidence was identified from a UK perspective. As such, HTW conducted a cost analysis from the perspective of NHS Wales to evaluate the likely economic impact of adopting robot-assisted surgery in sacrocolpopexy and hysterectomy.

The cost-consequence analysis conducted by HTW compared robot-assisted surgery to laparoscopic hysterectomy, laparoscopic sacrocolpopexy and open sacrocolpopexy. Robot-assisted surgery was found to increase costs against all included comparators. Scenario analyses and probabilistic sensitivity analyses explored changes in model inputs and assumptions and confirmed that base case results were robust to model changes.

Fair Treatment for the Women of Wales (FTWW) provided a written submission in addition to running an online survey. FTWW reported that patient attitudes towards robotic surgery for non-cancerous gynaecological conditions are mixed. While there is a consensus that robotic surgery has the potential to provide patients with a number of benefits - such as more accuracy and access to lesions that otherwise would be missed, less pain, better and quicker recoveries which could lead to shorter waiting lists – patients still held a number of concerns.

1. Purpose of the Evidence Appraisal Report

This report aims to identify and summarise evidence that addresses the following question: what is the clinical and cost effectiveness of robot-assisted benign gynaecological surgery compared to standard care?

Evidence Appraisal Reports are based on rapid systematic literature searches, with the aim of identifying the best published evidence on the effectiveness and cost-effectiveness of health and social care technologies and models of care and support. Researchers critically evaluate this evidence. The draft Evidence Appraisal Report is reviewed by experts and by Health Technology Wales multidisciplinary advisory groups before publication.

2. Context

Common benign (non-cancerous) gynaecological conditions include uterine fibroids (benign growths that develop in or around the uterus), endometriosis (endometrial tissue found outside the uterus), benign ovarian tumours, pelvic organ prolapse (one or more of the organs in the pelvis slip down from their normal position and bulge into the vagina), and vesicovaginal fistula (a passage between the bladder and the vagina), among others (Lawrie et al. 2019). These conditions can significantly affect quality of life and may affect fertility (NHS 2022).

Surgery for such conditions may involve removal of the affected part or structure (Lawrie et al. 2019). Hysterectomy is one such surgery, and involves the removal of the uterus. It is the most frequently performed major gynaecological surgical procedure (Pickett et al. 2023). Whilst hysterectomy can be done for cancerous conditions, approximately 90% of hysterectomies are performed for benign indications, the most common of which are uterine fibroids, abnormal uterine bleeding, endometriosis and pelvic organ prolapse (Pickett et al. 2023). The number of hysterectomies performed in NHS Wales for benign gynaecological conditions is uncertain, but based on the fact that one in five women[2] in the UK are likely to undergo hysterectomy during their lifetime (Lawrie et al. 2019), it is estimated that 2,028 and 3,870 women per year in Wales had a hysterectomy for a benign gynaecological condition in 2019 and 2021, respectively (NHS Digital 2021, Office for National Statistics 2022).

Other such surgeries include myomectomy (removal of uterine fibroids), endometriosis surgery or surgical repair, sacrocolpopexy (the repair of vaginal prolapse, where the uppermost part of the vagina slips downwards), fistula repair, or tubal re-anastomosis (joining two ends of one fallopian tube to restore fertility) (Lawrie et al. 2019). It is uncertain how many of each type of surgery are performed in Wales. It is estimated that endometriosis affects one in ten women in Wales (158,660 women with endometriosis in Wales in 2021) (Endometriosis Cymru 2024). It is estimated that approximately 137 open myomectomies took place in Wales in 2022 to 2023, and that 11 sacrocolpopexy surgeries took place in Wales in 2022 to 2023 (NHS Digital 2023).

Experts report that wait-times for laparoscopic surgery can be a few years in NHS Wales for benign gynaecological conditions. They highlight that robot-assisted benign gynaecological surgery is not routinely available in NHS Wales, despite being widely available across the UK.

[2] In this report, ‘women’ should be taken to include those who do not identify as women but who have female pelvic organs

3. Health technology

Traditionally, surgical approaches to benign gynaecological conditions involved open surgery, vaginal surgery, or conventional laparoscopic surgery. Open surgery involves a surgical incision into the abdominal cavity. For vaginal surgery, an incision is made in the vagina rather than the abdomen. Conventional laparoscopic (or 'keyhole') surgery is a minimally invasive technique, where several smaller incisions are made and the surgeon manually controls the instruments inside the patient at the operating table (HIQA 2012).

Since the late 1990s, robot-assisted surgery has been used in gynaecological surgery (Lawrie et al. 2019). Robot-assisted surgery widens the eligibility of a minimally-invasive approach to some patients who would ordinarily require an open approach, for example those with obesity, a larger uterus size, and those who require more complex procedures.

Robot-assisted surgery involves the use of an advanced surgical tool to perform minimally invasive laparoscopic surgery for certain procedures (HIQA 2012). The device includes up to four robotic arms equipped with surgical instruments that are controlled by the surgeon from an operating console a short distance from the patient. Robot-assisted surgery allows for improved three-dimensional imaging of the surgical area, together with a more intuitive manipulation of several surgical arms. A previous health technology assessment (HTA) notes that for the operating surgeon, there is a reduction in fatigue, and potentially complex procedures can be performed more comfortably. (HIQA 2012).

Six robot systems with a CE-mark for use in gynaecological indications were identified, but it is unclear whether they have UKCA marks (Boal et al. 2024):

- avatera system, avateramedical GmbH
- da Vinci, Intuitive Surgical Inc.
- Dexter, Distalmotion
- Senhance Surgical Robotic System, Asensus Surgical Inc.
- Hugo RAS System, Medtronic
- Versius, Cambridge Medical Robotics (CMR) Surgical

Most of the evidence in this appraisal either did not report the type of robot used or reported using the da Vinci robot system (Intuitive Surgical Inc.). Experts contacted by HTW stated that the da Vinci robot system (Intuitive Surgical Inc.) and the Versius robot system (CMR Surgical) are currently used in NHS Wales across urology, oncology gynaecology, hepato-biliary, colorectal and thoracic surgical indications.

The da Vinci system uses a patient cart with attached robotic arms separated from an enclosed, immersive surgeon console with hand controls and foot pedals (Mayor et al. 2022). Versius consists of separate single arm carts and an open console. The wristed instrument tips also provide seven degrees of freedom, but the handgrip design resembles a game controller. In contrast to the da Vinci system, the arms of Versius are lightweight and provide ease of transport and deployment. The versatility of Versius, with the ability to add and remove arm carts, makes it a more practical portable solution. The open console provides an ergonomic position and uses 3D glasses, facilitating team communication – a limitation of closed consoles (Mayor et al. 2022).

Experts reported that robot-assisted surgery may initially take longer than other types of surgery, due to the learning curve of the system, the additional set-up time for robotic surgery and the fact that more complex surgeries may be done with the robot.

4. Guidance

4.1 International

The HTA organisation of Ireland, the Health Information and Quality Authority (HIQA), looked at the use of robot-assisted surgery for multiple indications (HIQA 2012). They reported that meta-analyses of observational studies (low-certainty Grading of Recommendations Assessment, Development and Evaluation [GRADE] evidence) suggests that robot-assisted hysterectomy, when compared with open surgery, is associated with improved peri-operative outcomes. These include lower risk of transfusion, and shorter hospital stays. Compared to conventional laparoscopic hysterectomy, the benefits of robot-assistance are less pronounced. The HTA states that evidence to support the use of robot-assistance for a range of other gynaecology procedures (myomectomy, tubal re-anastomosis, and sacrocolpopexy) is limited in quantity and quality, and additional, higher quality research is required for these indications (HIQA 2012). The HIQA HTA included both benign and malignant conditions, and was based on observational studies. Since publication of this HTA, there have been randomised controlled trials (RCTs) published on benign gynaecological conditions, and they will be discussed in this EAR.

The American College of Obstetricians and Gynecologists (ACOG) and Society of Gynecologic Surgeons (SGS) recommended that robot-assisted gynaecologic surgery can be performed safely in centres with experienced surgeons. They reported that it has peri-operative outcomes equivalent to laparoscopy and improved outcomes compared with laparotomy (ACOG 2020). Robot-assisted cases should be selected based on the likelihood of improved outcomes compared with other surgical approaches due to the complexity of the case or patient factors, with appropriate consideration to costs. They recommended that further comparative studies are needed to assess long-term outcomes and patient safety, and to identify specific subgroups of patients who would benefit from a robot-assisted approach (ACOG 2020).

5. Effectiveness

5.1 Overview

We searched for evidence that could be used to answer the review question: what is the clinical effectiveness of robot-assisted benign gynaecological surgery compared to standard care?

For details on the methodology used to identify evidence for this report, refer to Appendix 1.

Table 1 summarises the outcomes and sources of evidence used in this EAR. Table 2 to Table 16 report the outcome data for each type of surgery. Table A1 (in Appendix 6) reports the design and characteristics of the systematic reviews in this EAR, and Table A2 (in Appendix 6) reports the design and characteristics of the RCTs in this EAR.

Due to the volume of evidence identified for hysterectomy, sacrocolpopexy and surgical treatment of endometriosis, we only included RCTs for these indications. No RCT evidence was identified which reported robot-assisted surgery for any other benign gynaecological conditions. After looking at NHS England data, it appeared that myomectomy was a frequently performed benign gynaecological surgery in NHS England in 2022 to 2023 (NHS Digital 2023). We therefore included comparative observational evidence for this type of surgery only.

5.2 Hysterectomy

5.2.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

Four systematic reviews of RCTs were identified which compared robot-assisted hysterectomy to conventional laparoscopic hysterectomy for benign gynaecological conditions (Albright et al. 2016, Lawrie et al. 2019, Lenfant et al. 2023, Pickett et al. 2023). Where reported, we included the pooled data from these systematic reviews. One additional RCT compared robot-assisted hysterectomy and/or lymphadenectomy for malignant gynaecological conditions with conventional laparoscopic surgery (Hotton et al. 2023).

Pickett et al. (2023) included RCTs for the following outcomes: total operating time, major short-term complications (febrile episodes or unspecified types of infection), and time taken to return to normal activities.

Lawrie et al. (2019) included RCTs for the following outcomes: length of hospital stay, re-admission to hospital, re-intervention rate, conversion from robotic-assisted hysterectomy or conventional laparoscopic hysterectomy to another surgical approach, need for blood transfusions, pain at two weeks, and quality of life (QoL) at six weeks and six months.

We reported the results from the primary RCTs for estimated blood loss as they were incorrectly reported in the meta-analysis by Lenfant et al. (2023). Albright et al. (2016) included RCTs for severe complications.

No relevant RCTs comparing robot-assisted hysterectomy with conventional laparoscopic hysterectomy were found for patient satisfaction or surgeon satisfaction.

5.2.1.1 Bottom line results

There was no statistically significant difference between robot-assisted hysterectomy and conventional laparoscopic hysterectomy for most outcomes. RCT evidence found that total operating time was significantly longer (by around 44 minutes) for robot-assisted hysterectomy than conventional laparoscopic hysterectomy, but that the length of hospital stay was significantly shorter (by around seven hours) for those who had robot-assisted hysterectomy than conventional laparoscopic hysterectomy. QoL was significantly improved at six weeks following robot-assisted hysterectomy, but there was no significant difference compared to conventional laparoscopic hysterectomy at six months. Surgeons performing hysterectomy or lymphadenectomy for malignant gynaecological conditions reported increased physical difficulty and perceived workload in conventional laparoscopic surgery compared with robot-assisted surgery. There were mixed findings for intra-operative blood loss, with one RCT reporting less blood loss with robot-assisted hysterectomy, and one RCT reporting no statistically significant difference between groups. Most of the outcomes were judged by the systematic review authors to be of very low or low certainty.

5.2.2 Robot-assisted hysterectomy versus open hysterectomy

One systematic review of an RCT comparing robot-assisted hysterectomy to open hysterectomy for post-operative infections, QoL at four weeks, and hospital re-admission (Lawrie et al. 2019). No RCT evidence was found for operating time, length of hospital stay, number of women requiring re-intervention, estimated blood loss, number of blood transfusions needed, conversions to another surgical approach, intra-operative complications, time taken to return to normal activities, pain, patient satisfaction and surgeon satisfaction.

5.2.2.1 Bottom line results

Limited RCT evidence was identified comparing robot-assisted hysterectomy to open hysterectomy. One small RCT of 20 participants reported that robot-assisted hysterectomy significantly improved QoL at four weeks compared to open hysterectomy. The authors of the systematic review judged this outcome to be of very low certainty. There was no significant difference between groups for post-operative infections or re-admissions.

5.2.3 Robot-assisted hysterectomy versus vaginal hysterectomy

One systematic review reporting an RCT was identified, which compared robot-assisted hysterectomy to vaginal surgery for conversion to another surgical approach, complications, re-admission and re-intervention (Lenfant et al. 2023). We reported results from the primary study for operative time, estimated blood loss and length of hospital stay as those reported in the systematic review were incorrectly reported. No RCT evidence was identified for number of blood transfusions needed, return to normal activities, pain, QoL, patient satisfaction and surgeon satisfaction.

5.2.3.1 Bottom line results

There was no statistically significant difference between robot-assisted hysterectomy and vaginal hysterectomy for most outcomes. One RCT in the systematic review reported that operating time was longer (17 minutes) for robot-assisted hysterectomy compared to vaginal surgery, but it is unclear whether this result is statistically significant. There was no statistically significant difference between the two interventions for length of hospital stay, re-admission to hospital, the number of women requiring re-intervention, estimated blood loss, conversion to open surgery, and intra-operative and post-operative complications. This RCT was judged by the authors of the systematic review to have an overall low risk of bias.

5.3 Sacrocolpopexy

5.3.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

Two systematic reviews of RCTs were identified which compared robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy (Lawrie et al. 2019, Maher et al. 2023). Where reported, we included the pooled data from these systematic reviews.

Maher et al. (2023) included RCTs for the following outcomes: total operating time, estimated blood loss, blood transfusions, serious complications, recurrence, re-intervention, pain, QoL and patient satisfaction. We used the primary studies for one of the patient satisfaction outcomes and some of the QoL outcomes as the data were incorrectly reported in the systematic review by Maher et al. (2023).

Lawrie et al. (2019) included RCTs for the following outcomes: conversion to another surgical approach, length of hospital stay and QoL.

No relevant RCTs comparing robot-assisted sacrocolpopexy with conventional laparoscopic sacrocolpopexy were found for hospital re-admissions, time taken to return to normal activities and surgeon satisfaction.

5.3.1.1 Bottom line results

There was no statistically significant difference between robot-assisted sacrocolpopexy and conventional laparoscopic sacrocolpopexy for most outcomes. Operating time was significantly shorter (by approximately 44 minutes) for those who had conventional laparoscopic sacrocolpopexy compared to robot-assisted sacrocolpopexy. Most of the outcomes were judged by the systematic review authors to be of low or moderate certainty.

5.3.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

Only indirect evidence was used in the network meta-analysis (NMA) by Chang et al. (2022), which was calculated through direct RCT evidence of robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy, and conventional laparoscopic sacrocolpopexy versus open sacrocolpopexy. There were six RCTs contributing to this NMA, but it was not clear which of the outcomes each RCT contributed to. The outcomes reported included operative time, estimated blood loss, recurrence, and post-operative complications. No RCT evidence was found for length of hospital stay, hospital re-admission, re-intervention, blood transfusions, conversion to another surgical approach, intra-operative complications, return to normal activities, pain, and QoL.

5.3.2.1 Bottom line results

Indirect RCT evidence in an NMA reported that operative time was significantly longer in robot-assisted sacrocolpopexy compared to open sacrocolpopexy, but that estimated blood loss and post-operative complications were significantly lower in robot-assisted sacrocolpopexy versus open sacrocolpopexy. There was no significant difference in recurrence of vaginal prolapse in women who had robot-assisted sacrocolpopexy compared to open sacrocolpopexy. The authors of the NMA reported that for the overall bias, approximately 90% of the included studies were of a low-risk of bias. However, it is unclear which RCTs were used to calculate the indirect data estimates. No RCT evidence was found comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.4 Treatment of endometriosis

5.4.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

One RCT of 73 women in the systematic review by Lawrie et al. (2019) reported outcomes for: total operative time, estimated blood loss, conversion to another surgical approach, complications, re-admission to hospital, pain and QoL. No RCT evidence was identified for blood transfusions, length of hospital stay, recurrence, re-intervention, time taken to return to normal activities, patient satisfaction and surgeon satisfaction.

5.4.1.1 Bottom line results

For most outcomes in this RCT, events rates were low. The authors of the systematic review judged the outcomes to be of very low to low certainty, due to the sample size being insufficient to show potential differences between groups. Only QoL reported statistically significant differences between the groups, favouring conventional laparoscopic surgery at six weeks follow up, although there were mixed findings for this outcome. No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery or vaginal surgery for endometriosis.

5.5 Myomectomy

5.5.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

Two pooled analyses of observational studies were identified which compared robot-assisted myomectomy to conventional laparoscopic myomectomy (Chen et al. 2024, Sheng et al. 2023). No RCT evidence was identified.

Chen et al. (2024) pooled data for total operating time. Sheng et al. (2023) included evidence for the following outcomes: estimated blood loss, blood transfusions, conversion to open surgery, complications and length of hospital stay. Chen et al. (2024) reported operating time by body mass index (BMI). No evidence was identified for recurrence rate, hospital re-admission, re-intervention, time taken to return to normal activities, pain, quality of life, patient satisfaction, and surgeon satisfaction.

5.5.1.1 Bottom line results

Pooled data from comparative observational studies reported that operating time was significantly longer (approximately 44 minutes) in robot-assisted myomectomy than conventional laparoscopic myomectomy, including in both normal-weight and overweight subgroups. Findings favoured robot-assisted myomectomy compared to conventional laparoscopic myomectomy for estimated blood loss (approximately 32 millilitres [ml] difference), blood transfusions, conversion to open surgery, complications, and length of hospital stay (by approximately three hours). Most of the studies in the pooled analyses were reported by the authors of the systematic review as being of high certainty. However, the observational studies in the systematic review were mainly retrospective, and therefore associated with a high risk of bias.

5.5.2 Robot-assisted myomectomy versus open myomectomy

One pooled analysis of observational studies was identified which compared robot-assisted myomectomy to open myomectomy (Chen et al. 2024). No RCT evidence was identified.

Chen et al. (2024) pooled data for the following outcomes: total operating time, estimated blood loss, blood transfusions, complications and length of hospital stay. No evidence was identified for recurrence rate, hospital re-admission, re-intervention, time taken to return to normal activities, pain, QoL, patient satisfaction, and surgeon satisfaction.

5.5.2.1 Bottom line results

Pooled data from comparative observational studies reported that operating time was significantly longer in robot-assisted myomectomy than open myomectomy (approximately 80 minutes). Findings favoured robot-assisted myomectomy compared to open myomectomy for estimated blood loss (approximately 104 ml difference), blood transfusions, complications and length of hospital stay (approximately 36 hours). Most of the studies in the pooled analysis were reported as being of high certainty. However, the observational studies in the systematic review were mainly retrospective, and therefore associated with a high risk of bias.

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

Table 1 – Summary of outcomes and sources of evidence used

Intervention	Robot-assisted hysterectomy			Robot-assisted sacrocolpopexy			Robot-assisted surgery for endometriosis			Robot-assisted myomectomy		
Comparator	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**
Total operating time	2 RCTs in PA		1 RCT (no p value reported)	3 RCTs in PA	Indirect NMA of RCTs		1 RCT in SR			19 obs studies in PA	16 obs studies in PA	
Estimated blood loss	1 RCT 1 RCT		1 RCT	2 RCTs in PA	Indirect NMA of RCTs		1 RCT in SR			11 obs studies in PA	15 obs studies in PA	
Blood transfusions	3 RCTs in PA			2 RCTs in PA						11 obs studies in PA	9 obs studies in PA	
Conversion to another surgical approach	3 RCTs in PA		1 RCT in SR	1 RCT in SR			1 RCT in SR			11 obs studies in PA		
Complications	3 RCTs in PA and 1 RCT in SR	1 RCT in SR	1 RCT in SR	2 RCTs in PA	Indirect NMA of RCTs		1 RCT in SR			11 obs studies in PA	12 obs studies in PA	
Length of hospital stay	2 RCTs in PA		1 RCT	1 RCT in SR						10 obs studies in PA	15 obs studies in PA	
Recurrence				1 RCT in SR	Indirect NMA of RCTs							
Re-admission to hospital	2 RCTs in PA	1 RCT in SR	1 RCT in SR				1 RCT in SR					
Re-intervention	1 RCT in SR		1 RCT in SR	1 RCT in SR								
Time taken to return to normal activities	1 RCT in SR											
Pain	1 RCT in SR			2 RCTs in PA			1 RCT in SR					

Intervention	Robot-assisted hysterectomy			Robot-assisted sacrocolpopexy			Robot-assisted surgery for endometriosis			Robot-assisted myomectomy		
Comparator	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**	**CLS**	**OS**	**VS**
Quality of life	1 RCT in SR 1 RCT in SR	1 RCT in SR		1 RCT in SR 2 RCTs			1 RCT in SR 1 RCT in SR					
Patient satisfaction				1 RCT 1 RCT in SR								
Surgeon satisfaction												
Ergonomics	1 RCT											
Subgroup analysis: pre and post menopause												
Subgroup analysis: operating time for healthy and high BMI											22 obs studies in PA	

Favours robot-assisted surgery
Favours comparator
No statistically significant difference between intervention and comparator
No relevant evidence identified

Abbreviations: BMI, body mass index; CLS, conventional laparoscopic surgery; FU, follow up; NMA, network meta-analysis; Obs, observational; OS, open surgery; PA, pooled analysis; RCT, randomised controlled trial; SR, systematic review; VS, vaginal surgery

5.6 Total operating time (Table 2)

5.6.1 Hysterectomy: total operating time

5.6.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 2)

Two RCTs by Paraiso et al. (2013) and Sarlos et al. (2012) of 152 participants, in the pooled analysis by Pickett et al. (2023), reported that robot-assisted hysterectomy takes significantly more time (approximately 44 minutes) than conventional laparoscopic hysterectomy (mean difference [MD]: 44.09 minutes, 95% confidence interval [CI]: 5.31 to 82.88).

5.6.1.2 Robot-assisted hysterectomy versus open hysterectomy

No RCT evidence was identified comparing robot-assisted hysterectomy to open hysterectomy.

5.6.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 2)

One RCT by Lönnerfors et al. (2015) of 86 participants, in the systematic review by Lenfant et al. (2023), reported that operative time was 17 minutes shorter with vaginal hysterectomy compared with robot-assisted hysterectomy, but it is not clear whether this difference is statistically significant.

5.6.2 Sacrocolpopexy: total operating time

5.6.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 2)

Three RCTs by Anger et al. (2014), Illiano et al. (2019) and Paraiso et al. (2011) of 245 participants, in the pooled analysis by Maher et al. (2023), reported that robot-assisted sacrocolpopexy takes significantly more time (approximately 44 minutes) than conventional laparoscopic sacrocolpopexy (MD: -43.71 minutes, 95% CI: -67.14 to -20.28).

5.6.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy (Table 2)

Indirect RCT evidence in the NMA by Chang et al. (2022) demonstrated a statistically significantly longer operative time in robot-assisted sacrocolpopexy than open sacrocolpopexy (standardised mean difference:-1.66, 95% CI: - 2.54 to - 0.78).

5.6.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.6.3 Treatment of endometriosis: total operating time

5.6.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 2)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference between the duration of robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (MD: 5.00 minutes, 95% CI: -20.71 to 30.71).

5.6.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.6.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.6.4 Myomectomy: total operating time

5.6.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 2)

Total operating time was reported in 19 comparative observational studies of 3,215 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported that the operating time was statistically significantly longer (by approximately 44 minutes) in robot-assisted myomectomy than conventional laparoscopic myomectomy (MD: 43.58 minutes, 95% CI: 25.22 to 61.93) (Chen et al. 2024).

5.6.4.2 Robot-assisted myomectomy versus open myomectomy (Table 2)

Total operating time was reported in 16 comparative observational studies of 2,818 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported that the operating time was statistically significantly longer (by approximately 80 minutes) in robot-assisted myomectomy than open myomectomy (MD: 79.60 minutes, 95% CI: 65.19 to 94.02) (Chen et al. 2024).

5.6.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.7 Estimated blood loss (Table 3)

5.7.1 Hysterectomy: estimated blood loss

5.7.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 3)

One RCT of 97 women, by Lönnerfors et al. (2015), reported a statistically significant reduction in blood loss during robot-assisted hysterectomy (median: 50 ml, range: 0 to 400 ml) compared to conventional laparoscopic hysterectomy (median: 100 ml, range 10 to 600 ml).

One RCT of 100 women, by Sarlos et al. (2012), reported no statistically significant difference in estimated blood loss between robot-assisted hysterectomy and conventional laparoscopic hysterectomy (MD: 8 millilitres [ml], 95% CI: - 10 to 20).

5.7.1.2 Robot-assisted hysterectomy versus open hysterectomy

Estimated blood loss was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.7.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 3)

One RCT of 86 participants, by Lönnerfors et al. (2015), reported no statistically significant difference in estimated blood loss between robot-assisted hysterectomy (median: 50 ml, range 0 to 400 ml) and vaginal hysterectomy (median: 50 ml, range: 0 to 350 ml).

5.7.2 Sacrocolpopexy: estimated blood loss

5.7.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 3)

Two RCTs by Anger et al. (2014) and Illiano et al. (2019) of 178 participants, in the pooled analysis by Maher et al. (2023), reported no statistically significant difference in estimated blood loss between robot-assisted sacrocolpopexy and conventional laparoscopic sacrocolpopexy (MD: 2.63 ml, 95% CI: -10.28 to 15.54).

5.7.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy (Table 3)

Indirect RCT evidence in the NMA by Chang et al. (2022) demonstrated a statistically significant higher estimated blood loss in open sacrocolpopexy than robot-assisted sacrocolpopexy (standardised mean difference: 2.07 , 95% CI: 0.66 to 3.49).

5.7.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.7.3 Treatment of endometriosis: estimated blood loss

5.7.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 3)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference between the estimated blood loss from robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (MD: 57.10 ml, 95% CI: -20.08 to 134.28).

5.7.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.7.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.7.4 Myomectomy: estimated blood loss

5.7.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 2)

Estimated blood loss was reported in 11 comparative observational studies of 1,367 participants in the pooled analysis by Sheng et al. (2023). This pooled analysis reported that there was a statistically significant lower amount of estimated blood loss (by approximately 32 ml) in robot-assisted myomectomy than conventional laparoscopic myomectomy (MD: −32.03 ml, 95% CI:−57.24 to −6.83) (Sheng et al. 2023).

5.7.4.2 Robot-assisted myomectomy versus open myomectomy (Table 2)

Estimated blood loss was reported in 16 comparative observational studies of 3,169 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported that there was a statistically significant lower amount of estimated blood loss (approximately 104 ml) in robot-assisted myomectomy than open myomectomy (MD: -104.47 ml, 95% CI: -164.31 to -44.63) (Chen et al. 2024).

5.7.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.8 Blood transfusions (Table 4)

5.8.1 Hysterectomy: blood transfusions

5.8.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 4)

Three RCTs by Green et al. (2013), Lönnerfors et al. (2015) and Paraiso et al. (2013) of 157 participants, in the pooled analysis by Lawrie et al. (2019), reported no statistically significant difference in the need for blood transfusion in those who had robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (risk ratio [RR]: 1.94, 95% CI: 0.3 to 12.76).

5.8.1.2 Robot-assisted hysterectomy versus open hysterectomy

The number of blood transfusions needed was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.8.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

The number of blood transfusions needed was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.8.2 Sacrocolpopexy: blood transfusions

5.8.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 4)

Two RCTs by Anger et al. (2014) and Illiano et al. (2019) of 178 participants, in the pooled analysis by Maher et al. (2023), reported no statistically significant difference in the need for blood transfusion in those who had robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (RR: 2.88, 95% CI: 0.12 to 69.16).

5.8.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.8.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.8.3 Treatment of endometriosis: blood transfusions

5.8.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.8.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.8.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.8.4 Myomectomy: blood transfusions

5.8.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 4)

The rate of blood transfusions was reported in 11 comparative observational studies of 45,347 participants in the pooled analysis by Sheng et al. (2023). This pooled analysis reported that the need for blood transfusions was statistically significantly lower in robot-assisted myomectomy than conventional laparoscopic myomectomy (odds ratio [OR]: 0.86, 95% CI: 0.77 to 0.97) (Sheng et al. 2023).

5.8.4.2 Robot-assisted myomectomy versus open myomectomy (Table 4)

The rate of blood transfusions was reported in nine comparative observational studies of 2,579 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported that the need for blood transfusions was statistically significantly lower in robot-assisted myomectomy than open myomectomy (OR: 0.37, 95% CI: 0.27 to 0.50) (Chen et al. 2024).

5.8.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.9 Conversion to another surgical approach (Table 5)

5.9.1 Hysterectomy: conversion to another surgical approach

5.9.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 5)

Three RCTs by Lönnerfors et al. (2015), Paraiso et al. (2013) and Sarlos et al. (2012) of 269 participants, in the pooled analysis by Lawrie et al. (2019), reported no statistically significant difference in conversion to another surgical approach from robot-assisted hysterectomy or conventional laparoscopic hysterectomy (RR: 1.17, 95% CI: 0.24 to 5.77). The systematic review by Lawrie et al. (2019) did not specify the type of surgery that the robot-assisted hysterectomies and conventional laparoscopic hysterectomies were converted to.

5.9.1.2 Robot-assisted hysterectomy versus open hysterectomy

Conversion to another surgical approach was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.9.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 5)

One RCT by Lönnerfors et al. (2015) of 86 participants, in the systematic review by Lenfant et al. (2023), reported no episodes of conversion to open surgery from robot-assisted hysterectomy or vaginal hysterectomy.

5.9.2 Sacrocolpopexy: conversion to another surgical approach

5.9.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 5)

One RCT by Paraiso et al. (2011) of 68 participants, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in conversion to another surgical approach from robot-assisted sacrocolpopexy or conventional laparoscopic sacrocolpopexy (RR: 1.41, 95% CI: 0.25 to 7.94).

5.9.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.9.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.9.3 Treatment of endometriosis: conversion to another surgical approach

5.9.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 5)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in conversion to another surgical approach from robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (RR: 0.36, 95% CI: 0.02 to 8.58).

5.9.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.9.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.9.4 Myomectomy: conversion to another surgical approach

5.9.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 5)

The rate of conversion to open surgery was reported in 11 comparative observational studies of 45,092 participants in the pooled analysis by Sheng et al. (2023). This pooled analysis reported a statistically significantly lower incidence of conversion to open surgery from robot-assisted myomectomy than from conventional laparoscopic myomectomy (OR: 0.82, 95% CI: 0.73 to 0.92) (Sheng et al. 2023).

5.9.4.2 Robot-assisted myomectomy versus open myomectomy (Table 5)

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.9.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.10 Complications (Table 6)

5.10.1 Hysterectomy: complications

5.10.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 6)

5.10.1.1.1 Serious complications

Three RCTs by Lönnerfors et al. (2015), Paraiso et al. (2013) and Sarlos et al. (2012) of 221 women, in the pooled analysis by Albright et al. (2016), reported no statistically significant difference between robot-assisted hysterectomy and conventional laparoscopic hysterectomy for severe complications requiring procedural intervention (class 3 and 4, stratified by the modified Expansion Accordion Severity Classification System) (RR: 1.07, 95% CI: 0.15 to 7.62). These complications included periumbilical haematoma drained under local anaesthetic, robotic problems requiring conversion to laparoscopy or vaginal suturing, conversion to laparotomy, intra-operative visceral or vascular injury, vaginal cuff haematoma or bleeding requiring re-operation, vaginal cuff dehiscence with re-operation, and suspected peritonitis treated with diagnostic laparoscopy. There were no severe complications constituting organ system failure or death (class 5 or class 6, respectively, of the stratified by the modified Expansion Accordion Severity Classification System) (Albright et al. 2016).

Another RCT by Deimling et al. (2017) included severe complications in addition to those described above in the pooled analysis by Albright et al. (2016). The additional RCT by Deimling et al. (2017) of 144 women was included in the systematic review by Pickett et al. (2023), and it reported no statistically significant difference between robot-assisted hysterectomy and conventional laparoscopic hysterectomy in febrile episodes or unspecified infection, which were described by the systematic review authors as being major short-term complications (OR: 1.00, 95% CI 0.06 to 16.30).

5.10.1.2 Robot-assisted hysterectomy versus open hysterectomy (Table 6)

5.10.1.2.1 Unspecified severity of complications

One RCT by Wijk et al. (2018) of 20 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference between robot-assisted hysterectomy and open hysterectomy for post-operative infection (RR: 0.33, 95% CI: 0.02 to 7.32). The severity of the infections was not reported in the systematic review (Lawrie et al. 2019). No RCT evidence was found comparing intra-operative complications between these two interventions.

5.10.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 6)

5.10.1.3.1 Unspecified severity of complications

One RCT by Lönnerfors et al. (2015) of 86 women, in the systematic review by Lenfant et al. (2023), reported no statistically significant difference in intra-operative complications between robot-assisted hysterectomy and vaginal hysterectomy (OR: 1.26, 95%: 0.05 to 32.09). The severity and details of the complications were not reported in the systematic review by Lenfant et al. (2023).

One RCT by Lönnerfors et al. (2015) of 86 women, in the systematic review by Lenfant et al. (2023), reported no statistically significant difference in immediate post-operative complications between robot-assisted hysterectomy and vaginal hysterectomy (OR: 0.28, 95% CI: 0.07 to 1.15). The severity and details of the complications were not reported in the systematic review by Lenfant et al. (2023).

5.10.2 Sacrocolpopexy: complications

5.10.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 6)

5.10.2.1.1 Serious complications

Two RCTs by Anger et al. (2014) and Illiano et al. (2019) of 177 participants, in the pooled analysis by Maher et al. (2023), reported no statistically significant difference in serious complications (all complications Clavien-Dindo 3 or greater) between robot-assisted sacrocolpopexy and conventional laparoscopic sacrocolpopexy (RR: 2.05, 95% CI: 0.55 to 7.62). The details of the complications were not reported.

5.10.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy (Table 6)

5.10.2.2.1 Unspecified severity of complications

Indirect RCT evidence in the NMA by Chang et al. (2022) demonstrated a statistically significant higher number of post-operative complications in open sacrocolpopexy than robot-assisted sacrocolpopexy (logarithm[log]OR: 1.31, 95% CI: 0.17 to 10.22). The details of the complications were not reported.

5.10.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.10.3 Treatment of endometriosis: complications

5.10.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 6)

5.10.3.1.1 Unspecified severity of complications

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in intra-operative complications between robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (RR: 0.36, 95% CI: 0.04 to 3.32), including urethral complications and bowel injury. There was also no statistically significant difference between groups for post-operative complications (RR: 0.78, 95% CI: 0.40 to 1.51) and risk of infection (RR: 0.54, 95% CI: 0.23 to 1.29) (Lawrie et al. 2019).

5.10.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.10.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.10.4 Myomectomy: complications

5.10.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 6)

5.10.4.1.1 Unspecified severity of complications

The incidence of post-operative complications was reported in 11 comparative observational studies of 1,622 participants in the pooled analysis by Sheng et al. (2023). This pooled analysis reported a statistically significant lower number of post-operative complications following robot-assisted myomectomy than conventional laparoscopic myomectomy (OR: 0.58, 95% CI: 0.40 to 0.86). These post-operative complications included endometriosis, post-operative wound infection, and bowel injury (Sheng et al. 2023).

5.10.4.2 Robot-assisted myomectomy versus open myomectomy (Table 6)

5.10.4.2.1 Unspecified severity of complications

Complication rates were reported in 12 comparative observational studies of 2,920 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported that the complication rate was statistically significantly lower in robot-assisted myomectomy than open myomectomy (OR: 0.43, 95% CI: 0.27 to 0.71). Different types of complications including fever, wound infection, post-operative bleeding, thrombosis, and chest pain were reported in these studies (Chen et al. 2024).

5.10.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.11 Length of hospital stay (Table 7)

5.11.1 Hysterectomy: length of hospital stay

5.11.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 7)

Two RCTs by Lönnerfors et al. (2015) and Sarlos et al. (2012) of 192 participants, in the pooled analysis by Lawrie et al. (2019), reported that the mean length of hospital stay was statistically significantly shorter (by around seven hours) in the robot-assisted hysterectomy group compared to the conventional laparoscopic hysterectomy group (MD: -0.30 days, 95% CI: -0.53 to -0.07).

5.11.1.2 Robot-assisted hysterectomy versus open hysterectomy

Length of hospital stay was not reported in RCT studies comparing robot-assisted hysterectomy and open surgery.

5.11.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 7)

One RCT by Lönnerfors et al. (2015), of 86 participants, reported no statistically significant difference in the length of stay in hospital for robot-assisted hysterectomy (median: 1.1 days, standard deviation: 0.52) compared to vaginal hysterectomy (1.4 days, standard deviation: 0.87).

5.11.2 Sacrocolpopexy: length of hospital stay

5.11.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 7)

One RCT by Paraiso et al. (2011) of 68 participants, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference length of hospital stay for robot-assisted sacrocolpopexy compared to conventional laparoscopic sacrocolpopexy (MD: -0.39 days, 95% CI: -0.81 to 0.03)

5.11.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.11.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.11.3 Treatment of endometriosis: length of hospital stay

5.11.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.11.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.11.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.11.4 Myomectomy: length of hospital stay

5.11.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy (Table 7)

Length of hospital stay was reported in 10 comparative observational studies of 1,425 participants in the pooled analysis by Sheng et al. (2023). This pooled analysis reported a statistically significant shorter duration (by approximately three hours) of hospital stay following robot-assisted myomectomy than conventional laparoscopic myomectomy (MD: -0.11 days, 95% CI: -0.21 to -0.01) (Sheng et al. 2023).

5.11.4.2 Robot-assisted myomectomy versus open myomectomy (Table 7)

Length of hospital stay was reported in 15 comparative observational studies of 3,093 participants in the pooled analysis by Chen et al. (2024). This pooled analysis reported a statistically significant shorter duration (by approximately 36 hours) of hospital stay following robot-assisted myomectomy than open myomectomy (MD: -1.49 days, 95% CI: -1.75 to -1.23) (Chen et al. 2024).

5.11.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.12 Recurrence (Table 8)

5.12.1 Hysterectomy: recurrence

5.12.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

No RCT evidence was identified comparing robot-assisted hysterectomy to conventional laparoscopic hysterectomy.

5.12.1.2 Robot-assisted hysterectomy versus open hysterectomy

No RCT evidence was identified comparing robot-assisted hysterectomy to open hysterectomy.

5.12.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

No RCT evidence was identified comparing robot-assisted hysterectomy to vaginal hysterectomy.

5.12.2 Sacrocolpopexy: recurrence

5.12.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 8)

One RCT by Paraiso et al. (2011) of 49 participants, in the systematic review by Maher et al. (2023), reported no statistically significant difference in the recurrence rate of vaginal prolapse (stage two or more) for robot-assisted sacrocolpopexy compared to conventional laparoscopic sacrocolpopexy (RR: 0.75, 95% CI: 0.14 to 4.12).

5.12.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy (Table 8)

Indirect evidence from RCTs in the NMA by Chang et al. (2022) reported no statistically significant difference in Pelvic Organ Prolapse Quantification (POP-Q) assessment Point Ba (most distal portion of the remaining upper anterior side of the vaginal wall), Bp (most distal portion of the remaining upper posterior side of the vaginal wall), and Point C (lowest edge of the cervix or the vaginal cuff) in robot-assisted sacrocolpopexy compared to open sacrocolpopexy.

5.12.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.12.3 Treatment of endometriosis: recurrence

5.12.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.12.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.12.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.12.4 Myomectomy: recurrence

5.12.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.12.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.12.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.13 Re-admission to hospital (Table 9)

5.13.1 Hysterectomy: re-admission to hospital

5.13.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 9)

Two RCTs by Green et al. (2013) and Lönnerfors et al. (2015) of 220 participants, in the pooled analysis by Lawrie et al. (2019), reported no statistically significant difference in the number of people requiring re-admission to hospital after robot-assisted hysterectomy or conventional laparoscopic hysterectomy (RR: 0.46, 95% CI: 0.14 to 1.48).

5.13.1.2 Robot-assisted hysterectomy versus open hysterectomy (Table 9)

One RCT by Wijk et al. (2018) of 20 participants, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in the number of people requiring re-admission to hospital after robot-assisted hysterectomy or open hysterectomy (RR: 0.33, 95% CI: 0.02 to 7.32).

5.13.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy (Table 9)

One RCT by Lönnerfors et al. (2015) of 86 participants, in the systematic review by Lenfant et al. (2023), reported no statistically significant difference in the number of people requiring re-admission to hospital after robot-assisted hysterectomy or vaginal surgery (OR: 0.38, 95% CI: 0.07 to 2.02).

5.13.2 Sacrocolpopexy: re-admission to hospital

5.13.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.13.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.13.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.13.3 Treatment of endometriosis: re-admission to hospital

5.13.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 9)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in the number of women needing re-admission to hospital following robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (RR: 0.72, 95% CI: 0.13 to 4.08).

5.13.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.13.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.13.4 Myomectomy: re-admission to hospital

5.13.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.13.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.13.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.14 Re-intervention (Table 10)

5.14.1 Hysterectomy: re-intervention

5.14.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 10)

One RCT by Lönnerfors et al. (2015) of 122 participants, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in the number of people requiring re-intervention in the robot-assisted hysterectomy group compared to the conventional laparoscopic hysterectomy group (RR: 0.25, 95% CI: 0.03 to 2.17).

5.14.1.2 Robot-assisted hysterectomy versus open hysterectomy

The number of people undergoing re-intervention was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.14.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

One RCT by Lönnerfors et al. (2015) of 86 participants, in the systematic review by Lenfant et al. (2023), reported no statistically significant difference in the number of people requiring re-intervention after robot-assisted hysterectomy or vaginal surgery (OR: 0.19, 95% CI: 0.02 to 2.22).

5.14.2 Sacrocolpopexy: re-intervention

5.14.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 10)

One RCT by Anger et al. (2014) of 78 participants, in the systematic review by Maher et al. (2023), reported no statistically significant difference in re-intervention surgery for stress urinary incontinence in the robot-assisted sacrocolpopexy group compared to the conventional laparoscopic sacrocolpopexy group (RR: 1.58, 95% CI: 0.28 to 8.94).

5.14.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.14.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.14.3 Treatment of endometriosis: re-intervention

5.14.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.14.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.14.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.14.4 Myomectomy: re-intervention

5.14.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.14.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.14.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.15 Return to normal activities (Table 11)

5.15.1 Hysterectomy: return to normal activities

5.15.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 11)

One RCT by Sarlos et al. (2012) of 100 women, in the systematic review by Pickett et al. (2023), reported no statistically significant difference in the number of days taken to return to normal activities following robot-assisted hysterectomy or conventional laparoscopic hysterectomy (MD: -2.40, 95% CI: -8.54 , 3.74). The authors of the systematic review suggested that if the return to normal activities after conventional laparoscopic hysterectomy is assumed to be 31 days, then after robot-assisted hysterectomy it would be between 22 and 35 days (Pickett et al. 2023).

5.15.1.2 Robot-assisted hysterectomy versus open hysterectomy

Return to normal activities was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.15.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

Return to normal activities was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.15.2 Sacrocolpopexy: return to normal activities

5.15.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.15.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.15.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.15.3 Treatment of endometriosis: return to normal activities

5.15.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.15.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.15.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.15.4 Myomectomy: return to normal activities

5.15.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.15.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.15.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.16 Pain (Table 12)

5.16.1 Hysterectomy: pain

5.16.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 12)

One RCT by Paraiso et al. (2013) of 38 women, in the systematic review by Lawrie et al. (2019), reported pain scores during normal activities at two weeks post hysterectomy, with no statistically significant difference between robot-assisted hysterectomy and conventional laparoscopic hysterectomy (MD: -2.00, 95% CI: -16.08 to 12.08).

5.16.1.2 Robot-assisted hysterectomy versus open hysterectomy

Pain was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.16.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

Pain was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.16.2 Sacrocolpopexy: pain

5.16.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 12)

Two RCTs by Anger et al. (2014) and Illiano et al. (2019) of 178 participants, in the pooled analysis by Maher et al. (2023), reported no statistically significant difference in pain scores between robot-assisted sacrocolpopexy and conventional laparoscopic sacrocolpopexy (MD in Anger et al. (2014): -0.90, 95% CI:-1.86 to 0.06, and MD in Illiano et al. (2019): 0.00, 95% CI: -0.20 to 0.20).

One RCT by (Illiano et al. 2019) of 52 participants, in the systematic review by Maher et al. (2023), reported no statistically significant difference in painful intercourse following robot-assisted sacrocolpopexy compared to conventional laparoscopic sacrocolpopexy (RR: 0.85, 95% CI: 0.26 to 2.79).

5.16.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.16.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.16.3 Treatment of endometriosis: pain

5.16.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 12)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported no statistically significant difference in pain scores at six months following robot-assisted surgery for endometriosis compared to conventional laparoscopic surgery for endometriosis (MD: 3.30, 95% CI: -8.31 to 14.91).

5.16.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.16.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.16.4 Myomectomy: pain

5.16.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.16.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.16.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.17 Quality of life (Table 13)

5.17.1 Hysterectomy: quality of life

5.17.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 13)

One RCT by Sarlos et al. (2012) of 95 women, in the systematic review by Lawrie et al. (2019), reported that QoL, using EuroQol-5D (EQ-5D), was significantly higher at six weeks in those who had robot-assisted hysterectomy compared to conventional laparoscopic hysterectomy (MD: 8.00, 95% CI: 3.12 to 12.88). However, another RCT by Paraiso et al. (2013) of 38 women, in the systematic review by Lawrie et al. (2019), reported a significant improvement in ability to do vigorous activity at six months in both groups using the 36-Item Short Form Survey (SF-36), but the difference between groups was not statistically significant different (MD: 5.00, 95% CI: -3.01 to 13.01).

5.17.1.2 Robot-assisted hysterectomy versus open hysterectomy (Table 13)

One RCT by Wijk et al. (2018) of 20 women, in the systematic review by Lawrie et al. (2019), found that fewer women in the robot-assisted hysterectomy group reported some restriction in activities of daily living than in the open hysterectomy group at four weeks post-surgery, using the World Health Organization (WHO) score (RR: 0.25, 95% CI: 0.07 to 0.9).

5.17.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

QoL was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.17.2 Sacrocolpopexy: quality of life

5.17.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 13)

One RCT of 100 participants, by Illiano et al. (2019), found no statistically significant difference in QoL using the Female Sexual Function Index at two years following conventional laparoscopic sacrocolpopexy (median: 22, range: 2 to 33) compared to robot-assisted sacrocolpopexy (median: 26.5, range: 13 to 30).

One RCT of 78 women, by Paraiso et al. (2011), did not find a statistically significant difference in QoL using the Pelvic Floor Disability Index at one year following robot-assisted sacrocolpopexy (median: 22, range: 2 to 33) compared to conventional laparoscopic sacrocolpopexy (median: 22, range: 2 to 33).

There was also no statistically significant difference in QoL at six weeks between the groups in one RCT of 78 women by Anger et al. (2014), in the systematic review by Lawrie et al. (2019) (MD: -0.01, 95% CI: -0.06 to 0.04).

5.17.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.17.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.17.3 Treatment of endometriosis: quality of life

5.17.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis (Table 13)

One RCT by Soto et al. (2017) of 73 women, in the systematic review by Lawrie et al. (2019), reported that QoL using the Physical Healthy Score of the 12-Item Short Form Health Survey (SF-12) (which assesses general health, how the current state of health limits moderate activity and climbing stairs, how physical health results in accomplishing less work or limiting kind of work the patient wants to do, and how pain limits normal work) was statistically significantly improved at six weeks following conventional laparoscopic surgery for endometriosis compared to robot-assisted surgery for endometriosis (MD: -2.3, 95% CI: -3.79 to -0.81). However, at six months, there was no statistically significant difference between the groups MD: 1.3, 95% CI: -0.58 to 3.18) (Lawrie et al. 2019).

5.17.4 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.17.5 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.17.6 Myomectomy: quality of life

5.17.6.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.17.6.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.17.6.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.18 Patient satisfaction (Table 14)

5.18.1 Hysterectomy: patient satisfaction

5.18.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy (Table 14)

Patient satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.18.1.2 Robot-assisted hysterectomy versus open hysterectomy

Patient satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.18.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

Patient satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.18.2 Sacrocolpopexy: patient satisfaction

5.18.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (Table 14)

One RCT of 78 women by Paraiso et al. (2011) reported no statistically significant improvement in Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire score at one year following robot-assisted sacrocolpopexy (median: 16, range: 3 to 27) compared to conventional laparoscopic sacrocolpopexy (median: 11, range: 3 to 22).

One RCT by Illiano et al. (2019) of 100 participants, in the systematic review by Maher et al. (2023), reported no statistically significant difference in the Patient Global Impression of Improvement at two years following conventional laparoscopic sacrocolpopexy compared to robot-assisted sacrocolpopexy (RR: 1.13, 95% CI: 0.97 to 1.32).

5.18.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.18.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.18.3 Treatment of endometriosis: patient satisfaction

5.18.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.18.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.18.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.18.4 Myomectomy: patient satisfaction

5.18.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.18.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.18.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.19 Surgeon satisfaction

5.19.1 Hysterectomy: surgeon satisfaction

5.19.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

Surgeon satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.19.1.2 Robot-assisted hysterectomy versus open hysterectomy

Surgeon satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.19.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

Surgeon satisfaction was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.19.2 Sacrocolpopexy: surgeon satisfaction

5.19.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.19.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.19.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.19.3 Treatment of endometriosis: surgeon satisfaction

5.19.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.19.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.19.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.19.4 Myomectomy: surgeon satisfaction

5.19.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.19.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.19.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.20 Ergonomics

5.20.1 Hysterectomy: Ergonomics (Table 15)

5.20.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

An RCT of 369 women with gynaecological cancer assessed the physical workload and perception of physical workload in surgeons performing conventional laparoscopic surgery or robot-assisted surgery. The majority of the surgeries were hysterectomies and lymphadenectomies (Hotton et al. 2023). When assessing physical difficulty, posture in conventional laparoscopic surgery was statistically significantly more challenging for all body parts except the back, compared to posture in robot-assisted surgery. There was a statistically significant increase in discomfort over time (in surgery up to four hours) for the hands and arms, neck, and legs in the surgeons performing conventional laparoscopic surgery compared with robot-assisted surgery. Perceived workload, and perceived physical activity and abilities, and perceived personal performance were statistically significantly higher in surgeons performing conventional laparoscopic surgery than those performing robot-assisted surgery. There was no significant difference between surgical approaches in mental load, perceived frustration, and effort invested (Hotton et al. 2023).

5.20.1.2 Robot-assisted hysterectomy versus open hysterectomy

Ergonomics was not reported in RCT studies comparing robot-assisted hysterectomy and open hysterectomy.

5.20.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

Ergonomics was not reported in RCT studies comparing robot-assisted hysterectomy and vaginal hysterectomy.

5.20.2 Sacrocolpopexy: Ergonomics

5.20.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.20.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.20.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No RCT evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.20.3 Treatment of endometriosis: Ergonomics

5.20.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.20.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.20.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No RCT evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.20.4 Myomectomy: Ergonomics

5.20.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.20.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.20.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.21 Subgroup analysis: body mass index (Table 16)

5.21.1 Hysterectomy: body mass index

5.21.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.21.1.2 Robot-assisted hysterectomy versus open hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.21.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.21.2 Sacrocolpopexy: body mass index

5.21.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.21.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.21.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.21.3 Treatment of endometriosis: body mass index

5.21.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.21.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.21.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.21.4 Myomectomy: body mass index

5.21.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

Twenty comparative observational studies in the pooled analysis by Chen et al. (2024) reported that operating time was significantly longer in both normal (18.5 to 24.9 kg/m^2) and overweight (> 25 kg/m^2) subgroups treated with robot-assisted myomectomy compared to conventional laparoscopic myomectomy (MD: 47.66 minutes, 95% CI: 21.63 to 73.69; and MD: 39.86 minutes, 95% CI: 12.30 to 67.42, respectively).

5.21.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.21.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

5.22 Subgroup analysis: age

5.22.1 Hysterectomy: age

5.22.1.1 Robot-assisted hysterectomy versus conventional laparoscopic hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.22.1.2 Robot-assisted hysterectomy versus open hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.22.1.3 Robot-assisted hysterectomy versus vaginal hysterectomy

No evidence was identified comparing robot-assisted hysterectomy and conventional laparoscopic hysterectomy.

5.22.2 Sacrocolpopexy: age

5.22.2.1 Robot-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to conventional laparoscopic sacrocolpopexy.

5.22.2.2 Robot-assisted sacrocolpopexy versus open sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to open sacrocolpopexy.

5.22.2.3 Robot-assisted sacrocolpopexy versus vaginal sacrocolpopexy

No evidence was identified comparing robot-assisted sacrocolpopexy to vaginal sacrocolpopexy.

5.22.3 Treatment of endometriosis: age

5.22.3.1 Robot-assisted surgery for endometriosis versus conventional laparoscopic surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to conventional laparoscopic surgery for endometriosis.

5.22.3.2 Robot-assisted surgery for endometriosis versus open surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to open surgery for endometriosis.

5.22.3.3 Robot-assisted surgery for endometriosis versus vaginal surgery for endometriosis

No evidence was found comparing robot-assisted surgery for endometriosis to vaginal surgery for endometriosis.

5.22.4 Myomectomy: age

5.22.4.1 Robot-assisted myomectomy versus conventional laparoscopic myomectomy

No evidence was found comparing robot-assisted myomectomy to conventional laparoscopic myomectomy.

5.22.4.2 Robot-assisted myomectomy versus open myomectomy

No evidence was found comparing robot-assisted myomectomy to open myomectomy.

5.22.4.3 Robot-assisted myomectomy versus vaginal myomectomy

No evidence was found comparing robot-assisted myomectomy to vaginal myomectomy.

Table 2 – Total operating time: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	2 RCTs by Paraiso et al. (2013) and Sarlos et al. (2012) in a pooled analysis by Pickett et al. (2023) (n = 152)	Robot-assisted hysterectomy: n = 76 Conventional laparoscopic hysterectomy: n = 76	MD: 44.09 minutes (95% CI: 5.31 to 82.88) **Favours conventional laparoscopic hysterectomy**	NR	Participants were not blinded in the RCT by Sarlos et al. (2012). Systematic review authors judged that there may be substantial heterogeneity (I^2 = 58%).
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	Median (range) for robot-assisted hysterectomy: 76 minutes (43 to 210 minutes) Median (range) for vaginal hysterectomy: 59 minutes (29 to 118 minutes) **Favours vaginal hysterectomy but statistical significance unclear**	NR	We did not use the results for this RCT reported in the systematic review by Lenfant et al. (2023) as they are incorrect. We used the results from the primary study. The p value wasn't reported in the primary study.
Sacrocolpopexy						
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	3 RCTs by Anger et al. (2014), Illiano et al. (2019) and Paraiso et al. (2011) in a pooled analysis by Maher et al. (2023) (n = 245)	Robot-assisted sacrocolpopexy: n = 124 Conventional laparoscopic	MD: -43.71 minutes (95% CI: -67.14 to -20.28] **Favours conventional**	NR	Systematic review authors judged the evidence to be of low-GRADE certainty. Authors of the systematic review downgraded it 2 levels: risk of performance and detection bias and inconsistency.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
			sacrocolpopexy: n = 121	**laparoscopic sacrocolpopexy**		Systematic review authors judged that there may be substantial heterogeneity (I^2 = 70%)
Robot-assisted sacrocolpopexy	Open sacrocolpopexy	Indirect evidence from RCTs in NMA by Chang et al. (2022) Unclear which RCTs were used for each outcome, but the NMA included 6 RCTs by Anger et al. (2014), Coolen et al. (2017), Costantini et al. (2016), Freeman et al. (2013), Illiano et al. (2019) and Paraiso et al. (2011) (n = 486)	NR	Standardised mean difference: -1.66 (- 2.54 to - 0.78) **Favours open sacrocolpopexy**	NR	The authors of the NMA stated that these results are associated with high heterogeneity. Only indirect evidence between robot-assisted surgery and open surgery could be calculated. Although the NMA authors stated that for the overall bias, approximately 90% of the included studies were of a low RoB, the studies included for each outcome in the NMA were not clearly reported.
Endometriosis						
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in systematic review by Lawrie et al. (2019) (n = 73)	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	MD: 5 minutes (95% CI: -20.71 to 30.71) **No statistically significant difference between groups**	NR	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	19 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 3,215)	Robot-assisted surgery: n = 1,311 Conventional laparoscopic surgery: n = 1,904	MD: 43.58 minutes, 95% CI: 25.22 to 61.93 **Favours conventional laparoscopic myomectomy**	NR	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate- to high-certainty evidence. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 95%).

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Robot-assisted myomectomy	Open myomectomy	16 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 2,818)	Robot-assisted surgery: n = 1,022 Conventional laparoscopic surgery: n = 1,796	MD: 79.60 minutes, 95% CI: 65.19 to 94.02 **Favours open myomectomy**	NR	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate- to high-certainty evidence. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 86%).

Abbreviations: CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; MD, mean difference; n, number of study participants; NMA, network meta-analysis; NOS, Newcastle-Ottawa Scale; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias;

Table 3 – Estimated blood loss: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	2 RCTs by Lönnerfors et al. (2015) and Sarlos et al. (2012) (n = 197)	Robot-assisted hysterectomy: n = 111 Conventional laparoscopic hysterectomy: n = 86	Lönnerfors et al. (2015): • Median (range) for robot-assisted hysterectomy: 50 ml (0 to 400 ml) • Median (range) for conventional laparoscopic hysterectomy: 100 ml (10 to 600 ml) p = 0.001 **Favours robot-assisted hysterectomy** Sarlos et al. (2012): MD: 8 ml (95% CI: -10 to 20 ml) **No statistically significant difference between groups**	NR	We did not use the results for these RCTs reported in the meta-analysis by Lenfant et al. (2023) as they are incorrect. We used the results from the primary studies. We assumed, and corrected, an error reported for the difference in blood loss between the groups in the primary study by Sarlos et al. (2012).
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	Median (range) for robot-assisted hysterectomy: 50 ml (0 to 400 ml) Median (range) for vaginal hysterectomy: 50 ml (0 to 350 ml) **No statistically significant difference between groups**	NR	We did not use the results for this RCT reported in the systematic review by Lenfant et al. (2023) as they are incorrect. We used the results from the primary study.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Sacrocolpopexy						
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	2 RCTs by Anger et al. (2014), Illiano et al. (2019) in a pooled analysis by Maher et al. (2023) (n = 178)	Robot-assisted sacrocolpopexy: n = 89 Conventional laparoscopic sacrocolpopexy: n = 89	MD: 2.63 ml (95% CI: -10.28 to 15.54) **No statistically significant difference between groups**	NR	Authors of the pooled analysis judged the RCTs to be at high risk of detection bias due to lack of blinding of the outcome assessment. Systematic review authors judged there to be no heterogeneity (I^2 = 0%).
Robot-assisted sacrocolpopexy	Open sacrocolpopexy	Indirect evidence from RCTs in NMA by Chang et al. (2022) Unclear which RCTs were used for each outcome, but the NMA included 6 RCTs by Anger et al. (2014), Coolen et al. (2017), Costantini et al. (2016), Freeman et al. (2013), Illiano et al. (2019) and Paraiso et al. (2011) (n = 486)	NR	Standardised mean difference: 2.07 (0.66 to 3.49) **Favours robot-assisted sacrocolpopexy**	NR	Only indirect evidence between robot-assisted surgery and open surgery could be calculated. Although the NMA authors stated that for the overall bias, approximately 90% of the included studies were of a low RoB, the studies included for each outcome in the NMA were not clearly reported.
Endometriosis						
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	MD: 57.1 ml (95% CI: -20.08 to 134.28) **No statistically significant difference between groups**	NR	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	11 comparative observational studies in pooled analysis by Sheng et al. (2023) (n = 1,367)	Robot-assisted surgery: n = 648	MD: -32.03 ml (95% CI:-57.24 to - 6.83)	NR	Authors of the systematic review judged the studies to have a NOS score of 7 to 9, indicating high certainty evidence.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
			Conventional laparoscopic surgery: n = 719	**Favours robot-assisted myomectomy**		Systematic review authors judged that there may be substantial heterogeneity (I^2 = 63%). Discrepancy in results between text and forest plot.
Robot-assisted myomectomy	Open myomectomy	16 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 3,169)	Robot-assisted surgery: n = 1,087 Conventional laparoscopic surgery: n = 2,082	MD: -104.47 ml (95% CI: -164.31 to -44.63) **Favours robot-assisted myomectomy**	NR	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate-to high-certainty evidence. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 90%).

Abbreviations: CI, confidence interval; MD, mean difference; ml; millilitres; n, number of study participants; NMA, network meta-analysis; NOS, Newcastle-Ottawa Scale; NR, not reported; RCT, randomised controlled trial; RoB, risk of bias

Table 4 – Blood transfusions: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	3 RCTs by, Green et al. (2013), Lönnerfors et al. (2015), and Paraiso et al. (2013) in pooled analysis by Lawrie et al. (2019) (n = 157)	Robot-assisted hysterectomy: n = 148 Conventional laparoscopic hysterectomy: n = 26	Robot-assisted hysterectomy: 3 events Conventional laparoscopic hysterectomy: 1 event	RR: 1.94 (0.3 to 12.76) **No statistically significant difference between groups**	The authors of the systematic review judged 2 of the RCTs (Green et al. 2013, Lönnerfors et al. 2015) to have a high risk of performance bias, due to blinding of participants and personnel. In the RCT by Green et al. (2013), 10 women were withdrawn because procedures were cancelled for medical or personal reasons (2 in the robotic surgery group), and 5 women underwent alternative procedures (2 in the robotic surgery group). Eleven women in the conventional laparoscopic group underwent robot-assisted hysterectomy instead and a per-protocol analysis was performed. The study by Green et al. (2013) appeared to have closed early Systematic review authors judged there to be no heterogeneity (I^2 = 0%)
Sacrocolpopexy						
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	2 RCTs by Anger et al. (2014) and Illiano et al. (2019) in a pooled analysis by Maher et al. (2023) (n = 178)	Robot-assisted sacrocolpopexy: n = 89 Conventional laparoscopic sacrocolpopexy: n = 89	Robot-assisted sacrocolpopexy: 0 events Conventional laparoscopic sacrocolpopexy: 1 event	RR: 2.88 (0.12 to 69.16) **No statistically significant difference between groups**	Authors of the pooled analysis judged the RCTs to be at high risk of detection bias due to lack of blinding of the outcome assessment. Data in pooled analysis came from 1 of the RCTs (Illiano et al. 2019) as the relative effect was not estimable in the other RCT.
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	11 comparative observational studies in	Robot-assisted surgery: n = 11,464	Robot-assisted myomectomy: 400 events	OR: 0.86 (0.77 to 0.97)	Authors of the systematic review judged the studies to have a NOS score of 7 to 9, indicating high certainty evidence.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
		pooled analysis by Sheng et al. (2023) (n = 45,347)	Conventional laparoscopic surgery: n = 33,883	Conventional laparoscopic myomectomy: 1,348 events	**Favours robot-assisted myomectomy**	Systematic review authors judged that there was no heterogeneity (I^2 = 0%)
Robot-assisted myomectomy	Open myomectomy	9 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 2,579)	Robot-assisted myomectomy: n = 741 Open myomectomy: n = 1,838	Robot-assisted myomectomy: 61 events Open myomectomy: 295 events	OR: 0.37 (0.27 to 0.50) **Favours robot-assisted myomectomy**	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate- to high-certainty evidence. Systematic review authors judged that there may be moderate heterogeneity (I^2 = 38%).

Abbreviations: CI, confidence interval; n, number of study participants; NOS, Newcastle-Ottawa Scale; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias; RR, risk ratio

Table 5 – Conversion to another surgical approach: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	3 RCTs by Lönnerfors et al. (2015), Paraiso et al. (2013), and Sarlos et al. (2012) in pooled analysis by Lawrie et al. (2019) (n = 269)	Robot-assisted hysterectomy: n = 134 Conventional laparoscopic hysterectomy: n = 135	Robot-assisted hysterectomy: 3 events Conventional laparoscopic hysterectomy: 3 events	RR: 1.17 (0.24 to 5.77) **No statistically significant difference between groups**	Systematic review authors judged the evidence to be of low-GRADE certainty. The authors of the systematic review judged 2 of the RCTs (Lönnerfors et al. 2015, Sarlos et al. 2012) to have a high risk of performance bias, due to blinding of participants and personnel. The systematic review does not specify whether the surgery was converted to open surgery or laparoscopic surgery. Some of these events may overlap with the events for the severe complications outcome. Systematic review authors judged there to be no heterogeneity (I^2 = 0%).
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) in a systematic review by Lenfant et al. (2023) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	Robot-assisted hysterectomy: 0 events Conventional laparoscopic hysterectomy: 0 events **No statistically significant difference between groups**	NR	Systematic review authors judged an overall low RoB for this RCT.
Sacrocolpopexy						
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Paraiso et al. (2011) in	Robot-assisted sacrocolpopexy: n = 35	Robot-assisted sacrocolpopexy: 3 events	RR: 1.41 (0.25 to 7.94)	Systematic review authors judged this RCT to have low RoB across all domains.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
		systematic review by Lawrie et al. (2019) (n = 68)	Conventional laparoscopic sacrocolpopexy: n = 33	Conventional laparoscopic sacrocolpopexy: 2 events	**No statistically significant difference between groups**	
Endometriosis						
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	Robot-assisted surgery: 0 events Conventional laparoscopic surgery: 1 event	RR: 0.36 (0.02 to 8.58) **No statistically significant difference between groups**	Authors of the systematic review stated that data are very difficult to interpret because the SDs were very high in both arms of the trial; this study included women with a broad range of severity of disease who were undergoing surgery, with some women undergoing extensive surgery.
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	11 comparative observational studies in pooled analysis by Sheng et al. (2023) (n = 45,092)	Robot-assisted surgery: n = 11,347 Conventional laparoscopic surgery: n = 33,745	Robot-assisted myomectomy: 376 events Conventional laparoscopic myomectomy: 1,354 events	OR: 0.82 (0.73 to 0.92) **Favours robot-assisted myomectomy**	Authors of the systematic review judged the studies to have a NOS score of 7 to 9, indicating high certainty evidence Systematic review authors judged that there was low heterogeneity (I^2 = 13%)

Abbreviations: CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; n, number of study participants; NOS, Newcastle-Ottawa Scale; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias; RR: risk ratio; SD, standard deviation

Table 6 – Complications: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Outcome	Evidence source(s)	Population	Follow-up time	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy								
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	Serious complications	3 RCTs by Lönnerfors et al. (2015), Paraiso et al. (2013), and Sarlos et al. (2012) in the pooled analysis by Albright et al. (2016) (n = 221)	Robot-assisted hysterectomy: n = 111 Conventional laparoscopic hysterectomy: n = 110	6 weeks to 6 months	Robot-assisted hysterectomy: 13 events Conventional laparoscopic hysterectomy: 10 events	RR: 1.07 (0.15 to 7.62) **No statistically significant difference between groups**	Systematic review authors judged there to be a high RoB due to blinding of subjects and providers for all of the RCTs. Additionally, they judged Lönnerfors et al. (2015) to have a high RoB due to allocation concealment. Some of these events may overlap with the events for the conversion to another surgical approach outcome. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 64%).
		Serious febrile episodes or unspecified infections	1 RCT by Deimling et al. (2017) in systematic review by Pickett et al. (2023) (n = 144)	Robot-assisted hysterectomy: n = 72 Conventional laparoscopic hysterectomy: n = 72	12 weeks	Robot-assisted hysterectomy: 1 event Conventional laparoscopic hysterectomy: 1 event	OR: 1.00 (0.06 to 16.30) **No statistically significant difference between groups**	The authors of the systematic review judged the RCT to have a high risk of performance bias, due to participants and study investigators being unmasked to group assignments.
Robot-assisted hysterectomy	Open hysterectomy	Unspecified severity of post-operative infection	1 RCT by Wijk et al. (2018) in systematic review by Lawrie et al. (2019) (n = 20)	Robot-assisted hysterectomy: n = 10 Open hysterectomy: 10	30 days	Robot-assisted hysterectomy: 0 events Open hysterectomy: 1 event	RR: 0.33 (0.02 to 7.32) **No statistically significant difference**	Authors of the systematic review reported that the small sample size in the RCT is unlikely to detect differences between groups. Authors of the systematic review judged there to be a

Intervention	Comparator	Outcome	Evidence source(s)	Population	Follow-up time	Absolute effect	Relative effect (95% CI)	Comments on reliability
							between groups	high risk of performance bias and detection bias in the RCT as women and staff were aware of the different surgical techniques applied. The severity of the infection was NR in the RCT.
Robot-assisted hysterectomy	Vaginal hysterectomy	Unspecified severity of immediate *post-operative complications*	1 RCT by Lönnerfors et al. (2015) in a systematic review by Lenfant et al. (2023) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	NR just stated as "immediate"	Robot-assisted hysterectomy: 4 events Vaginal hysterectomy: 5 events	OR: 0.28 (0.07 to 1.15) **No statistically significant difference between groups**	Systematic review authors judged an overall low RoB for this RCT. Type and severity of post-operative complication NR.
Robot-assisted hysterectomy	Vaginal hysterectomy	Unspecified severity of *intra-operative complications*	1 RCT by Lönnerfors et al. (2015) in a systematic review by Lenfant et al. (2023) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	NA	Robot-assisted hysterectomy: 1 event Vaginal hysterectomy: 0 events	OR: 1.26 (0.05 to 32.09) **No statistically significant difference between groups**	Systematic review authors judged an overall low RoB for this RCT. Type and severity of intra-operative complication NR.
Sacrocolpopexy								
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	Serious complications (all complications Clavien-Dindo 3 or greater)	2 RCTs by Anger et al. (2014) and Illiano et al. (2019) in a pooled analysis by Maher et al.	Robot-assisted sacrocolpopexy: n = 88 Conventional laparoscopic sacrocolpopexy: n = 89	6 months to 2 years	Robot-assisted sacrocolpopexy: 3 events. Risk: 34 per 1,000 Conventional laparoscopic	RR: 2.05 (0.55 to 7.62) **No statistically significant difference between groups**	Systematic review authors judged the evidence to be of moderate-GRADE certainty. The authors stated that it was downgraded one level: risk of performance and detection bias.

Intervention	Comparator	Outcome	Evidence source(s)	Population	Follow-up time	Absolute effect	Relative effect (95% CI)	Comments on reliability
			(2023) (n = 177)			sacrocolpopexy: 6 events. Risk: 70 per 1,000 (95% CI: 19 to 260)		Data in pooled analysis came from 1 of the RCTs (Anger et al. 2014) as the relative effect was not estimable in the other RCT.
Robot-assisted sacrocolpopexy	Open sacrocolpopexy	Unspecified severity of *post-operative complications*	Indirect evidence from RCTs in NMA by Chang et al. (2022) Unclear which RCTs were used for each outcome, but the NMA included 6 RCTs by Anger et al. (2014), Coolen et al. (2017), Costantini et al. (2016), Freeman et al. (2013), Illiano et al. (2019), and Paraiso et al. (2011) (n = 486)	NR	NR	NR	logOR: 1.31 (0.17 to 10.22) **Favours robot-assisted sacrocolpopexy**	Only indirect evidence between robot-assisted surgery and open surgery could be calculated. Although the NMA authors stated that for the overall bias, approximately 90% of the included studies were of a low RoB, the studies included for each outcome in the NMA were not clearly reported. Type and severity of post-operative complication NR.
Endometriosis								
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	Unspecified severity of *intra-operative complications*	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	NA	Robot-assisted surgery: 1 event Conventional laparoscopic	RR: 0.36 (0.04 to 3.32) **No statistically significant difference**	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.

Intervention	Comparator	Outcome	Evidence source(s)	Population	Follow-up time	Absolute effect	Relative effect (95% CI)	Comments on reliability
						surgery: 3 events	**between groups**	
		Unspecified severity of *intra-operative complications*			NA	Robot-assisted surgery: 10 events Conventional laparoscopic surgery: 14 events	RR: 0.78 (0.4 to 1.51) **No statistically significant difference between groups**	Systematic review authors stated that these results are difficult to interpret because it is not clear from the published results whether an individual woman may have had more than one complication. Systematic review authors judged that there is substantial heterogeneity (I^2 = 100%).
		Unspecified severity of infection			6 months	Robot-assisted surgery: 6 events Conventional laparoscopic surgery: 12 events	RR: 0.54 (0.23 to 1.29) **No statistically significant difference between groups**	Systematic review authors stated that the 95% CI for this outcome was wide.
Myomectomy								
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	Unspecified severity of *post*-operative complications	11 comparative observational studies in pooled analysis by Sheng et al. (2023) (n = 1,622)	Robot-assisted surgery: n = 793 Conventional laparoscopic surgery: n = 829	NR	Robot-assisted myomectomy: 47 events Conventional laparoscopic myomectomy: 72 events	OR: 0.58 (0.40 to 0.86) **Favours robot-assisted myomectomy**	Authors of the systematic review judged the studies to have a NOS score of 7 to 9, indicating high certainty evidence. Systematic review authors judged that there was low heterogeneity (I^2 = 27%).

Intervention	Comparator	Outcome	Evidence source(s)	Population	Follow-up time	Absolute effect	Relative effect (95% CI)	Comments on reliability
								Severity of complications NR.
Robot-assisted myomectomy	Open myomectomy	Unspecified severity and type of complication	12 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 2,920)	Robot-assisted myomectomy: n = 910 Open myomectomy: n = 2,010	NR	Robot-assisted myomectomy: 130 events Open myomectomy: 494 events	OR: 0.43 (0.27 to 0.71) **Favours robot-assisted myomectomy**	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate- to high-certainty evidence. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 63%). Severity and type of complications NR.

Abbreviations: CI, confidence interval; log, logarithm; n, number of study participants; NMA, network meta-analysis; NA, not applicable; NOS, Newcastle-Ottawa Scale; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias; RR: risk ratio

Table 7 – Length of hospital stay: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	2 RCTs by Lönnerfors et al. (2015) and Sarlos et al. (2012) in a pooled analysis by Lawrie et al. (2019) (n = 192)	Robot-assisted hysterectomy: n = 108 Conventional laparoscopic hysterectomy: n = 84	MD: -0.30 days (95% CI: -0.53 to -0.07) **Favours robot-assisted hysterectomy**	NR	Systematic review authors judged the evidence to be of very-low GRADE certainty. Systematic review authors reported that studies contributing data had very serious RoB for this outcome, and the studies had small sample sizes. Lönnerfors et al. (2015) was an open-label RCT. Participants were not blinded in Sarlos et al. (2012). Length of stay varied considerably in the 2 RCTs [mean stay in the conventional laparoscopic group was 3.6 days in Sarlos et al. (2012) and 1.4 days in Lönnerfors et al. (2015)]. Systematic review authors judged there to be no heterogeneity (I^2 = 0%).
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) (n = 86)	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	Median (SD) for robot-assisted hysterectomy: 1.1 days (0.52) Median (SD) for vaginal hysterectomy: 1.4 days (0.87) p = 0.09 **No statistically significant difference between groups**	NR	We did not use the results for this RCT reported in the systematic review by Lenfant et al. (2023) as they are incorrect. We used the results from the primary study.

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Sacrocolpopexy						
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Paraiso et al. (2011) in systematic review by Lawrie et al. (2019) (n = 68)	Robot-assisted sacrocolpopexy: n = 35 Conventional laparoscopic sacrocolpopexy: n = 33	MD: -0.39 (-0.81 to 0.03) **No statistically significant difference between groups**	NR	Systematic review authors judged the evidence to be of moderate-GRADE certainty. It was downgraded one level: indirectness (single study).
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	10 comparative observational studies in pooled analysis by Sheng et al. (2023) (n = 1,425)	Robot-assisted surgery: n = 669 Conventional laparoscopic surgery: n = 756	MD: -0.11 days (95% CI: -0.21 to -0.01) **Favours robot-assisted myomectomy**	NR	Authors of the systematic review judged the studies to have a NOS score of 7 to 9, indicating high certainty evidence. Systematic review authors judged that there was no heterogeneity (I^2 = 0%).
Robot-assisted myomectomy	Open myomectomy	15 comparative observational studies in pooled analysis by Chen et al. (2024) (n = 3,093)	Robot-assisted myomectomy: n = 1,049 Open myomectomy: n = 2,044	MD: -1.49 days (95% CI: -1.75 to -1.23) **Favours robot-assisted myomectomy**	NR	Authors of the systematic review judged the studies to have a NOS score of 5 to 8, indicating moderate- to high-certainty evidence. Systematic review authors judged that there may be substantial heterogeneity (I^2 = 90%).

Abbreviations: CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; MD, mean difference; n, number of study participants; NOS, Newcastle-Ottawa Scale; NR, not reported; RCT, randomised controlled trial; RoB; risk of bias; SD, standard deviation

Table 8 – Recurrence robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Measurement	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Sacrocolpopexy								
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	Any recurrent prolapse (Stage 2 or more)	1 RCT by in Paraiso et al. (2011) in systematic review by Maher et al. (2023) (n = 49)	1 year	Robot-assisted sacrocolpopexy : n = 26 Conventional laparoscopic sacrocolpopexy : n = 23	Robot-assisted sacrocolpopexy: 3 events. Risk: 115 per 1,000 Conventional laparoscopic sacrocolpopexy: 2 events. Risk: 87 per 1,000 (95% CI: 16 to 475)	RR: 0.75 (0.14 to 4.12) **No statistically significant difference between groups**	Systematic review authors judged the evidence to be of low-GRADE certainty. Authors stated that it was downgraded 2 levels: risk of indirectness (single study) and imprecision (wide CI).
Robot-assisted sacrocolpopexy	Open sacrocolpopexy	POP-Q assessment Point Ba	Indirect evidence from RCTs in NMA by Chang et al. (2022) Unclear which RCTs were used for each outcome, but the NMA included 6 RCTs by Anger et al. (2014), Coolen et al. (2017), Costantini et al. (2016), Freeman et al. (2013), Illiano et al. (2019), and Paraiso	Follow-up times of the 6 RCTs ranged from 12 to 41.7 months	NR	NR	logOR: - 0.11 (- 1.48 to 1.26) **No statistically significant difference between groups**	Only indirect evidence between robot-assisted surgery and open surgery could be calculated. Although the NMA authors stated that for the overall bias, approximately 90% of the included studies were of a low RoB, the studies included for each outcome in the NMA were not clearly reported. logOR assumed for this outcome. Type and severity of post-operative complication NR.
		POP-Q assessment Point Bp					logOR: 0.14 (-0.53 to 0.80) **No statistically significant difference between groups**	
		POP-Q assessment Point C					logOR: 0.17 (- 0.84 to 1.18) **No statistically significant difference between groups**	

Intervention	Comparator	Measurement	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
			et al. (2011) (n = 486)					

Abbreviations: Ba, most distal portion of the remaining upper anterior side of the vaginal wall; Bp, most distal portion of the remaining upper posterior side of the vaginal wall; CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; MD: mean difference; n, number of study participants; NMA, network meta-analysis; NR, not reported; POP-Q, Pelvic Organ Prolapse Quantification System; Point C, lowest edge of the cervix or the vaginal cuff; RCT, randomised controlled trial; RoB, risk of bias; RR, risk ratio

Table 9 – Re-admission to hospital: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy							
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	2 RCTs by Green et al. (2013) and Lönnerfors et al. (2015) in a pooled analysis by Lawrie et al. (2019) (n = 220)	The RCT by Lönnerfors et al. (2015) reported a follow-up time of 4 months. Follow up NR in other RCT	Robot-assisted hysterectomy: n = 122 Conventional laparoscopic hysterectomy: n = 98	Robot-assisted hysterectomy: 4 events Conventional laparoscopic hysterectomy: 8 events	RR: 0.46 (0.14 to 1.48) **No statistically significant difference between groups**	Authors of the systematic review reported that the data were sparse and at RoB (very low- to low-certainty evidence). Both RCTs were open label. In the RCT by Green et al. (2013), 10 women were withdrawn because procedures were cancelled for medical or personal reasons (2 in the robotic surgery group), and 5 women underwent alternative procedures (2 in the robotic surgery group). Eleven women in the conventional laparoscopic group underwent robot-assisted hysterectomy instead and a per-protocol analysis was performed. The study by Green et al. (2013) appeared to have closed early. Systematic review authors judged there to be no heterogeneity (I^2 = 0%).
Robot-assisted hysterectomy	Open hysterectomy	1 RCT by Wijk et al. (2018) in systematic review by Lawrie et al. (2019) (n = 20)	30 days	Robot-assisted hysterectomy: n = 10 Open hysterectomy: n = 10	Robot-assisted hysterectomy: 0 events Open hysterectomy: 1 event	RR: 0.33, 95% CI: 0.02 to 7.32 **No statistically significant difference between groups**	Authors of the systematic review reported that the small sample size in the RCT is unlikely to detect differences between groups. Authors of the systematic review judged there to be a high risk of performance bias and detection bias in the RCT as women and staff were aware of the different surgical techniques applied.
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) in a systematic review by	4 months	Robot-assisted hysterectomy: n = 61	Robot-assisted hysterectomy: 3 events	OR: 0.38 (0.07 to 2.02) **No statistically significant**	Systematic review authors judged an overall low RoB for this RCT.

Intervention	Comparator	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
		Lenfant et al. (2023) (n = 86)		Vaginal hysterectomy: n = 25	Vaginal hysterectomy: 3 events	**difference between groups**	
Endometriosis							
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	6 months	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	Robot-assisted surgery: 2 events Conventional laparoscopic surgery: 3 events	RR: 0.72 (0.13 to 4.08) **No statistically significant difference between groups**	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.

Abbreviations: CI, confidence interval; n, number of study participants; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias; RR: risk ratio

Table 10 – Re-intervention: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy							
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	1 RCT by Lönnerfors et al. (2015) in systematic review by Lawrie et al. (2019) (n = 122)	4 months	Robot-assisted hysterectomy: n = 61 Conventional laparoscopic hysterectomy: n = 61	Robot-assisted hysterectomy: 1 event Conventional laparoscopic hysterectomy: 4 events	RR: 0.25 (95% CI: 0.03 to 2.17) **No statistically significant difference between groups**	Authors of the systematic review reported that the data were sparse and at RoB (very low- to low-GRADE certainty evidence).
Robot-assisted hysterectomy	Vaginal hysterectomy	1 RCT by Lönnerfors et al. (2015) in a systematic review by Lenfant et al. (2023) (n = 86)	4 months	Robot-assisted hysterectomy: n = 61 Vaginal hysterectomy: n = 25	Robot-assisted hysterectomy: 1 event Vaginal hysterectomy: 2 events	OR: 0.19 (0.02 to 2.22) **No statistically significant difference between groups**	Systematic review authors judged an overall low RoB for this RCT.
Sacrocolpopexy							
Robot-assisted sacrocolpopexy (surgery for stress urinary incontinence)	Conventional laparoscopic sacrocolpopexy	1 RCT by Anger et al. (2014) in a systematic review by Maher et al. (2023) (n = 78)	6 months	Robot-assisted sacrocolpopexy: n = 40 Conventional laparoscopic sacrocolpopexy: n = 38	Robot-assisted sacrocolpopexy: 2 events Conventional laparoscopic sacrocolpopexy: 3 events	RR: 1.58 (0.28 to 8.94) **No statistically significant difference between groups**	Authors of the systematic review judged the RCT to be at high risk of detection bias due to lack of blinding of the outcome assessment.

Abbreviations: CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; n, number of study participants; NR, not reported; OR, odds ratio; RCT, randomised controlled trial; RoB, risk of bias; RR: risk ratio

Table 11 – Time taken to return to normal activities: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	1 RCT by Sarlos et al. (2012) in systematic review by Pickett et al. (2023)	Robot-assisted hysterectomy: n = 50 Conventional laparoscopic hysterectomy: n = 50	Risk with robot-assisted hysterectomy: 28.8 days Risk with conventional laparoscopic hysterectomy: 31.2 days MD: -2.40 days (-8.54 to 3.74) **No statistically significant difference between groups**	NR	Systematic review authors judged the evidence to be of very-low GRADE certainty. Downgraded one level for RoB: in the one study reporting on this outcome, allocation concealment was not described, blinding was not performed and follow-up was not described. Downgraded two levels for indirectness: a single study cannot be held to represent all possible populations having this surgery. Downgraded one level for imprecision: this was a small study (50 participants per arm) and the confidence interval includes the possibility of treatment benefit or harm.

Abbreviations: CI, confidence interval; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; n, number of study participants; NR, not reported; RCT, randomised controlled trial; RoB, risk of bias

Table 12 – Pain: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy							
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	1 RCT by Paraiso et al. (2013) in systematic review by Lawrie et al. (2019) (n = 36)	2 weeks	Robot-assisted hysterectomy: n = 18 Conventional laparoscopic hysterectomy: n = 18	Mean in robot-assisted hysterectomy group (SD): 17 (20) Mean in conventional laparoscopic hysterectomy group (SD): 19 (23) MD: -2.00 (95% CI: -16.08 to 12.08) **No statistically significant difference between groups**	NR	9 women withdrew after random assignment (5 to the conventional laparoscopic group and 4 to the robot-assisted group); 1 woman put down for conventional laparoscopy underwent robot-assisted surgery in error (protocol deviation), and 1 woman in the conventional laparoscopic group was withdrawn as the result of missing data. 2 women for robot-assisted surgery were converted to laparoscopy. The report states that 26 women were analysed in each group, but denominators are not specifically given for each outcome. More than 20% of data on pain and activity outcomes were missing; therefore, high risk was assigned for these outcomes.
Sacrocolpopexy							
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	2 RCTs by Anger et al. (2014) and Illiano et al. (2019) in a pooled analysis by Maher et al. (2023) (n = 178)	1 RCT was 1 week post-op (Anger et al. 2014). Other RCT reported 2 year follow up	Robot-assisted sacrocolpopexy: n = 89 Conventional laparoscopic sacrocolpopexy: n = 89	MD in Anger et al. (2014): -0.90 (95% CI:-1.86 to 0.06) MD in Illiano et al. (2019): 0.00 (95% CI: -0.20 to 0.20) **No statistically significant difference between groups**	NR	Authors of the pooled analysis judged the RCTs to be at high risk of detection bias due to lack of blinding of the outcome assessment. Data from the 2 RCTs were not pooled together.

Intervention	Comparator	Evidence source(s)	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Robot-assisted sacrocolpopexy (painful intercourse)	Conventional laparoscopic sacrocolpopexy	1 RCT by Illiano et al. (2019) in systematic review by Maher et al. (2023) (n = 52)	2 years	Robot-assisted sacrocolpopexy: n = 21 Conventional laparoscopic sacrocolpopexy: n = 31	Robot-assisted sacrocolpopexy: 4 events Conventional laparoscopic sacrocolpopexy: 5 events	RR: 0.85 (0.26 to 2.79) **No statistically significant difference between groups**	Systematic review authors judged RCT to be at high risk of detection bias due to lack of blinding of outcome assessment.
Endometriosis							
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	6 months	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	MD: 3.3 (95% CI: -8.31 to 14.91) **No statistically significant difference between groups**	NR	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.

Abbreviations: CI, confidence interval; n, number of study participants; NR, not reported; RCT, randomised controlled trial; RoB, risk of bias; SD, standard deviation

Table 13 – Quality of life: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Measure	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy								
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	1 RCT by Sarlos et al. (2012) in systematic review by Lawrie et al. (2019) (n = 95)	EQ-5D	6 weeks	Robot-assisted hysterectomy: n = 47 Conventional laparoscopic hysterectomy: n = 48	Mean in robot-assisted hysterectomy group (SD): 13 (10) Mean in conventional laparoscopic hysterectomy group: (SD): 5 (14) MD: 8.00 (95% CI: 3.12 to 12.88) **Favours robot-assisted hysterectomy**	NR	Study authors of the systematic review judged that the self-reported outcome in this RCT was subject to significant RoB. This RCT was reported to have a high risk of performance bias, due to blinding of participants and personnel Scores from each of the EQ-5D dimensions were NR
Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	1 RCT by Paraiso et al. (2013) in systematic review by Lawrie et al. (2019) (n = 38)	SF-36	6 months	Robot-assisted hysterectomy: n = 19 Conventional laparoscopic hysterectomy: n = 19	Mean in robot-assisted hysterectomy group (SD): 50 (11) Mean in conventional laparoscopic hysterectomy group (SD): 45 (14) MD: 5.00 (95% CI: -3.01 to 13.01) **No statistically significant difference between groups**	NR	9 women withdrew after random assignment (5 to the conventional laparoscopic group and 4 to the robot-assisted group); 1 woman put down for conventional laparoscopy underwent robot-assisted surgery in error (protocol deviation), and 1 woman in the conventional laparoscopic group was withdrawn as the result of missing data. 2 women for robot-assisted surgery were converted to laparoscopy. The report states that 26 women were analysed in each group, but denominators are not specifically given for each outcome. More than 20% of data on pain and activity outcomes were missing; therefore, high risk was assigned for these outcomes

Intervention	Comparator	Evidence source(s)	Measure	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Robot-assisted hysterectomy	Open hysterectomy	1 RCT by Wijk et al. (2018) in systematic review by Lawrie et al. (2019) (n = 20)	WHO score (activity level)	4 weeks	Robot-assisted hysterectomy: n = 10 Open hysterectomy: 10	Robot-assisted hysterectomy: 2 events Open hysterectomy: 8 events	RR: 0.25 (0.07 to 0.9) **Favours robot-assisted hysterectomy**	Systematic review authors judged the evidence to be of very-low GRADE certainty. Authors of the systematic review judged there to be a high risk of performance bias and detection bias in the RCT as women and staff were aware of the different surgical techniques applied.
Sacrocolpopexy								
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Illiano et al. (2019) (n = 100)	FSFI	2 years	Robot-assisted sacrocolpopexy: n = 51 Conventional laparoscopic sacrocolpopexy: n = 49	Median (range) in robot-assisted sacrocolpopexy group: 26.5 (13 to 30) Median (range) in conventional laparoscopic sacrocolpopexy group: 22 (2 to 33) p = 0.097 **No statistically significant difference between groups**	NR	We did not use the results for this RCT reported in the systematic review by Maher et al. (2023) as they are incorrect. We used the results from the primary study.
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Anger et al. (2014) in systematic review by Lawrie et al. (2019) (n = 78)	NR	6 weeks	Robot-assisted sacrocolpopexy: n = 40 Conventional laparoscopic sacrocolpopexy: n = 38	MD: -0.01 (95% CI: -0.06 to 0.04) **No statistically significant difference between groups**	NR	Authors of the systematic review mainly judged the RCT to be of low RoB.

Intervention	Comparator	Evidence source(s)	Measure	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Paraiso et al. (2011) (n = 78)	PFDI-20	1 year	Robot-assisted sacrocolpopexy: n = 35 Conventional laparoscopic sacrocolpopexy: n = 33	Median (range) in robot-assisted sacrocolpopexy group: 44 (0 to 161) Median (range) in conventional laparoscopic sacrocolpopexy group: 38 (0 to 226) **No statistically significant difference between groups**	NR	We did not use the results for this RCT reported in the systematic review by Maher et al. (2023) as they are incorrect. We used the results from the primary study.
Endometriosis								
Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	1 RCT by Soto et al. (2017) in SR by Lawrie et al. (2019) (n = 73)	SF-12 (Physical Health Score)	6 weeks	Robot-assisted surgery: n = 35 Conventional laparoscopic surgery: n = 38	Mean in robot-assisted surgery group (SD): 39.6 (3.6) Mean in conventional laparoscopic surgery group (SD): 41.9 (2.8) MD: -2.3 (95% CI: -3.79 to -0.81) **Favours conventional laparoscopic surgery**	NR	Systematic review authors reported that these results are difficult to interpret because baselines scores were also higher in the conventional laparoscopic surgery group than in the robot-assisted surgery group.
				6 months		Mean in robot-assisted surgery group (SD): 42.4 (3.9) Mean in conventional laparoscopic surgery group (SD): 41.1 (4.3) MD: 1.3 (95% CI: -0.58 to 3.18) **No statistically significant difference between groups**	NR	Authors of the systematic review judged there to be a high risk of performance bias and detection bias, due to staff being aware of the group allocations.

Intervention	Comparator	Evidence source(s)	Measure	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability

Abbreviations: CI, confidence interval; EQ-5D, EuroQol-5 Dimension; FSFI, Female Sexual Function Index; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; MD, mean difference; n, number of study participants; NR, not reported; PFDI-20, Pelvic Floor Disability Index; RCT, randomised controlled trial; RoB, risk of bias; RR, risk ratio; SD, standard deviation; SF-12, 12-Item Short Form Health Survey; SF-36, 36-Item Short Form Health Survey; WHO, World Health Organization

Table 14 – Patient satisfaction: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Measure	Follow-up time	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Sacrocolpopexy								
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Illiano et al. (2019) in systematic review by Maher et al. (2023) (n = 100)	PGI-I (better or very much better)	2 years	Robot-assisted sacrocolpopexy: n = 51 Conventional laparoscopic sacrocolpopexy: n = 49	Robot-assisted sacrocolpopexy: 40 events Conventional laparoscopic sacrocolpopexy: 47 events	RR: 1.13 (0.97 to 1.32) **No statistically significant difference between groups**	Systematic review authors judged RCT to be at high risk of detection bias due to lack of blinding of outcome assessment.
Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	1 RCT by Paraiso et al. (2011) (n = 78)	PISQ	1 year	Robot-assisted sacrocolpopexy: n = 35 Conventional laparoscopic sacrocolpopexy: n = 33	Median (range) in robot-assisted sacrocolpopexy group: 16 (3 to 27) Median (range) in conventional laparoscopic sacrocolpopexy group: 11 (3 to 22) **No statistically significant difference between groups**	NR	We did not use the results for this RCT reported in the systematic review by Maher et al. (2023) as they are incorrect. We used the results from the primary study.

Abbreviations: CI, confidence interval; MD, mean difference; n, number of study participants; PGI-I, Patient Global Impression of Improvement; PISQ, Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire; RCT, randomised controlled trial; RR, risk ratio

Table 15 – Ergonomics: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Hysterectomy						
Robot-assisted hysterectomy and/or lymphadenectomy	Conventional laparoscopic hysterectomy and/or lymphadenectomy	1 RCT by Hotton et al. (2023)	n = 385 Women with malignant gynaecological lesions Follow-up time: 4 hours	Borg scale level of discomfort (mean ± SD): Legs: 1.3 ± 1.7 (CLS) and 0.3 ± 0.7 (RAS) Shoulders and arms (left): 1. 8 ± 1.6 (CLS) and 0.6 ± 1.0 (RAS) Shoulders and arms (right): 1.8 ± 1.8 (CLS) and 0.4 ± 1.0 (RAS) Forearms and hands (left): 1.2 ± 0.2 (CLS) and 0.2 ± 0.5 (RAS) Forearms and hands (right): 1.3 ± 1.8 (CLS) and 0.1 ± 0.7 (RAS) **Favours RAS** Back: 1.6 ± 1.6 (CLS) versus 1.6 ± 1.5 (RAS) **No significant difference between groups** Perceived physical activity assessed by NASA-TLX scale (mean ± SD): 4.7 ± 2.0 (CLS) versus 3.2 ± 2.0 (RAS), $p < 0.01$ **Favours RAS** Perceived abilities assessed by NASA-TLX scale (mean ± SD): 5.8 ± 2.0 (CLS) versus 5.2 ± 2.1 (RAS), $p < 0.01$ **Favours CLS** Personal performance assessed by NASA-TLX scale (mean ± SD): 3.5 ± 2.1 (CLS) versus 4.1 ± 2.3 (RAS), $p < 0.01$) **Favours CLS** Mental load assessed by NASA-TLX scale (mean ± SD): 4.9 ± 2.2 (CLS) versus 5.1 ± 2.3 (RAS) **No significant difference between groups** Perceived frustration assessed by NASA-TLX scale (mean ± SD):	NR	Studies did not include participants with benign gynaecological conditions. Type of robot: NR

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
				3.0 ± 2.2 (CLS) versus 2.9 ± 2.2 (RAS) **No significant difference between groups** Effort invested assessed by NASA-TLX scale (mean ± SD): 4.8 ± 2.0 (CLS) versus 4.6 ± 2.3 (RAS) **No significant difference between groups**		

CI, confidence interval; CLS, conventional laparoscopic; NR, not reported; RCT, randomised controlled trial; RAS, robot-assisted surgery: SD, standard deviation

Table 16 – Subgroup analysis – operating time by body mass index: robot-assisted surgery compared to other types of surgery

Intervention	Comparator	Evidence source(s)	Population	Absolute effect	Relative effect (95% CI)	Comments on reliability
Myomectomy						
Robot-assisted myomectomy	Conventional laparoscopic myomectomy	20 comparative observational studies in the pooled analysis by Chen et al. (2024)	Normal weight (BMI: 18.5–24.9 kg/m²)	MD: 47.66 minutes (95% CI: 21.63 to 73.69) p = < 0.001 **Favours conventional laparoscopic myomectomy**	NR	The number of participants included in the pooled analysis is unclear Systematic review authors judged there to be substantial heterogeneity (I^2 = 95%)
			Overweight (BMI: >25 kg/m²)	MD: 39.86 minutes (95% CI: 12.30 to 67.42) p = 0.005 **Favours conventional laparoscopic myomectomy**		

Abbreviations: BMI, body mass index; CI, confidence interval; kg, kilograms; m, metre; MD, mean difference; n, number of study participants; NR, not reported

5.23 Ongoing studies

Due to the volume of evidence identified, we only searched for ongoing RCTs. No relevant ongoing RCTs were identified.

5.24 Certainty of the evidence

Systematic reviews, sometimes including pooled analyses, of RCTs were identified for hysterectomy, sacrocolpopexy and treatment of endometriosis. These RCTs had small sample sizes and the event rates may have lead to underpowered studies. Experts commented that the issue of learning curve, end-user experience, or surgeon competency between studies is also not addressed within small RCTs, as a small change in event rate between surgeons of different skill-levels can have significant impacts on results.

Robot-assisted hysterectomy and robot-assisted surgery for endometriosis were reported by the authors of the systematic reviews as having very low- to low-certainty RCT evidence. Sacrocolpopexy was reported by the authors of the systematic review as having low- to moderate-certainty RCT evidence. Most of the RCTs were judged to be at high risk of performance and detection bias, due to lack of blinding of participants, staff and the outcome assessment.

Although RCT evidence was identified, only one RCT of 73 women was included in the systematic review for robot-assisted surgery for endometriosis, and NMA data for robot-assisted sacrocolpopexy compared to open sacrocolpopexy came from indirect evidence.

The evidence for robot-assisted myomectomy came from observational studies with mainly historical controls. Although the observational outcomes were judged by the systematic review authors as being mainly of high certainty, the risk of bias in these study designs is high because of the lack of randomised allocation and the use of some historical control groups that may not be adequately matched to the intervention group.

Most of the RCT evidence compared robot-assisted surgery to conventional laparoscopic surgery. Limited evidence was identified which compared robot-assisted surgery to open surgery or vaginal surgery. No RCT evidence was identified which compared robot-assisted surgery for endometriosis to open surgery. Only evidence comparing robot-assisted hysterectomy to vaginal surgery was found, with none of the other types of surgery having any evidence compared to vaginal surgery.

Most of the evidence identified was for short-term outcomes, with some long-term evidence found for post-operative complications, recurrence, pain, quality of life, and patient satisfaction.

Limited RCT evidence was found for patient satisfaction and no RCT evidence was found for surgeon satisfaction. No QoL evidence was found for robot-assisted myomectomy. Limited evidence was found for outcomes stratified by BMI. No relevant evidence was found for the subgroup analysis of outcomes stratified by pre- and post-menopause. We did not identify any evidence for use of robot-assisted surgery in people undergoing preventative surgery for increased familial risk of cancer.

There was a high degree of heterogeneity observed for many of the pooled results, as indicated by the I^2 values given for each estimate of effect. This indicates that there is a high degree of inconsistency between the reported results of individual studies, and they should be interpreted with due consideration of this.

Most of the studies were conducted in the USA. None of them were conducted in the UK, meaning that applicability to NHS Wales is uncertain. Most systematic reviews either did not report the type of robot used or reported using the da Vinci robot system, and is it unclear how generalisable these findings are to other types of robot systems. Additionally, the generation of da Vinci platform was not reported in the reviews, which may impact outcomes.

6. Cost effectiveness

6.1 Economic literature review

We conducted a rapid systematic literature review to answer the following research question: what is the cost effectiveness of robot-assisted benign gynaecological surgery compared to standard care? Appendix 4 summarises the selection of articles for inclusion in the evidence review. The titles and abstracts of 3,450 records identified in the search for this research question were screened and 153 records were deemed potentially relevant from an economic perspective. The full texts of these studies were reviewed against the inclusion/exclusion criteria and 123 studies were excluded.

The majority of studies were excluded as they were systematic reviews (n = 23) or included patients with malignant disease (n = 17). Fifteen studies were evaluating the wrong intervention or comparator, and twelve identified studies were only abstracts. Further papers were excluded as they were not comparative (n = 11), they were a letter to the editor rather than a study (n = 10), they included insufficient information for our appraisal (n = 9), they were not economic studies (n = 8), or various other reasons (n = 18).

Following the initial study sift, 30 studies were left for inclusion. These studies compared the use of robot-assisted surgery in various indications: myomectomy, sacrocolpopexy, hysterectomy, tubal anastomosis, and endometriosis.

One study (Dharia Patel et al. 2008) was identified which looked at tubal anastomosis, however, following a lack of information identified at clinical review, it was decided to exclude this indication. A further study (Verrelli et al. 2024) was identified for endometriosis; however, it had limited cost information and so was selectively excluded.

Three studies were identified which looked at myomectomy. Two studies (Advincula et al. 2007, Nash et al. 2012) had limited cost information and so were selectively excluded. The remaining study is summarised in Table 17.

Behera et al. (2012) conducted a cost-minimisation analysis to assess differences between robot-assisted laparoscopic myomectomy (RM) with both abdominal myomectomy (AM) and traditional laparoscopic myomectomy (LM) from a US hospital perspective. The model inputs were populated from a literature review, and equivalent clinical outcomes were assumed between models. The authors considered two analyses: one where the upfront cost of the robot was included, and another where it was assumed that the purchase price for the robot had already been absorbed. Only direct surgical costs and immediate hospital stay were included in the analysis.

In both analyses, RM was found to be the most expensive option, at $7,280 (£5,169) per case in the analysis without robotic purchase price included. When the cost of the robot was included, this cost increased by $2,814 (£1,998), $1,939 (£1,377) and $1,090 (£774) per case when purchase and maintenance prices were distributed over 12-, 18- and 32- cases per month, respectively. Before costs of robotics are considered, AM was estimated to be the least costly option at $4,937 (£3,506), and LM was expected to cost $6,199 (£4,402). Compared to AM and LM, RM incurs an additional $2,343 (£1,664) and $1,081 (£768), respectively. The increased cost associated with RM was driven mostly by costs associated with disposable instruments and early conversion costs to a AM.

One-way sensitivity analysis showed that RM became less costly than AM when surgeons fee for AM was greater than $3,473 (£2,466) (compared to $1,068 (£758) in the base case analysis). RM became less costly than LM when robotic disposable equipment costs were less than $1,400 (£994) (compared to $2,511 (£1,783) in the base case analysis).

This study was deemed partially applicable to the research question, as being from the US limits applicability to a Welsh setting, with minor limitations. Two key limitations are that the study only considers costs associated with the surgery and immediate hospital stay, with no consideration of long-term costs or consequences, and no complications of the surgical options are considered.

Eight studies were identified which looked at the costs of sacrocolpopexy. Three of the identified studies (Baker et al. 2023, Hoyte et al. 2012, Patel et al. 2009) were selectively excluded from our review as they were retrospective cost analyses, and it was deemed that we had better evidence available. One study (Hullfish et al. 2011) was excluded as although it was a cost-utility analysis, it looked at various treatments and contained minimal information about the interventions of interest and also assumed equivalent utility between them. The remaining four studies (one cost utility study, two cost minimisation studies and one randomised controlled trial) are described in detail in Table 16.

Anger et al. (2014) assessed the costs and quality of life within a randomised controlled trial, where women with symptomatic stage II or greater pelvic prolapse were randomised on the day of surgery to receive either robotic sacrocolpopexy (RS) or laparoscopic sacrocolpopexy (LS). The study was conducted from a US health care perspective where cost and quality of life data were collected on the day of surgery and 6-weeks following surgery. Quality of life was collected using the EQ-5D and converted to a utility value.

The study found non-significant differences in costs between the two approaches when the cost of robotics was not included in the analysis. Without robotic costs, day of surgery costs for RS were $1,013 (£708) more expensive than LS ($p = 0.161$), and total 6-week costs were $1,697 (£1,185) more expensive ($p = 0.050$). However, when the cost of robotics was included, RS was significantly more expensive than LS for both on the day of surgery ($2,419 (£1,690) more expensive ($p = 0.001$)) and 6-weeks following surgery ($3,104 (£2,168) more expensive ($p < 0.001$)).

No significant differences were identified in quality of life between RS and LS either at baseline or 6-weeks post-surgery. Quality of life was found to be 0.83 and 0.86 at baseline for RS and LS, respectively, with RS being 0.03 lower than LS ($p = 0.374$). At 6-weeks post-surgery, quality of life was 0.90 and 0.91 for RS and LS, respectively, with RS being 0.01 lower than LS ($p = 0.685$).

A cost-utility study was identified (Wang et al. 2021) evaluating treatment pathways combining RS, LS and vaginal apical suspension (VAS) for women with apical prolapse from a US health care perspective. Women were assumed to be retreated with one of the surgical options if they had a recurrence. The study used a decision tree approach with a Markov model to capture long-term outcomes and was conducted over 5- and 10-year time horizons. Input parameters were sourced from the literature. Equivalent utility was applied for RS and LS.

The model found that treatment pathways beginning with RS were either dominated or had a very high ICER compared to pathways beginning with VAS or LS over 5 years. Similarly, over 10 years, when compared to LS, RS remained dominated, however, when compared to pathways beginning with VAS, RS could be a cost-effective option, with a cited ICER of $35,479 (£23,759) when RS followed by VAS is compared to VAS followed by VAS.

The biggest limitation of this study is that it is not clear whether the VAS is sacrocolpopexy or uterosacral or sacrospinous ligament fixation. Therefore, it is uncertain whether this is a relevant comparator for our appraisal.

Two cost-minimisation analyses were identified, both conducted from a US hospital perspective. One study used retrospective data to inform their analysis (Elliott et al. 2012), and the other conducted a literature review (Judd et al. 2010). Elliott et al. (2012) compared RS with abdominal open sacrocolpopexy (AOS), and Judd et al. (2010) compared RS with LS and AOS.

Judd et al. (2010) looked at surgical and short-term costs only and found that RS was more expensive than both LS and AOS regardless of whether costs of robotics are included in the analysis. This was likely driven by a longer operative time, despite a shorter length of stay (LOS) associated with RS compared to the other two approaches.

Alternatively, Elliott et al. (2012) was the only identified study which found RS to be cheaper than the comparator. They evaluated costs during the immediate post-operative period of 30 days and found that RS was $1,129 (£792) cheaper than AOS. However, this study is associated with potentially serious limitations, including bias towards treating more serious cases with AOB leading to longer LOS. This could explain the disparity between the difference in operative times cited in this study compared to others. The operative times of RS were significantly shorter than other studies evaluating the cost of RS, resulting in a shorter time to conduct RS compared to AOS.

All of the studies evaluating costs of sacrocolpopexy were deemed partially applicable as being from the USA limits applicability to a Welsh setting.

Seventeen studies were identified which looked at hysterectomy. Due to the large number of studies identified, 10 studies (Bauer et al. 2022, Dandolu & Pathak 2018, Dayaratna et al. 2014, Ghomi et al. 2022, Hart et al. 2013, Kaaki et al. 2020, Moawad et al. 2017, Shepherd et al. 2014, Wright et al. 2012, Wright et al. 2014) were selectively excluded as they were from the US, which was deemed less relevant to a Welsh setting than the identified European studies. Two studies (Landeen et al. 2011, Sarlos et al. 2012) were excluded as there was stronger evidence in the same population available.

Lönnerfors et al. (2015) conducted an RCT of benign gynaecologic disorders in women with uterine size less than or equal to 16 gestational weeks comparing robot-assisted laparoscopic hysterectomy (RH) with vaginal hysterectomy (VH) and laparoscopic hysterectomy (LH). They conducted the 3.5-year trial from a hospital perspective in Sweden. Data was collected on patients until four-months post-surgery.

They found that when the costs of robotics were not included, RH was more expensive than VH but slightly cheaper than LF. Incremental costs were $2,437 (£1,710) when compared to VH and a saving of $43 (£30) when compared to LH. However, when the cost of robotics was included, RH was found to be more expensive than both alternative surgeries, with incremental costs of $4,044 (£2,837) and $1,564 (£1,097) when compared to VH and LS, respectively. It was noted that the study was unpowered to detect differences in RH and LH.

Martínez-Maestre et al. (2019) conducted a cost-minimisation analysis for female adults scheduled for total laparoscopic hysterectomy for benign conditions, who were undergoing elective surgery and had a uterine length less than or equal to 16cm at vaginal ultrasound. The study was conducted from a Spanish healthcare perspective and was informed by an analytical observational study of prospective cohorts. The analysis compared RH to LH and found costs of €7,762 (£8,087) and €6,593 (£6,869), respectively, resulting in RH costing $1,169 (£1,218) more than LH. Increased costs with RH were driven by the increased equipment costs for this procedure.

A prospective hospital cost analysis conducted from Italy, Pellegrino et al. (2017), compared RH to LH and open hysterectomy (OH) for three months post-surgery. They found costs of RH were €2,642 (£2,477) and €1,849 (£1,734) more expensive than LH and OH, respectively. It should be noted that there are potentially serious limitations associated with this study; the costs of robotics were not included as the hospital conducting the study had already purchased the equipment for robotic surgery, and so costs could be underestimated if these have not already been purchased. Patients were also not randomised in this trial and were only able to have robotic surgery when it was available, which was two times per week.

Laursen et al. (2018) conducted a register based longitudinal study in the health care sector in Denmark. The study compared outcomes for women who underwent hysterectomy at six hospitals around Denmark during the 7.5-year study period one year prior to, and one year post surgery. Women were included who underwent RH, LH and OH. The difference in costs in the year before and after surgery were €2,483 (£2,312), €4,136 (£3,852) and €5,137 (£4,784) for RH, LH and OH, respectively. The study concluded that cost savings attributable to RH were €1,653 (£1,539) and €2,654 (£2,472) compared to LH and OH, respectively. Cost of the robotics are not included in the analysis.

However, this study is associated with potentially serious limitations. A key limitation is that the study is non-randomised, limiting the generalisability and comparability of included patients. Additionally, as costs are evaluated in the year before and after surgery, we cannot be certain that cost differences are due entirely to the surgical option as there may be other potential confounders.

A retrospective, mono-centric study informed a cost-effectiveness analysis by Paul-Dehlinger et al. (2024). This study used data from 2016 – 2019 on women who underwent a total hysterectomy for a benign condition at the Pitié-Salpétrière University Hospital and compared outcomes and costs for those undergoing RH and LH for one-month post-surgery. The study found statistically significant increased costs of €2,756 for procedures done robotically compared to those done with conventional laparoscopy. Cost-effectiveness was calculated as the cost per additional patient without major post-operative complication and with a range of outcomes. ICERs of €377,534, €1,722,500, €248,288 were reported for those with a Clavien-Dindo grade $\geq$ 3, a Clavien-Dindo grade $\geq$ 3 and/or transfusion, and a Clavien-Dindo grade $\geq$ 3 and/or transfusion and/or blood loss per op $\geq$ 500 cc, respectively.

This study is associated with minor limitations. The reported ICERs are reported on outcomes that did not show statistically significant differences between treatment arms. In addition, the retrospective and monocentric nature of the study means that results are not necessarily representative of a wider population.

All of the studies evaluating costs of hysterectomy were deemed partially applicable as being from Europe limits applicability to a Welsh setting.

Table 17 – Summary of included economic studies (Anger et al. 2014, Behera et al. 2012, Elliott et al. 2012, Judd et al. 2010, Laursen et al. 2018, Lönnerfors et al. 2015, Martínez-Maestre et al. 2019, Pellegrino et al. 2017, Wang et al. 2021, Paul-Dehlinger et al. 2024)

Study details	Study population and design	Data sources	Results	Quality assessment
Myomectomy				
Author and year: Behera et al. (2012) **Country:** USA **Type of economic analysis:** Cost-minimisation analysis **Perspective:** Healthcare system **Currency:** US dollars **Price year:** 2009 **Time horizon:** Direct surgical costs and immediate hospital stay afterwards only. **Discounting:** NA **Potential conflict of interest:**	**Population:** Women undergoing myomectomy by various surgical approaches. **Intervention:** Robotic-assisted laparoscopic myomectomies (RM). **Comparators:** Abdominal myomectomy (AM) Traditional laparoscopic myomectomy (LM). **Study design** Cost-minimisation study informed from a literature search and produced in TreeAge Pro 2008.	**Source of baseline and effectiveness data:** Equivalent surgical outcomes assumed for the three operative routes given the results of prior studies comparing each mode of myomectomy (Advincula et al. 2007, Alessandri et al. 2006, Nezhat et al. 2009) **Source of resource use and cost data:** Parameter values for operative time, conversion risk, transfusion risk and length of stay were derived from a search of the published literature. (Alessandri et al. 2006, Advincula et al. 2007, Glaser et al. 2008, Nezhat et al. 2009, Palomba et al. 2007, Sesti et al. 2008, Stringer et al. 1997, Subramanian et al. 2001) Cost estimates for physician reimbursement and anaesthesia were based on Medicare reimbursement by Current Procedural Terminology (CPT) codes. Overall costs of procedures were determined on the basis of compilation of all surgery-related costs incurred at their institution. Intraoperative costs included basic operating room costs. Costs for surgical disposables and standardised	**Base case results** Robot purchase and maintenance costs not included: AM: $4,937 (£3,506) LM: $6,199 (£4,402) RM: $7,280 (£5,169) RM incurs $2,343 (£1,664) compared to AM and $1,081 (£768) compared to LM. Robot purchase and maintenance costs included: Robotic costs increased by $2,814 (£1,998), $1,939 (£1,377) and $1,090 (£774) per case when purchase and maintenance prices were distributed over 12-, 18- and 32- cases per month. **Sensitivity analysis** One way sensitivity analysis showed that when robot purchase and maintenance costs were not included, AM remained the least expensive approach in most scenarios. In scenarios where AM length of hospital stay exceeded 4.3 days, LM became the least expensive option. In scenarios where the surgeons fee for AM exceeded $3,473 (£2,466), RM was less costly than AM but more costly than LM. The only scenario where RM was less costly than LM was when robotic	**Applicability** Partially applicable – correct intervention and comparator but being from the USA limits applicability. **Limitations** This study has minor limitations: • Unable to evaluate the impact of each route of surgery on quality-of-life due to limited data. • Includes only direct costs from a US perspective. • Data on long-term outcomes of different surgical approaches are limited and so clinical outcomes assumed equivalent. • Study only looks at short-term cost associated with surgery and no long-term costs are included. • Study does not include complications of surgery. • Lack of clarity on how many surgeries are likely to be performed per month and, therefore, which robotic surgery costs are most appropriate. • Sensitivity analysis limited to only a one-way sensitivity

Study details	Study population and design	Data sources	Results	Quality assessment
No commercial, proprietary, or financial interest in the products or companies described in this article.		instruments were obtained from hospital finance and accounting records. The cost of purchase and maintenance of the robot was based on the DaVinci S HD system obtained from Intuitive Surgical.	disposable equipment costs were less than $1,400 (£994).	analysis. No probabilistic or scenario analyses presented.
Sacrocolpopexy				
Author and year: Anger et al. (2014) **Country:** USA **Type of economic analysis:** Randomised control trial **Perspective:** Health care provider **Currency:** US dollars **Price year:** Not stated – assumed 2014. **Time horizon:** Patients followed up to 6 months following surgery. **Discounting:** NA	**Population:** Women with symptomatic stage II or greater pelvic prolapse with the leading edge of the prolapse to 1cm on either side of the introitus, including apical support loss to half total vaginal length. **Intervention:** Robotic Sacrocolpopexy (RS) **Comparator:** Laparoscopic sacrocolpopexy (LS) **Study design** Randomised comparative effectiveness trial described in Mueller et al. (2012) – this paper explores the	**Source of baseline and effectiveness data:** Quality of life was collected using the Short Form Health Survey and the EuroQol-5D. Other questionnaires specific to pelvic floor disorders were also included. EuroQol-5D was collected at baseline and 2 and 6 weeks after surgery and converted to a utility. **Source of resource use and cost data:** Hospital costs were obtained from charges from each patients' billing information and then applied cost-to-charge ratios. Cost-to-charge ratios were obtained from the cost reports which the hospitals submit annually to the Centres for Medicare and Medicaid Services. Estimates of physician costs were based on billing information. Cost per procedure of the robot was estimated based on the average	**Results** **Costs** Day of surgery costs: LS: $11,573 (£8,083) Excluding cost of robotics: RS: $12,586 (£8,791) Incremental: $1,013 (£708) ($p = 0.161$) Including cost of robotics: RS: $13,992 (£9,773) Incremental: $2,419 (£1,690) ($p = 0.001$) Total 6-week costs: LS: $12,170 (£8,500) Excluding cost of robotics: RS: $13,867 (£9,685) Incremental: $1,697 (£1,185) ($p = 0.050$) Including cost of robotics: RS: $15,274 (£10,668) Incremental: $3,104 (£2,168) ($p < 0.001$) **Effectiveness** EuroQol: Baseline: RS: 0.83	**Applicability** Partially applicable – correct intervention and comparator but being from the USA limits applicability. **Limitations** This study has minor limitations: • Relatively low patient numbers – 35 in LS arm and 38 in RS arm. • Only evaluates outcome for 6 weeks post-surgery and does not consider long-term costs. • Did not assess the feasibility and applicability of laparoscopic and robotic approaches to surgeons in non-academic medical centres. • Generalisability is limited to surgeons who may be more experienced in the technique. • Study included only two sites limiting the power to measure the effects of surgeon volume on operative time and cost.

Study details	Study population and design	Data sources	Results	Quality assessment
Potential conflict of interest: Funded by a National Institute of Biomedical Imaging and Bioengineering Recovery Act Limited Competition Challenge Grant	cost and quality of life within the study.	purchase price of the robots, the number of years of service it will provide, the resale or trade in value, the annual maintenance costs of the robot and the number of treatments for which the robot will be used per year. Costs of subsequent hospitalisations during 6 weeks after discharge for procedure were estimated from charges records on uniform billing 2004 forms or equivalent, which were converted to costs using cost-to-charge ratios.	LS: 0.86 Incremental: -0.03 (p = 0.374) 6-weeks post-surgery: RS: 0.90 LS: 0.91 Incremental: -0.01 (p = 0.685) Quality adjusted life years at 6 weeks post-surgery: RS: 0.098 LS: 0.101 Incremental: -0.003 (p=0.234)	
Author and year: Judd et al. (2010) **Country:** USA **Type of economic analysis:** Cost-minimisation analysis **Perspective:** Health care system **Currency:** US dollars **Price year:** 2008 **Time horizon:** Surgery and short-term events only	**Population:** Cohort of women with advanced pelvic organ prolapse who have elected to undergo surgical correction via sacrocolpopexy with synthetic polypropylene mesh. **Intervention:** Robot-assisted sacrocolpopexy (RS) **Comparators:** Laparoscopic sacrocolpopexy (LS) Abdominal sacrocolpopexy (AS) **Study design** Cost-minimisation analysis informed	**Source of baseline and effectiveness data:** Parameter estimates were derived from a systematic review of the medical literature. Parameters associated with RS were sourced from Geller et al. (2008). Parameters for LS were sourced from Paraiso et al. (2005). Parameters for abdominal surgery were sourced from Brubaker et al. (2006) and Geller et al. (2008). Parameters for sensitivity analyses were sourced from Akl et al. (2009), Brubaker et al. (2006), Geller et al. (2008), Hsiao et al. (2007), Nygaard et al. (2004), and Paraiso et al. (2005). Where estimates were not available from the literature, expert opinion was used. **Source of resource use and cost data:**	**Base case results** **Costs** RS (robot pre-existed): $8,508 (£5,970) RS (robot purchased): $9,962 (£6,990) LS: $7,353 (£5,160) AS: $5,792 (£4,064) Robot pre-existed: Incremental LS: $1,155 (£810) Incremental AS: $2,716 (£1,906) Robot purchased: Incremental LS: $2,609 (£1,831) Incremental AS: $4,170 (£2,926) **Sensitivity analysis** One way sensitivity analysis conducted using ranges from the literature. Robot pre-existed: When operative times of RS and LS were assumed equal, RS was only $773 (£542) more expensive.	**Applicability** Partially applicable – correct intervention and comparator but being from the USA limits applicability. **Limitations** This study has minor limitations: • Did not assess the effect of each route of surgery on quality of life. • Did not account for every potential cost that could be incurred during the perioperative period. • Only short-term events are considered that may occur during the initial admission – no long-term costs included. • Only one-way sensitivity analysis conducted - no probabilistic or scenario analyses.

Study details	Study population and design	Data sources	Results	Quality assessment
Discounting: NA **Potential conflict of interest:** The authors have no commercial, proprietary, or financial interest in the products or companies. Dr Visco (one author) is a proctor and assists with procedure development for Intuitive Surgical, Inc.	from a literature review and conducted in TreeAge Pro Suite 2008.	Costs were derived using a micro-costing approach based on their own institutional data. Physician reimbursements were derived from Medicare reimbursement rates. Procedure costs were derived by examining the perioperative, intraoperative, and postoperative costs incurred at Duke medical centre. For the cost of robotics, the cost of each reusable instrument was evenly distributed across 10 robotic procedures. It was assumed that hospitals already had equipment for LS and AS. Estimates for intravenous pharmacy costs were obtained from the Medicare Part B maximum allowable charge and oral medication costs were derived from the lowest advertised price online. The costs for hospital room and board and transfusions packed red blood cell unit costs were obtained from hospital billing department. The costs for the purchase and maintenance of the DaVinci Surgical system were based on the DaVinci S HD system. A cost to charge ratio of 0.6 was applied where only charges were supplied.	Cost equivalence between RS and LS was only reached when RS operative time was decreased below its lowest reported estimate in the literature. There were two scenarios when RS was less costly than LS: - Robotic disposables were reduced to less than $2,132 (£1,496) from the baseline cost of $3,293 (£2,311) - Laparoscopic disposables increased to more than $3,413 (£2,396) from the baseline cost of $2,244 (£1,575) Robot purchased: No scenario in which RS was less costly than LS.	

Study details	Study population and design	Data sources	Results	Quality assessment
Author and year: Wang et al. (2021) **Country:** USA **Type of economic analysis:** Cost-utility model **Perspective:** Health care system **Currency:** US dollars **Price year:** 2019 **Time horizon:** 5 and 10 years **Discounting:** Costs: 3% Outcomes: 3% **Potential conflict of interest:** No conflicts declared.	**Population:** Women with apical prolapse. **Intervention:** Robotic sacrocolpopexy (RS) **Comparators:** Vaginal apical suspension (VAS) Laparoscopic sacrocolpopexy (LS) **Study design** Cost utility analysis informed by the literature, using a decision tree designed with StoTree software followed by Markov model which evaluated a number of treatment pathways using vaginal, laparoscopic, or robotic sacrocolpopexy	**Source of baseline and effectiveness data:** Recurrence risk was derived from Coolen et al. (2017), Diwadkar et al. (2009), Lavelle et al. (2016), Pan et al. (2016), and Unger et al. (2015). Complication risks were derived from Childers & Maggard-Gibbons (2018), Coolen et al. (2017), Diwadkar et al. (2009), Hullfish et al. (2011), Pan et al. (2016), and Xu et al. (2010). Reoperation rate after recurrence was from Diwadkar et al. (2009) and Pan et al. (2016). Health state utilities were estimated from the literature. The utility of no prolapse and symptomatic prolapse was calculated from Rutstein et al. (2016) and Watanabe et al. (2017). The utility of vaginal apical suspension and minimally invasive sacrocolpopexy was from Chatterjee et al. (2014), Fawsitt et al. (2013), Fischer et al. (2016), Kang et al. (2017), Li et al. (2018), Neary et al. (2017) and Watanabe et al. (2017). The utility of diagnostic laparoscopy for complications was sourced from Dageforde et al. (2012), Hazen (2002), Neumann et al. (2014) and Welk et al. (2015).	**Base case results** Treatment pathways beginning with RS were either dominated or had a very high ICER compared to pathways beginning with VAS or LS over 5 years. Similarly, over 10 years, when compared to LS, RS remained dominated. However, when compared to pathways beginning with VAS, RS could be a cost-effective option, with a cited ICER of $35,479 (£23,759), when robotic surgery followed by vaginal repair is compared to vaginal surgery followed by vaginal repair. **Sensitivity analysis** One way sensitivity analysis showed that rates of recurrence and costs of surgery had the greatest impact on results.	**Applicability** Partially applicable – correct intervention and comparator but being from the USA limits applicability. **Limitations** This study has potentially serious limitations: • Unclear whether the vaginal surgery is sacrocolpopexy or whether it is a uterosacral or sacrospinous ligament fixation and so not a relevant comparator. • Efficacy inputs are equivalent for LS and RS and so the comparison between these two interventions is really a cost-minimisation analysis. • Limited data on the efficacy of subsequent apical suspension procedures after failure of the initial surgery. Analysis considers rates for initial procedures. • Limited data on quality of life associated with specific health states. • Sensitivity analysis restricted to one-way sensitivity analysis – no probabilistic analysis performed.

Study details	Study population and design	Data sources	Results	Quality assessment
		Source of resource use and cost data: Estimates of costs for surgical procedures, office visits and laboratory tests were based on values from the Healthcare Bluebook, which calculate costs from actual claims and uses commercial and Medicare data (Mowat et al. 2016, Rogers et al. 2018). Costs associated with laparoscopic sacrocolpopexy were sourced from Mowat et al. (2016), Pan et al. (2016) and Rogers et al. (2018). Costs of robotic sacrocolpopexy were sourced from Jacklin & Duckett (2013) and Pan et al. (2016).		
Author and year: Elliott et al. (2012) **Country:** USA **Type of economic analysis:** Cost-minimisation model **Perspective:** Hospital cost **Currency:** US dollars **Price year:** 2008	**Population:** Women who underwent abdominal open or robot-assisted sacrocolpopexy operations at the institution between July 2006 and July 2010. **Intervention:** Robotic sacrocolpopexy (RS) **Comparator:** Abdominal open sacrocolpopexy (AOS) **Study design**	**Source of resource use and cost data:** Operating room costs per minute and anaesthesiology costs were calculated using previously published data and online calculators, respectively, using the appropriate International Classification of Diseases (ICD) codes. Surgery duration was estimated using institutional data. Cost of robot per case calculated using robotic cost amortized during 5 years at 5.5% interest with yearly maintenance, divided by the total number of cases done annually at the institution. The institutional number of robotic cases was derived from Stanford	**Base case results** RS: $10,178 (£7,142) AOS: $11,307 (£7,934) Incremental: $1,129 (£792) saving **Sensitivity analysis** One way sensitivity analysis showed that the number of robotic cases done at an institution has the greatest impact on overall costs of RS. Other important variables driving costs were cost per day of hospital stay, length of stay, operating room time and disposable costs.	**Applicability** Partially applicable – correct intervention and comparator but being from the USA limits applicability. **Limitations** This study has potentially serious limitations: • Low number of surgeries performed – 40 RS and 19 AOS. • Decision for surgery was down to the surgeon – 2 surgeons always chose open, and 2 surgeons always chose robotic. • Robotic operative times were significantly shorter than other studies evaluating the cost of RS.

Study details	Study population and design	Data sources	Results	Quality assessment
Time horizon: Costs considered for the immediate post-operative period (30 days) **Discounting:** NA **Potential conflict of interest:** No conflicts declared.	Cost-minimisation analysis using TreeAge software informed by a retrospective review of all abdominal open or robot-assisted sacrocolpopexy operations collected over 4 years.	University Medical Centre operating room records. Costs of hospital stay were calculated based on United States Census Bureau estimates. Length of stay per operation were derived from institutional data.		• Included RS cases were done during the operative learning curve of 2 surgeons. • More complicated cases were performed with the open approach which could lead to a bias in these cases towards a greater chance of postoperative ileus and longer operating times. • Length of stay (LOS) for AOS was impacted by two patients who were hospitalised by over a week due to postoperative ileus. • Few concurrent hysterectomies were done at sacrocolpopexy, which may mean that results can only apply to patients with vaginal vault prolapse and not those with uterovaginal prolapse. • Statistical analyses of baseline characteristics showed significant differences in age. Only age and body mass index (BMI) were included in baseline characteristics and so it is unclear how similar the two cohorts were.
Hysterectomy				
Author and year: Lönnerfors et al. (2015) **Country:**	**Population:** Benign gynaecologic disorders in women with uterine size less than or equal to 16	**Source of baseline and effectiveness data:** Total operating room time, total operative time, intraoperative blood loss and complications were collected.	**Results** **Costs** MIH: $6,023 (£4,226) VH: $4,579 (£3,213)	**Applicability** Partially applicable – correct intervention and comparator but being from Sweden limits applicability.

Study details	Study population and design	Data sources	Results	Quality assessment
Sweden **Type of economic analysis:** Randomised controlled trial. **Perspective:** Hospital costs **Currency:** US dollars **Price year:** 2012 **Time horizon:** Trial took place over 3.5 years with patients followed for 4 months post-surgery. **Discounting:** NA **Potential conflict of interest:** Dr Persson is a proctor in robotic surgery.	gestational weeks after excluding women referred for vaginal hysterectomy. **Intervention:** Robot assisted laparoscopic hysterectomy (RAH) using the DaVinci Si Surgical system. **Comparator:** Minimally invasive hysterectomy (MIH) - Vaginal (VH) or laparoscopic (LH) **Study design** Randomised controlled trial with cost collection	**Source of resource use and cost data:** Admittance fee, operating room time, hospital LOS, cost of complications, readmission and repeat interventions collected until 4 months after surgery. Hospital internal charge based on the average real cost for the respective parameter. Per-minute charge for use of the operating room is based on the previous year's mean institutional cost and includes the operating theatre, 1 surgeon, 1 assistant, 1 scrub nurse, 1 circulating nurse, anaesthetic staff, cleaning, and basic expendables such as gowns and gloves. Cost of procedures were also collected.	LH: $7,059 (£4,953) Robot pre-existed: RAH: $7,016 (£4,923) Incremental (MIH): $993 (£697) Incremental (VH): $2,437 (£1,710) Incremental (LH): -$43 (£30) Robot purchased: RAH: $8,623 (£6,050) Incremental (MIH): $2,600 (£1,824) Incremental (VH): $4,044 (£2,837) Incremental (LH): $1,564 (£1,097)	**Limitations** This study has minor limitations: • Only looks at women with uterine size less than or equal to 16 gestational weeks– potentially a subset of our population of interest. • Laparoscopic procedure was a second option if vaginal surgery not appropriate. It is not clear what made these women inappropriate for vaginal surgery and whether they may be more complex cases and thus have higher costs associated with their procedure. • Use of instruments and equipment in study may not be reflective of other centres. • Study was underpowered for comparing LH to RAH. • Study was not powered to detect differences in infrequent adverse events.
Author and year: Martínez-Maestre et al. (2019) **Country:** Spain	**Population:** Female adults scheduled for total laparoscopic hysterectomy for benign conditions.	**Source of resource use and cost data:** Healthcare resource data was extracted from hospital information system databases.	**Base case results** **Costs** CLH: €6,593 (£6,869) RAH: €7,762 (£8,087) Incremental: €1,169 (£1,218)	**Applicability** Partially applicable – correct intervention and comparator but being from Spain limits applicability.

Study details	Study population and design	Data sources	Results	Quality assessment
Type of economic analysis: Cost-minimisation analysis **Perspective:** Healthcare and indirect **Currency:** Euros **Price year:** 2015 **Time horizon:** 5 years **Discounting:** None specified. **Potential conflict of interest:** No conflicts declared	Undergoing elective surgery and had a uterine length less than or equal to 16cm at vaginal ultrasound. **Intervention:** Robotic-assisted hysterectomy (RAH) using the da Vinci system. **Comparator:** Conventional laparoscopic hysterectomy (CLH) **Study design** Cost minimisation analysis informed by an analytic observational study of prospective cohorts	Healthcare costs were calculated based on the use of healthcare services. A&E department consultations and specialist consultations were estimated using the price list published by the Andalusian Public Health System. Hospitalisation costs were estimated based on diagnosis related groups (DRG). Material costs were calculated using market prices.	**Sensitivity analysis** Equipment costs demonstrated the largest impact on cost difference. Variations in the equipment and material costs maximise the cost difference between groups. Variations in the hospital admissions and productivity loss costs minimize the cost difference between groups.	**Limitations** This study has minor limitations: • Only looks at women with uterine size less than or equal to 16 gestational weeks-potentially a subset of our population of interest. • Unable to do a randomised trial as the robot could only be used once per week and is shared with other specialties.
Author and year: Pellegrino et al. (2017) **Country:** Italy **Type of economic analysis:** Prospective cost analysis	**Population:** Women undergoing hysterectomy during the study period. **Intervention:** Four armed DaVinci robot assisted hysterectomy (RAH) **Comparators:**	**Source of resource use and cost data:** Per minute charge for use of operating room based on institutional cost. Standard operating room staff for 3 procedures; one scrub nurse, one circulating nurse, one anaesthesiology nurse, one anaesthetist, two gynaecological surgeons.	**Results** RAH: €4,695 (£4,402) TLH: €2,052.70 (£1,924) OH: €2,846 (£2,668) Incremental (TLH): €2.642 (£2,477) Incremental (OH): €1.849 (£1,734)	**Applicability** Partially applicable – correct intervention and comparator but being from Italy limits applicability. **Limitations** This study has potentially serious limitations. • Not randomised – patients referred to robotic surgery if

Study details	Study population and design	Data sources	Results	Quality assessment
Perspective: Medico-economic – hospital costs **Currency:** Euros **Price year:** Not stated – assumed 2015. **Time horizon:** Data collected for 1 year – patients followed for 3 months post-surgery. **Discounting:** NA **Potential conflict of interest:** None declared	Total laparoscopic hysterectomy (TLH) Open hysterectomy (OH) **Study design** Prospectively collected cost study	Time cost of the operating room was evaluated using fixed charges and variable charges. Robot cost was divided into basic cost and robot-associated specific cost. The cost of each reusable instrument with RAH was calculated based on the hypothesis that each instrument is replaced after 10 uses. Maintenance cost of robot calculated by adding yearly maintenance, multiplying by the percentage of all RAHs and diving by the total number of hysterectomies performed robotically. Personnel costs for surgeons, anaesthetists and nurses were calculated as cost per minute with different personnel factors.		vaginal expected to be difficult and so unclear if they would also be eligible for other options. If contraindicated for minimally invasive surgery, open surgery was adopted suggesting that patients wouldn't be eligible for all surgery options. • Laparoscopic procedures only took place when the DaVinci system was unavailable (room available only 2 days per week). • Cost of the robotic system was not included as it had already been acquired in the institution. This may translate to lower costs than newly implementing the whole robotic system. • No statistical analysis conducted to determine how patients receiving different surgical options compare to one another.
Author and year: Laursen et al. (2018) **Country:** Denmark **Type of economic analysis:** Registry cost collection **Perspective:**	**Population:** Women who underwent hysterectomy at six hospitals around Denmark during the study period. **Intervention:** Robot-assisted hysterectomy (RAH)	**Source of resource use and cost data:** Information on use of primary care was derived from the Danish National Health Service Register and was valued using the national collectively bargained tariffs. Information on the use of secondary care was obtained from the Danish National Patient Register and valued using tariffs of the national DRG system	**Base case results** **Costs** RAH: Year before surgery: €5,939 (£5,531) Year after surgery: €8,422 (£7,843) Difference: €2,483 (£2,312) TLH: Year before surgery: €4,055 (£3,776) Year after surgery: €8,191 (£7,628) Difference: €4,136 (£3,852)	**Applicability** Partially applicable – correct intervention and comparator but being from Denmark limits applicability. **Limitations** This study has potentially serious limitations: • Costs of robotic machine are not included which could underestimate the cost of RAH.

Study details	Study population and design	Data sources	Results	Quality assessment
Health care sector **Currency:** Euros **Price year:** 2014 **Time horizon:** Data used from a 7.5-year period. Women were followed from 1 year before to 1 year after surgery. **Discounting:** NA **Potential conflict of interest:** No conflicts declared	**Comparators:** Total laparoscopic hysterectomy (TLH) Open abdominal hysterectomy (OAH) **Study design** Register based longitudinal study	and the Danish Outpatient Grouping System (DAGS).	OAH: Year before surgery: €4,064 (£3,785) Year after surgery: €9,201 (£8,568) Difference: €5,137 (£4,784) Cost savings attributable to RAH: Compared to TLH: €1,653 (£1,539) Compared to OAH: €2,654 (£2,472) **Sensitivity analysis** Length of stay and potential misclassification of surgical procedure were included in regression analysis. Bootstrapping method conducted with 5,000 replicates. None of the sensitivity analyses were found to change the results noticeably. Potential misclassification of surgical procedure showed the largest impact on the results. Multivariate analysis showed similar savings to the base case analysis, with savings of €1,045 (£973) compared to TLH and €2,460 (£2,291) compared to OAH.	• As this was not a randomised trial, there is limited understanding on how surgical approaches were assigned to patients and if they were appropriate for all approaches considered. • Cost savings of RAH based on the incremental cost before and after all surgical approaches, but we don't know what other confounders there could be that might affect these costs for the differing surgeries. • Patients selected for RAH had more severe disease, limiting the comparability. • Covariates such as psychological health and BMI were not included in the multivariate analysis.
Author and year: Paul-Dehlinger et al. (2024) **Country:** France **Type of economic analysis:**	**Population:** All women over the age of 18 who underwent a total hysterectomy for a benign condition at the Pitié-Salpétrière University Hospital	**Source of baseline and effectiveness data:** Data on patient characteristics, duration of surgery, operative complications and number and type of staff present during study were collected retrospectively, in a Case Report Form from patients' medical records.	**Base case results** **Statistically significant differences in:** **Operating room occupancy time (minutes):** RAH: 252 CLH: 198 Incremental: 54	**Applicability** Partially applicable – correct intervention and comparator but being from France limits applicability. **Limitations** This study has minor limitations:

Study details	Study population and design	Data sources	Results	Quality assessment
Cost-effectiveness analysis **Perspective:** Healthcare system **Currency:** Euro **Price year:** 2021 **Time horizon:** Data used from a 3-year period. Women were followed from 1 month following surgery. **Discounting:** NA **Potential conflict of interest:** Competing interest reported. Pr Geoffroy Canlorbe and Dr Jeremy Belghiti are speaker and proctor for Intuitive Surgical. Intuitive Surgical has financed data collection. Note that Intuitive Surgical had no control over the protocol,	**Intervention:** Robotic-assisted surgery (RAH) **Comparators:** Conventional laparoscopic (CLH) **Study design:** Cost-effective analysis on data from a non-interventional, retrospective, and mono-centric study	The main outcome was the rate of patients without major post-operative complications corresponding to a Clavien-Dindo grade ≥ 3. Other outcomes of interest were: - the rate of patients without major post-operative complications nor pre or postoperative transfusions. - the rate of patients without major post-operative complications, no pre or postoperative transfusions nor blood loss ≥ 500cc during the surgery. - operating room occupancy time - operative time - the length of initial stay **Source of resource use and cost data:** Data on initial hospital stay and readmissions were extracted from the French Hospital Medical Information System (PMSI) database and data from Intuitive Surgical. Total cost comprised procedural costs, bed days costs and readmission costs. Staff costs per hour were calculated using the average salary costs and social charges for each type of staff member for full-time contracts of 1,607 hours per year. Operating room costs were derived from the cost accounting of operating rooms under the assumption that operating rooms functioned 10 hours a day for 249 days in 2019. Hospital stays and readmission costs were valued using the French national hospital cost study (EtudeNationale de	**Operative time (minutes):** RAH: 153 CLH: 120 Incremental: 33 **Costs** RAH: €6,615 CLH: €3,859 Incremental: €2,756 **ICER (cost per additional patient without major post-operative complication for each of the below effectiveness criterion):** Clavien-Dindo grade ≥ 3: €377,534 Clavien-Dindo grade ≥ 3 and/or transfusion: €1,722,500 Clavien-Dindo grade ≥ 3 and/or transfusion and/or blood loss per op ≥ 500 cc: €248,288 None of the above ICERs are based on statistically significant differences between arms. **Sensitivity analysis** Nonparametric bootstrap method tested uncertainty which provided multiple estimates of the ICER by 1,000 random resamples presented. For Clavien Dindo grade ≥ 3, a threshold of €290,000/patient resulted in RAH having a 50.0% probability of being cost-effective. For Clavien-Dindo grade ≥ 3 and/or transfusion and/or blood loss per op, RAH has a 50.0% chance of being cost-	• Cost-effectiveness calculated on non-statistically significant differences between RAH and CLH. • Lack of experience in robotic surgery at the time of the study, which may affect operating times and complications. • Follow-up of only a month. • Retrospective monocentric study, therefore, there is a lack of external validity of results on a national scale.

Study details	Study population and design	Data sources	Results	Quality assessment
analysis, and interpretation of results.		Coûts à Méthodologie Commune, ENCC) by adjusting costs to the length of stay (LOS).	effective when the threshold is €1,050,000 /patient. One way-deterministic analysis explored uncertainty of the mean total cost of robotic surgeries. Length of hospital stay had the biggest impact on the total costs, followed by the number of robotic surgeries performed each year.	

Abbreviations: AM, abdominal myomectomy; AOS, abdominal open sacrocolpopexy; AS, abdominal sacrocolpopexy; BMI, body mass index; CLH, conventional laparoscopic hysterectomy; CPT, current procedural terminology; DAGS, Danish Outpatient Grouping System; DRG, diagnosis related groups; ICD, international classification of diseases; ICER, incremental cost-effectiveness ratio; LH, laparoscopic hysterectomy; LM, laparoscopic myomectomy; LOS, length of stay; LS, laparoscopic sacrocolpopexy; MIH, minimally invasive hysterectomy; NA, not applicable; OAH, open abdominal hysterectomy; OH, open hysterectomy; RAH, robot-assisted hysterectomy; RM, robotic myomectomy; RS, robotic sacrocolpopexy; TLH, total laparoscopic hysterectomy; VAS, vaginal apical suspension; VH, vaginal hysterectomy.
Costs converted to UK pounds using purchasing power parities (OECD 2023) for the price year of each study. Costs have not been inflated to current values.

6.2 HTW cost consequence analysis

A cost-consequence analysis was developed using Microsoft Excel to compare the costs and outcomes of surgical options for benign gynaecological conditions. Three comparisons are conducted in the analysis, which evaluate the cost-consequence of robot-assisted surgery against the following strategies:

1. Conventional laparoscopic hysterectomy
2. Conventional laparoscopic sacrocolpopexy
3. Abdominal open sacrocolpopexy

The model captured costs and outcomes for the surgical period and immediate hospital stay, as no evidence of a long-term benefit was identified in the literature.

Outcomes identified in the effectiveness review with statistically significant differences between surgical options were considered in the analysis. For more information on the studies identified in the effectiveness literature review, please refer to Section 5.

The costs considered reflect the perspective of the analysis, thus only costs that are relevant to the UK NHS & PSS were included. Where possible, all costs were estimated in 2023 prices. Where costs were reported in a different cost year, they were inflated to 2023 prices using the NHS cost inflation index (Jones et al. 2022).

Costs within the model have been sourced from NHS Reference costs 2022-23 (NHS England 2023) to account for costs of each procedure. For patients admitted to hospital, a daily cost of £460 associated with staying on a general ward was applied to their length of stay, informed by excess bed day costs reported in the NHS National Cost Collection reference costs (2017/18) (NHS Improvement 2020).

Costs of the da Vinci Single Xi and Versius robotic systems were provided by their respective manufacturers, Intuitive Surgical and CMR Surgical. The da Vinci Single Xi system costs £1.6 million and the Versius system £1.2 million, with annual maintenance costs of £140,000 and £120,000, respectively. An average cost for both systems was used in the base case analysis. The average cost of the robot and maintenance was assumed to be spread over 7 years, with an assumed 300 benign gynaecological surgeries being undertaken by the robots per year. This aligns with evidence identified in the economic review, and information provided by experts during our appraisal process. This resulted in an average cost of £1,038 per patient for the purchase of the robot.

In addition to the robotic purchase price, each procedure is associated with instrument costs. An average of instrument costs from both the da Vinci Single Xi and Versius robotic systems was applied in the analysis, resulting in an additional £924 per procedure.

The base case results of the analysis are provided in Table 18 The results show that using robot-assisted surgery compared to laparoscopic hysterectomy, laparoscopic sacrocolpopexy and open sacrocolpopexy is expected to increase costs by £2,462, £1,962 and £790 per patient, respectively.

Compared to laparoscopic hysterectomy, robotic-assisted surgery is also expected to increase operating time by 44.13 minutes and decrease length of stay by 0.3 days. Robotic-assisted sacrocolpopexy is expected to increase operating time by 43.71 minutes and 1.66 minutes when compared to laparoscopic and open approaches, respectively. It is also associated with a reduced blood loss of 2.07ml and a reduced rate of complications by 6.59% when compared to open sacrocolpopexy.

Table 18 – Results of the base case analysis

Outcome	Comparator	Robotic-assisted surgery	Incremental
Costs			
Laparoscopic hysterectomy	£6,961	£9,423	£2,462
Laparoscopic sacrocolpopexy	£7,315	£9,277	£1,962
Open sacrocolpopexy	£8,487	£9,277	£790
Operating time (minutes)			
Laparoscopic hysterectomy	104.37	148.50	44.13
Laparoscopic sacrocolpopexy	189.97	233.67	43.71
Open sacrocolpopexy	121.45	123.11	1.66
Length of stay (days)			
Laparoscopic hysterectomy	1.49	1.19	-0.30
Blood loss (ml)			
Open sacrocolpopexy	216.29	214.22	-2.07
Complications (%)			
Open sacrocolpopexy	27.87%	21.27%	-6.59%

Various scenario analyses were conducted to assess the impact of key modelling assumptions on results.

As the evidence base for robotic systems is based on using the da Vinci robots, scenario analyses explored applying the costs of the systems separately. Both scenarios were expected to cost more than all modelled comparators, however, the da Vinci system was expected to be more costly than the Versius system. It cannot be assumed, however, that the evidence collected using da Vinci robots can be applied to the Versius systems, and so these results should be used with caution.

The base case analysis assumes that the robots will perform 300 benign gynaecological surgeries per year. In practice, robots are likely to be used across multiple indications, and so scenario analyses tested the assumption of 150 and 735 surgeries performed using the robots per year. Additionally, a scenario was conducted where there were no upfront capital costs of the robots, reflecting a situation where a Welsh hospital already has a robotic system installed.

In all modelled scenarios, robotic-assisted surgery was expected to be more costly than comparators. Results of the probabilistic sensitivity analysis also show minimal changes from the base case results. As such, results of the base case analysis are robust to changes in modelled inputs and assumptions, supporting the conclusion that robotic-assisted surgery is likely to cost more than modelled comparators.

The cost-consequence analysis was limited due to the availability of evidence in the published literature. The limitations of the clinical evidence, therefore, apply to the economic analysis as well, such as the evidence captured generally being older.

Although the clinical evidence is conducted on da Vinci robots, the analysis has applied an average cost of the da Vinci robots and Versius robots in the base case. There are likely differences between the systems, such as the size, as the Versius robot is much smaller and transportable. As such, it is uncertain whether the results from the da Vinci systems can be assumed to apply for the Versius systems. A separate cost analysis has been provided whereby the costs of the systems are provided independently of one another.

Additionally, the model explores a payment option for the robotic system spread over 7 years. While other payment options have been discussed with the manufacturers, it is uncertain which approach Wales would adopt. However, the 7-year option appears to be the most common in other economic analyses.

The economic analysis is also unable to capture benefits to surgeons, such as the ergonomics of the robots, discussed in Section 5.20.

Please refer to Appendix 6 for more details on the economic analysis.

7. Organisational considerations

Experts reported that laparoscopic surgery wait-times can be a few years long in NHS Wales for benign gynaecological conditions. They highlight that robot-assisted benign gynaecological surgery is not routinely available in NHS Wales, despite being widely available across the UK.

Robot-assisted surgery may enable more people to access minimally-invasive surgery instead of open surgery, as some patient characteristics mean that conventional laparoscopic techniques would not be suitable (e.g. people with obesity, people with frailties, procedures deep within the pelvic region, a large uterus). Additionally, experts stated that minimally-invasive surgery for some procedures is reserved to only the most technically-skilled surgeons , and that the ease of performance whilst using the robot may open the door to a wider pool of surgeons able to perform such minimally-invasive operations.

Experts highlighted the potential impact of robot-assisted benign gynaecological surgery on racial disparities and equity. They stated that uterine fibroids disproportionately affect more women of black African or Caribbean ethnicity, and that they usually undergo open surgery for the removal of these fibroids, so robot-assisted surgery would allow more patients to be eligible for a minimally invasive approach. Additionally, they noted that benign robot-assisted surgery is routinely offered across the UK for a large number of surgical specialities whose primary patient group are predominantly male, and so robot-assisted surgery in benign gynaecology has the potential to redress this inequity for women.

Robot-assisted surgery has the potential to introduce a complete transformation of surgical provision (RCS 2023). There will be significant training requirements for individual surgeons in an organisation if they have not previously been trained in the technique in another institution (HIQA 2012). The HTA by HIQA recommends that ongoing training to ensure currency of skills and training of other theatre staff and auxiliary staff is required, as is the use of designated training programmes and a system of mentoring by experienced staff (HIQA 2012).

Robot-assisted surgery increases theatre time and associated costs per procedure. These increases are higher in the early stages of implementation when staff are new to the technology (HIQA 2012). The HTA by HIQA recommends that arrangements for leadership, identification of multidisciplinary robot-assisted surgery teams, coordination of access to the programme for a range of specialities, identification of the optimal theatre space, careful patient selection and a commitment to monitor and report clinical outcomes of the surgeries performed are all issues that should be assessed carefully. Additional arrangements may be required to facilitate access by surgeons from other institutions (HIQA 2012).

As robotic platforms are expensive, they may only be placed in larger hospitals, with more resources, which could create inequity in access to robot-assisted surgery.

8. Patient, carer and family considerations

Health Technology Wales partnered with Fair Treatment for the Women of Wales (FTWW) to learn from patients with 'benign' (non-cancerous) gynaecological conditions about their experiences and to gather their views of robotic-assisted surgery. FTWW provided a written submission in addition to running an online survey. The results of the online survey are detailed below.

8.1 Results of HTW and FTWW survey

This survey aimed to capture people's experiences of living with various non-cancerous gynaecological conditions, their experiences engaging with healthcare services towards a diagnosis and treatment, and their views on robotic-assisted surgery. The survey was promoted by FTWW and ran for two weeks. Nineteen responses were garnered.

8.1.1 Begin gynaecological conditions: symptoms, diagnosis and impact on patient wellbeing.

Of the 19 respondents, one reported having uterine fibroids and perimenopausal polyps; 16 had endometriosis (four of which had both endometriosis and adenomyosis, one of which had endometriosis and polycystic ovaries); one had adenomyosis and polycystic ovary syndrome, and one had pelvic prolapse treated with vaginal mesh. Patients reporting living with these conditions for a period of six to 39 years.

Respondents reported experiencing symptoms such as heavy menstruation/bleeding, irregular and break-through bleeding, bloating, weight gain, pain, difficult bowel movements, brain fog, and mood changes.

Respondents advised that these conditions impacted nearly all aspects of their lives, including their physical health, mental health, emotional wellbeing, relationships, professional, and social life. Commonly reported impacts included:

- Tiredness and fatigue described as 'extreme' and impacting physical stamina
- Hormonal imbalance
- Anxiety, embarrassment, and fear of social situations
- Low mood
- Infertility
- Taking significant amounts of time off work and avoiding socialising
- Losing significant periods of schooling (two weeks a month)
- Loss of independence and self confidence
- Constipation/urgent urination/vomiting
- Further medical complications due to damage or medication
- Reduced mobility

Of these, pain was hugely significant to all respondents. Pain experienced included abdominal pain, pain during sex, chronic pelvic pain, pain opening bowels and pain during menstruation. This pain was described by respondents as 'debilitating', 'severe', 'extreme' and 'constant'. Experiences of pain and bleeding were closely associated. Breakout bleeding, heavy bleeding and irregular bleeding were described by respondents not only as very painful, but also 'embarrassing', 'shameful' and 'humiliating'. Respondents were on a regimen of daily medications to manage both pain and bleeding.

"Extreme menstrual Pain (including several days confined to bed sweating, vomiting and shaking per month and occasional black outs/collapse)".

"I'd basically pass out [due to menstruation pain] (unusually in work toilets) for half an hour or so, once or twice a month. Pain at other times of the month: at worst, nearly every single day".

"Stabbing, gnawing, heaviness like I'm carry a bag of stones".

"Visibly writhing in pain has caused some problems at work, at university, in public, with friends. Bleeding on other people's furniture is a new, surprisingly humiliating development. Being drained and anaemic after a period is exhausting and limits what I can do in all areas of life, as do the times when I'm in pain and never know what to expect if I sit down".

Infertility was also a concern listed by a high number of respondents. Many were undergoing in vitro fertilisation (IVF) procedures due to infertility caused by their condition before they received a formal diagnosis or were even aware they had it.

"Being unable to conceive has made my relationship with my partner more difficult in some ways".

Respondents also reported breakdowns in their relationships with partners, family and friends, describing such breakdowns as 'a huge strain'. Being unable to care for children, their partners becoming their 'carers', lack of intimacy in romantic relationships, lost friendships, and fear of socialising left some patients requiring counselling to deal with the psychological toll.

"As I had symptoms so young and missed so much school this affected my studies, my confidence and I lost a lot of friendships as I was not able to do the activities that they were doing. The constant advocating for my health has been exhausting and has led to many episodes of depression where I have felt very lost, broken and upset and anger towards my body along with the physical health declining affecting my ability".

"Difficulties with being intimate with my husband for fear of the pain. Reluctance to go out due to vomiting & diarrhoea".

"People just don't understand what always being in pain actually is".

Gaining a diagnosis was reported as challenging with the process described as 'horrendous' and 'agonising'. Respondents describe journeys of between 10 and 12 years to reach diagnosis. One respondent advised it took 19 years to arrive at her diagnosis of endometriosis, and this was only obtained after emergency laparoscopic investigation.

Pathways to diagnosis include multiple admissions and visits to hospitals to undergo a plethora of tests and procedures, including ultrasound scans, colonoscopy and explorative surgery. Respondents were incorrectly diagnosed with other conditions, such as irritable bowel syndrome (IBS) and cancer, or told that their symptoms were 'normal' or that their pain was 'psychological'. Respondents described multiple attempts to be taken seriously, while healthcare professionals repeatedly dismissed symptoms. Several respondents advised only arriving at a diagnosis by going through private practice.

"Went to GP with painful & heavy periods at the age of 13, having had about 6 months of periods before they got to the point where both myself & my mum thought something was wrong. Was completely dismissed & ridiculed. Went a year or so later with the same complaints but now showing symptoms of anaemia & was prescribed the combi contraceptive pill. Even as my symptoms progressed over the years, including ovulation pain, pain with bowel movements, cyclical vomiting & bowel changes, increase in migraines & rectal bleeding, I was always given the "its normal women's stuff" fob off & prescribed different contraceptives. Took me researching 2 decades later & figuring out I had endo myself, walking into the GP with my

conclusion & demanding to be referred to gynaecology to be taken surgery [seriously]. With wait times as they were (7+ years for a diagnostic laparoscopy) I then went private & was diagnosed with Stage 4 DIE [Deep Infiltrating Endometriosis] & suspected Adenomyosis, which I am only now being given surgery for on the NHS, over 3 years since being put on the "urgent" priority surgical list".

The delays and difficulties in getting to a diagnosis had significant impacts on respondents' lives. They describe being left in significant pain and suffering for prolonged periods of time which, in addition to the physical symptoms of their condition, also included the psychological impacts of medical 'gaslighting' from healthcare professionals.

"Being in pain for so long without being believed & instead being made to believe I am weak or a poor excuse of a woman".

Due in part to the length of time a diagnosis takes, there is also the burden of lost potential and hidden costs that drastically alter the landscape of a person's life, such as being able to have children, developing additional medical conditions, and undergoing multiple additional procedures.

"It has literally effected everything. I am about to have my 12th surgery (my colon and rectum removed). I have already had an ileostomy, hysterectomy, bladder resection and ureter repair twice".

"Had my endometriosis been diagnosed earlier maybe I would have been able to conceive naturally without IVF, which most likely would have meant I didn't get ovarian cancer as it was hormone driven cancer, I think brought on by hormones in IVF".

"I've spent years of my life in agonising pain and told there's nothing wrong with me, I've met cruel consultants who have laughed at me and denied that I have ANYTHING wrong with me until my diagnosis".

"By this point (of diagnosis) I had undergone 6 failed rounds of IVF, 2 laps for cysts removals and 1 laparotomy".

"Due to long term medications (chemical menopause) which weren't sufficiently explained I have lost sleep, fitness, motivation, self confidence and gained considerable weight (making me obese for the first time in my life) which I am finding very hard to shift even with a personal trainer and considerable effort".

"Due to the long wait until diagnosis, it travelled to other parts of my body...I have a prolapse bowel and a lazy bladder which both affect me daily...along with other illnesses I eventually had a full breakdown 2019 where I wanted to take my own life".

"I have had multiple surgical procedures and operations due to pelvic mesh implants and prolapse. This has gone on for approximately 20 yrs. The waiting times have been awful".

However, in contrast, one respondent reports a straightforward experience of seven months from initial GP consultation to surgery to confirm diagnosis.

8.1.2 Patient experiences with non-robotic surgery

Most of the respondents had surgery without the use of the robot. Surgeries listed by respondents included:

- Hysteroscopy
- Surgery for biopsy

- Insertion of Mirena coil
- Removal of polyp
- Excision of endometriosis
- Adhesiolysis
- Ureterolysis
- Laparotomy

Respondents described their experiences with these surgeries as 'old-fashioned, undignified and barbaric'. Some patients were also required to undergo further surgeries, such as appendix or bowel removal, due to damage sustained to other organs because of their condition. One respondent advised her uterus was damaged during surgery.

> *"Laparotomy was very unpleasant and invasive and long recovery".*

> *"My uterus was perforated during non robotic surgery, which meant they couldn't fit the Mirena coil".*

8.1.3 Patient understanding of, attitudes towards, and experiences with robotic surgery

Respondents had a mixed understanding of robotic-assisted surgery. Most had a reasonably good understanding of what robotic-assisted surgery involved, describing it as 'surgery performed by a robotic arm controlled by a surgeon'. Some were unclear what robotic surgery would involve.

Attitudes were also mixed. Most respondents advised that they would 'trust the clinician using the robot' and would not be put off at the idea of the robot. Respondents felt that robotic-assisted surgery would be quicker and less invasive than surgery without the robot, leading to faster recoveries. The biggest potential impact about which respondents were enthusiastic was its potential to reduce pain, provide surgeons with better access to anatomical sites and more specific/targeted margins, leading to shorter recovery times. It was also considered to be a safer option than surgery without the robot as it may mitigate human error.

> *"I believe the surgeon might have greater accuracy with removal of lesions & adhesions & therefore perhaps less risk of lesions being missed & therefore the need for additional surgeries minimised".*

However, many respondents felt that patients may need help to trust the use of the robot. Respondents anticipated concerns that the robot may fail or malfunction. There were some respondents who found the idea 'scary' and that it made them 'very nervous' as it could 'fail halfway through' and mistakes could be made. There was some feeling that surgery performed with the robot would lack the intuitive senses of a surgeon's hands.

> *"Worry about surgeons being unable to "feel" problematic areas as obviously a robot doesn't have that sense of touch. Some surgeons will rely on not just their sight to remove lesions, but feel tissues & areas & act appropriately".*

Some respondents felt they did not know enough about how the robot works to make a judgement. Another concern was over-reliance on a machine and it eventually leading to the full removal of the human surgeon.

> *"As long as there is an actual person to overlook it..."*

> *"There's something a bit extra worrying about robotic equipment which won't always be able to course-correct as readily and quickly as a person if there is a need to".*

"However, the feeling persisted that, given the challenges currently facing patients, the introduction of robotic-assisted surgery could be the 'way forward".

"It would be good for gynae surgery to move with the times and be modernised as it is often old fashioned, undignified and barbaric".

"Sounds like a step in the right direction".

Three respondents had accessed robotic-assisted surgery for endometriosis treatment. Two respondents had accessed this through private practice. One had robotic-assisted surgery on the NHS in England. One respondent had previously had five surgeries without the robot for endometriosis diagnosis and treatment that left her still requiring more treatment, which she then had with the robot. Two of the three respondents accessing robotic-assisted surgery compared their experiences with and without the robot as follows:

- Recovery was quicker following robotic surgery
- Scars healed quicker following robotic surgery
- Less pain with robotic surgery
- Better outcome overall – respondents did not have to return for further surgery, which they attribute to better visualisation and access for surgeons with the use of the robot

"My symptoms have resolved after robotic surgery".

However, one respondent had a poor experience with robotic surgery, during which her uterus was perforated.

"I personally believe surgeons using robotic arms can't feel a patient like a human".

8.1.4 Summary of survey findings

There was a strong sense from all respondents that treatments for non-cancerous gynaecological conditions need to 'move with the times and be modernised'. There is a critical need among patients to reduce delays in accessing diagnosis and treatment, particularly considering the life-altering impact delays create. Patients feel strongly that non-cancerous gynaecological conditions are systematically neglected by healthcare providers and much needs to be done to correct this imbalance.

However, patient attitudes towards robotic surgery for non-cancerous gynaecological conditions are mixed. While there is a consensus that robotic surgery has the potential to provide patients with a number of benefits - such as more accuracy and access to lesions that otherwise would be missed, less pain, better and quicker recoveries which could lead to shorter waiting lists – patients still held a number of concerns. However, patient reassurance can be achieved if these concerns are addressed.

"Being able to be confident that it's safe, that a fully trained, qualified, experienced surgeon is involved and can instantly take over at the slightest thing if there's a need for it, would be pretty reassuring".

8.1.5 Additional Comment

In addition to the survey responses, one comment was received from a member of FTWW's patient network who did not complete a questionnaire. This comment was relayed by FTWW on that patient's behalf, as follows:

"[The patient] mentioned that she would have been frightened of having the robot used on her, not knowing anything about it, and because of historical (and ongoing) suggestions that women's pain / trauma during procedures is not taken seriously, until she learned that it was routinely used in male urological / prostate operations. Once she learned this, she said it put her mind at ease about it being offered to gynae patients, because that meant it was well-proven / reliable etc…Had it been used on female patients first, she would have been less convinced of its safety".

8.2 Patient Submission from FTWW

Fair Treatment for Women in Wales provided a Patient Submission to accompany the results of the patient survey. The submission can be read in full in Appendix 7.

Key points from this submission are listed below:

- Women, girls, and those registered female at birth, with 'benign' or non-cancerous gynaecological conditions are a vastly under-served community. Women are often unseen and unheard by the healthcare systems that are meant to protect their health and wellbeing, spending years undiagnosed while experiencing painful, debilitating symptoms that have life-altering implications.
- For some, the physical, mental, and societal challenges of having to cope with an invisible – often embarrassing or taboo – set of symptoms (pain, bleeding and infertility) can lead to poor self-worth, guilt, shame, social and professional isolation, relationship and family breakdown, anxiety and depression. Some withdraw completely. The resulting impact of loneliness and social isolation on physical, mental health and longevity is well-evidenced, on top of the challenges of trying to manage chronic symptoms.
- Despite their prevalence and impact, obtaining a definitive diagnosis of a non-cancerous gynaecological condition can be challenging. Poor knowledge of gynaecological conditions and the wide range of symptoms, such as pain and feelings of pressure, nausea, sickness, fertility issues, cramping, vaginal bleeding and fatigue, can make it difficult to pinpoint a precise cause. However, there is much evidence to suggest that patients reporting symptoms like these can also find that their impact is not well understood by healthcare professionals. Symptoms might be attributed to a psychological cause or seen as 'normal'. This can lead to significant diagnostic delay.
- This means that patients can live for years with debilitating health issues without a clear understanding of why it is happening to them and what can help. This in itself causes harm. Patients must rely on self-advocacy which is, in itself a barrier to care for those who don't speak English as a first language, who have different communication needs, or have a learning disability. The need to repeatedly self-advocate, whilst seriously unwell, places a tremendous burden on patients, detracts from their daily lives and relationships, and can lead to deteriorating physical health, mental health and emotional wellbeing. It also prolongs the period of time that patients must continue to live with symptoms that make daily life difficult.
- Assuming patients are referred on for further investigations, access to adequate imaging, a technique commonly used to locate fibroids/cysts etc can be problematic. In some cases, such as with endometriosis and ovarian tumours, a diagnosis can only be reached with secondary care procedures like surgery (most commonly a diagnostic laparoscopy) to locate and/or assess potential lesions, cysts, tumours, or adhesions, and perform biopsies where appropriate. However, a diagnostic laparoscopy isn't always

successful in establishing a cause of the patients' symptoms. Endometriosis lesions in particular can be difficult to locate or identify, especially if operations are not undertaken by those with additional training in visualising endometriosis. The result is that patients with this disease may go undiagnosed even following surgery.

- Some of the challenges associated with gynaecological operations can be attributed to inadequate training in minimal access surgery and insufficiently advanced laparoscopic skills for gynaecologists to confidently identify and treat disease, particularly endometriosis, which can take on a multitude of appearances and be difficult to visualise, locate, or treat optimally. Lesions can sometimes be missed, resulting in more surgery for patients and the continuation of debilitating symptoms.

- A huge challenge in current practice concerns a widespread inequity of service provision, knowledge and understanding, particularly when it comes to conditions that primarily concern women and people assigned female at birth. There are notable disparities in care between men and women in Wales, with numerous reports evidencing how women's reporting of symptoms can be dismissed or normalised, with patients often expected to self-manage with inadequate support.

- In part, a lack of appropriate diagnoses and treatment plans can be attributed to the fact that women have historically been excluded from clinical trials, and the tendency to base diagnostic criteria for health issues affecting males and females on white men. This extends further into lack of prioritisation and funding awarded to medical research which prioritises health conditions disproportionately or exclusively impacting females. In practice, the result is failure to develop consistent, equitable care pathways for patients. Gynaecology is particularly poorly-served, not least because, outside of cancer services, it is typically described as 'benign', which the RCOG finds has contributed to its not being prioritised or taken seriously.

- In England and Scotland, these equity issues are being addressed by the implementation of women's health strategies. It is of great concern that women in Wales are unfairly treated; from the perspective of patients, it is difficult to justify.

- Increasing the options that gynaecology patients have is an important part of improving patient experiences and addressing widespread inequities in service provision. However, providing patients with adequate and accessible information so that they can make informed choices about their care is absolutely essential.

- Making available enhanced training and technology for gynaecology services in Wales could improve recruitment and retention of associated healthcare professionals, reducing waiting times and improving patient experience. Long waits are associated with deteriorating health and poorer outcomes, including for those whose fertility is being compromised.

- Investing in new technology and training in gynaecology is important to signal a change in mindset on the part of healthcare providers, demonstrating that it is a specialty worthy of prioritisation, and the patients affected are being taken seriously. However, innovation in new technology should not be seen as a panacea – improving Wales's skillset in gynaecology services is vital to reduce variation and inequity of experience and outcome, with or without the robot.

9. Surgeon considerations

See Section 5.20 of this report for evidence identified on the ergonomics of robot-assisted gynaecological surgery.

The HTA by HIQA reports that there is general consensus that robot-assisted surgery is more ergonomic than laparoscopic surgery for the operating surgeon. This HTA notes that for the operating surgeon, there is a reduction in fatigue, and potentially complex procedures can be performed more comfortably. However, this benefit may not apply to the rest of the surgical team, including the assisting surgeon (HIQA 2012).

10. Conclusions

This evidence review summarised published evidence on the effectiveness and cost effectiveness of robot-assisted benign gynaecological surgery compared to standard care.

Six systematic reviews of RCTs were identified, which compared robot-assisted hysterectomy, robot-assisted sacrocolpopexy and robot-assisted surgery for endometriosis to conventional laparoscopic surgery. Most of the RCT evidence investigated robot-assisted hysterectomy or robot-assisted sacrocolpopexy compared to conventional laparoscopic surgery. Two systematic reviews of large comparative observational studies reported outcomes for robot-assisted myomectomy compared to conventional laparoscopic myomectomy or open myomectomy, but no evidence compared it to vaginal myomectomy.

Most of the outcomes were associated with no statistically significant difference between robot-assisted surgery and comparators. All systematic reviews reported that operating time was longer during robot-assisted surgeries than other surgical approaches. Experts suggested that this may be due to the learning curve of the system, the additional set-up time for robotic surgery and the fact that more complex surgeries may have been done with the robot.

The RCT evidence included in this review indicates that women undergoing some types of robot-assisted benign gynaecological surgery have a shorter hospital stay, less blood loss, fewer complications and improved QoL than conventional laparoscopic surgery or open surgery. The observational evidence reported more statistically significant outcomes to support the effectiveness of robot-assisted benign gynaecological surgery than reported in RCTs.

No RCT evidence was found for surgeon satisfaction. No relevant evidence was found for the subgroup analysis of pre- and post-menopause. We did not identify any evidence for use of robot-assisted surgery in people undergoing preventative surgery for increased familial risk of cancer.

Most of the outcomes are reported by the authors of the systematic reviews as having very low-to low-certainty, mainly due to high risk of bias from lack of blinding. The observational outcomes were largely from retrospective studies and therefore associated with a high risk of bias. There was a high degree of heterogeneity observed for many of the pooled results, indicating that there is a high degree of inconsistency between the reported results of individual studies.

HTW conducted a cost-consequence analysis to estimate the impact of introducing robotic-assisted surgery in benign gynaecological conditions. The analysis found that robotic-assisted surgery is likely to cost more than conventional laparoscopic hysterectomy, conventional laparoscopic sacrocolpopexy and open sacrocolpopexy. This finding was robust to sensitivity and scenario analyses, supporting the conclusion that robotic-assisted surgery is likely to be a cost-incurring method of surgery.

11. Contributors

This topic was proposed by colleagues in the NHS.

The HTW staff involved in producing this report were:

- J. Williams, Health Services Researcher - Effectiveness author
- N. Bromham, Senior Health Services Researcher/Principal Researcher – Effectiveness quality assurance
- R. Boyce, Health Economist – Cost effectiveness author
- R. Miller, Senior Health Economist/Principal Researcher – Cost effectiveness quality assurance
- J. Washington, Information Specialist – Literature search & information management
- A Evans, Patient and Public Involvement (PPI) Manager – PPI author
- R. Shepherd, Project Manager/Project Support Officer – Project Management

The HTW Assessment Group advised on methodology throughout the scoping and development of the report.

We are grateful to the following subject experts, who also contributed to this appraisal:

- Dr D. Warm, Head of Planning, Hywel Dda University Health Board (didn't reply on behalf of organisation)
- J. Ahmed, Experienced robotic surgeon and leader of an established robotic gynaecology programme at Chelsea and Westminster NHS Foundation Trust
- Professor J. Chatterjee, Consultant Gynae-oncology and Gynaecology Consultant - experienced expert robotic Gynaecology and Gynae-oncology surgeon
- L. Morris, Access Value and Economics Director (UK & Ireland) - Intuitive Surgical (Manufacturers of da Vinci robot assisted surgical systems)
- L. Shamsuddin, Consultant gynaecologist

Subject experts contributed to this appraisal by commenting on a draft of this report, and in some cases providing other advice to HTW's staff and decision-making groups. All contributions from reviewers were considered by HTW's Assessment Group and actioned accordingly. However, subject experts had no role in authorship or editorial control, and the views expressed are those of Health Technology Wales.

References

ACOG. (2020). Robot-assisted surgery for noncancerous gynecologic conditions. Committee Opinion Number 810. Americal College of Obstetricians and Gynecologists. Available at: https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2020/09/robot-assisted-surgery-for-noncancerous-gynecologic-conditions [Accessed 25 Apr 2024].

Advincula AP, Xu X, Goudeau IV S, et al. (2007). Robot-assisted laparoscopic myomectomy versus abdominal myomectomy: a comparison of short-term surgical outcomes and immediate costs. Journal of Minimally Invasive Gynecology. 14(6): 698-705. doi: https://doi.org/10.1016/j.jmig.2007.06.008

Akl MN, Long JB, Giles DL, et al. (2009). Robotic-assisted sacrocolpopexy: technique and learning curve. Surgical Endoscopy. 23(10): 2390-4. doi: https://doi.org/10.1007/s00464-008-0311-4

Albright BB, Witte T, Tofte AN, et al. (2016). Robotic versus laparoscopic hysterectomy for benign disease: a systematic review and meta-analysis of randomized trials. Journal of Minimally Invasive Gynecology. 23(1): 18-27. doi: https://doi.org/10.1016/j.jmig.2015.08.003

Alessandri F, Lijoi D, Mistrangelo E, et al. (2006). Randomized study of laparoscopic versus minilaparotomic myomectomy for uterine myomas. Journal of Minimally Invasive Gynecology. 13(2): 92-7. doi: https://doi.org/10.1016/j.jmig.2005.11.008

Anger JT, Mueller ER, Tarnay C, et al. (2014). Robotic compared with laparoscopic sacrocolpopexy: a randomized controlled trial. Obstetrics and Gynecology. 123(1): 5-12. doi: https://doi.org/10.1097/aog.0000000000000006

Baker MV, Teles Abrao Trad A, Tamhane P, et al. (2023). Abdominal and robotic sacrocolpopexy costs following implementation of enhanced recovery after surgery. International Journal of Gynecology and Obstetrics. 161(2): 655-60. doi: https://doi.org/10.1002/ijgo.14623

Bauer HH, Sahmoud A, Rhodes SP, et al. (2022). Inpatient hospital costs and route of hysterectomy for management of benign uterine disease in the 90-day global billing period. Obstetrics and Gynecology. 144(2): 226-74. doi: https://doi.org/10.1097/aog.0000000000005643

Behera MA, Likes III CE, Judd JP, et al. (2012). Cost analysis of abdominal, laparoscopic, and robotic-assisted myomectomies. Journal of Minimally Invasive Gynecology. 19(1): 52-7. doi: https://doi.org/10.1016/j.jmig.2011.09.007

Bennett K. (2012). Robotic surgery: da Vinci® and beyond. Bulletin of the Royal College of Surgeons of England. 94(1): 8-9. doi: https://doi.org/10.1308/147363512X13189526438431

Boal M, Di Girasole CG, Tesfai F, et al. (2024). Evaluation status of current and emerging minimally invasive robotic surgical platforms. Surgical Endoscopy. 38(2): 554-85. doi: https://doi.org/10.1007/s00464-023-10554-4

Brubaker L, Cundiff GW, Fine P, et al. (2006). Abdominal sacrocolpopexy with Burch colposuspension to reduce urinary stress incontinence. New England Journal of Medicine. 354(15): 1557-66. doi: https://doi.org/10.1056/nejmoa054208

Chang CL, Chen CH, Yang SS, et al. (2022). An updated systematic review and network meta-analysis comparing open, laparoscopic and robotic-assisted sacrocolpopexy for managing pelvic organ prolapse. Journal of Robotic Surgery. 16(5): 1037-45. doi: https://doi.org/10.1007/s11701-021-01329-x

Chatterjee A, Krishnan NM, Rosen JM. (2014). Complex ventral hernia repair using components separation with or without synthetic mesh: a cost-utility analysis. Plastic and Reconstructive Surgery. 133(1): 137-46. doi: https://doi.org/10.1097/01.prs.0000436835.96194.79

Chen W, Ma J, Yang Z, et al. (2024). Robotic-assisted laparoscopic versus abdominal and laparoscopic myomectomy: a systematic review and meta-analysis. International Journal of Gynecology and Obstetrics. 166(3): 994-1005. doi: https://doi.org/10.1002/ijgo.15485

Childers CP, Maggard-Gibbons M. (2018). Estimation of the acquisition and operating costs for robotic surgery. JAMA. 320(8): 835-6. doi: https://doi.org/10.1001/jama.2018.9219

Coolen A-LW, van Oudheusden AM, Mol BWJ, et al. (2017). Laparoscopic sacrocolpopexy compared with open abdominal sacrocolpopexy for vault prolapse repair: a randomised controlled trial. International Urogynecology Journal. 28(10): 1469-79. doi: https://doi.org/10.1007/s00192-017-3296-5

Costantini E, Mearini L, Lazzeri M, et al. (2016). Laparoscopic versus abdominal sacrocolpopexy: a randomized, controlled trial. Journal of Urology. 196(1): 159-65. doi: https://doi.org/10.1016/j.juro.2015.12.089

Dageforde LA, Landman MP, Feurer ID, et al. (2012). A cost-effectiveness analysis of early vs late reconstruction of iatrogenic bile duct injuries. Journal of the American College of Surgeons. 214(6): 919-27. doi: https://doi.org/10.1016/j.jamcollsurg.2012.01.054

Dandolu V, Pathak P. (2018). Health resource utilization and costs during the first 90 days following robot-assisted hysterectomy. International Urogynecology Journal. 29(6): 865-72. doi: https://doi.org/10.1007/s00192-017-3432-2

Dayaratna S, Goldberg J, Harrington C, et al. (2014). Hospital costs of total vaginal hysterectomy compared with other minimally invasive hysterectomy. American Journal of Obstetrics and Gynecology. 210(2): 120.e1-6. doi: https://doi.org/10.1016/j.ajog.2013.09.028

Deimling TA, Eldridge JL, Riley KA, et al. (2017). Randomized controlled trial comparing operative times between standard and robot-assisted laparoscopic hysterectomy. International Journal of Gynecology and Obstetrics. 136(1): 64-9. doi: https://doi.org/10.1002/ijgo.12001

Dharia Patel SP, Steinkampf MP, Whitten SJ, et al. (2008). Robotic tubal anastomosis: surgical technique and cost effectiveness. Fertility and Sterility. 90(4): 1175-9. doi: https://doi.org/10.1016/j.fertnstert.2007.07.1392

Diwadkar GB, Barber MD, Feiner B, et al. (2009). Complication and reoperation rates after apical vaginal prolapse surgical repair: a systematic review. Obstetrics and Gynecology. 113(2 Part 1): 367-73. doi: https://doi.org/10.1097/aog.0b013e318195888d

Elliott CS, Hsieh MH, Sokol ER, et al. (2012). Robot-assisted versus open sacrocolpopexy: a cost-minimization analysis. Journal of Urology. 187(2): 638-43. doi: https://doi.org/10.1016/j.juro.2011.09.160

Endometriosis Cymru. (2024). Endometriosis affects one in ten women in Wales. Available at: https://endometriosis.cymru/ [Accessed 21 Jun 2024].

Fawsitt CG, Bourke J, Greene RA, et al. (2013). At what price? A cost-effectiveness analysis comparing trial of labour after previous caesarean versus elective repeat caesarean delivery. PloS One. 8(3): e58577. doi: https://doi.org/10.1371/journal.pone.0058577

Fischer JP, Basta MN, Krishnan NM, et al. (2016). A cost-utility assessment of mesh selection in clean-contaminated ventral hernia repair. Plastic and Reconstructive Surgery. 137(2): 647-59. doi: https://doi.org/10.1097/01.prs.0000475775.44891.56

Freeman R, Pantazis K, Thomson A, et al. (2013). A randomised controlled trial of abdominal versus laparoscopic sacrocolpopexy for the treatment of post-hysterectomy vaginal vault prolapse: LAS study. International Urogynecology Journal. 24(3): 377-84. doi: https://doi.org/10.1007/s00192-012-1885-x

Geller EJ, Siddiqui NY, Wu JM, et al. (2008). Short-term outcomes of robotic sacrocolpopexy compared with abdominal sacrocolpopexy. Obstetrics and Gynecology. 112(6): 1201-6. doi: https://doi.org/10.1097/aog.0b013e31818ce394

Ghomi A, Nolan W, Sanderson DJ, et al. (2022). Robotic hysterectomy compared with laparoscopic hysterectomy: is it still more costly to perform? Journal of Robotic Surgery. 16(3): 537-41. doi: https://doi.org/10.1007/s11701-021-01273-w

Glaser G, Lee A, Schinfeld J, et al. (2008). Clinical and cost-effectiveness analysis of da Vinci Robot assisted versus laparotomy myomectomy. Fertility and Sterility. 90(Supplement): S83. Available at: https://www.fertstert.org/article/S0015-0282(08)01784-6/fulltext

Green J, Deimling T, Tam T, et al. (2013). A randomized controlled trial comparing conventional laparoscopic hysterectomy with robot-assisted laparoscopic hysterectomy in a teaching institution. Journal of Minimally Invasive Gynecology. 20(6 Supplement): S4. Available at: https://www.jmig.org/article/S1553-4650(13)00443-3/abstract

Hart S, Hashemi L, Sobolewski CJ. (2013). Effect of a disposable automated suturing device on cost and operating room time in benign total laparoscopic hysterectomy procedures. JSLS: Journal of the Society of Laparoscopic & Robotic Surgeons. 17(4): 508-16. doi: https://doi.org/10.4293/108680813x13693422522231

Hazen GB. (2002). Stochastic trees and the *StoTree* modeling environment: models and software for medical decision analysis. Journal of Medical Systems. 26(5): 399-413. doi: https://doi.org/10.1023/a:1016401115823

HIQA. (2012). HTA of robot-assisted surgery. Health Technology Assessment. Health Information and Quality Authority. Available at: https://www.hiqa.ie/reports-and-publications/health-technology-assessment/hta-robot-assisted-surgery [Accessed 23 April 2024].

Hotton J, Bogart E, Le Deley MC, et al. (2023). Ergonomic assessment of the surgeon's physical workload during robot-assisted versus standard laparoscopy in a French multicenter randomized trial (ROBOGYN-1004 Trial). Annals of Surgical Oncology. 30(2): 916-23. doi: https://doi.org/10.1245/s10434-022-12548-3

Hoyte L, Rabbanifard R, Mezzich J, et al. (2012). Cost analysis of open versus robotic-assisted sacrocolpopexy. Urogynecology. 18(6): 335-9. doi: https://doi.org/10.1097/spv.0b013e318270ade3

Hsiao KC, Latchamsetty K, Govier FE, et al. (2007). Comparison of laparoscopic and abdominal sacrocolpopexy for the treatment of vaginal vault prolapse. Journal of Endourology. 21(8): 926-30. doi: https://doi.org/10.1089/end.2006.0381

Hullfish KL, Trowbridge ER, Stukenborg GJ. (2011). Treatment strategies for pelvic organ prolapse: a cost-effectiveness analysis. International Urogynecology Journal. 22(5): 507-15. doi: https://doi.org/10.1007/s00192-011-1383-6

Illiano E, Ditonno P, Giannitsas K, et al. (2019). Robot-assisted vs laparoscopic sacrocolpopexy for high-stage pelvic organ prolapse: a prospective, randomized, single-center study. Urology. 134: 116-23. doi: https://doi.org/10.1016/j.urology.2019.07.043

Jacklin P, Duckett J. (2013). A decision-analytic Markov model to compare the cost–utility of anterior repair augmented with synthetic mesh compared with non-mesh repair in women with surgically treated prolapse. BJOG: An International Journal of Obstetrics and Gynaecology. 120(2): 217-23. doi: https://doi.org/10.1111/1471-0528.12028

Jones KC, Weatherley H, Birch S. (2022). Unit costs of health and social care 2022. Personal Social Services Research Unit, University of Kent, Canterbury. Available at: https://www.pssru.ac.uk/unitcostsreport/ [Accessed 26 Feb 2024].

Judd JP, Siddiqui NY, Barnett JC, et al. (2010). Cost-minimization analysis of robotic-assisted, laparoscopic, and abdominal sacrocolpopexy. Journal of Minimally Invasive Gynecology. 17(4): 493-9. doi: https://doi.org/10.1016/j.jmig.2010.03.011

Kaaki B, Lewis E, Takallapally S, et al. (2020). Direct cost of hysterectomy: comparison of robotic versus other routes. Journal of Robotic Surgery. 14(2): 305-10. doi: https://doi.org/10.1007/s11701-019-00982-7

Kang JR, Sin AT, Cheung EV. (2017). Treatment of massive irreparable rotator cuff tears: a cost-effectiveness analysis. Orthopedics. 40(1): e65-e76. doi: https://doi.org/10.3928/01477447-20160926-06

Landeen LB, Bell MC, Hubert HB, et al. (2011). Clinical and cost comparisons for hysterectomy via abdominal, standard laparoscopic, vaginal and robot-assisted approaches. South Dakota Medicine. 64(6): 197-9.

Laursen KR, Hyldgård VB, Jensen PT, et al. (2018). Health care cost consequences of using robot technology for hysterectomy: a register-based study of consecutive patients during 2006–2013. Journal of Robotic Surgery. 12(2): 283-94. doi: https://doi.org/10.1007/s11701-017-0725-x

Lavelle RS, Christie AL, Alhalabi F, et al. (2016). Risk of prolapse recurrence after native tissue anterior vaginal suspension procedure with intermediate to long-term followup. Journal of Urology. 195(4 Part 1): 1014-20. doi: https://doi.org/10.1016/j.juro.2015.10.138

Lawrie TA, Liu H, Lu D, et al. (2019). Robot-assisted surgery in gynaecology. Cochrane Database of Systematic Reviews. CD011422(4). doi: https://doi.org/10.1002/14651858.CD011422.pub2

Lenfant L, Canlorbe G, Belghiti J, et al. (2023). Robotic-assisted benign hysterectomy compared with laparoscopic, vaginal, and open surgery: a systematic review and meta-analysis. Journal of Robotic Surgery. 17(6): 2647-62. doi: https://doi.org/10.1007/s11701-023-01724-6

Li K, Cannon JG, Jiang SY, et al. (2018). Diagnostic staging laparoscopy in gastric cancer treatment: a cost-effectiveness analysis. Journal of Surgical Oncology. 117(6): 1288-96. doi: https://doi.org/10.1002/jso.24942

Life Sciences Hub Wales. (2023). Pioneering the All-Wales Robotic Assisted Surgery Programme. Available at: https://lshubwales.com/success-stories/pioneering-all-wales-robotic-assisted-surgery-programme-0#:~:text=CMR%20Surgical%20was%20soon%20selected,Versius%20system%20at%20their%20hospital. [Accessed 10 Sep 2024].

Lönnerfors C, Reynisson P, Persson J. (2015). A randomized trial comparing vaginal and laparoscopic hysterectomy vs robot-assisted hysterectomy. Journal of Minimally Invasive Gynecology. 22(1): 78-86. doi: https://doi.org/10.1016/j.jmig.2014.07.010

Maher C, Yeung E, Haya N, et al. (2023). Surgery for women with apical vaginal prolapse. Cochrane Database of Systematic Reviews. CD012376(7). doi: https://doi.org/10.1002/14651858.CD012376.pub2

Martínez-Maestre MA, Melero-Cortés LM, Coronado PJ, et al. (2019). Long term COST-minimization analysis of robot-assisted hysterectomy versus conventional laparoscopic hysterectomy. Health Economics Review. 9(1): 18. doi: https://doi.org/10.1186/s13561-019-0236-8

Mayor N, Coppola AS, Challacombe B. (2022). Past, present and future of surgical robotics. Trends in Urology & Men's Health. 13(1): 7-10. doi: https://doi.org/10.1002/tre.834

Moawad GN, Abi Khalil ED, Tyan P, et al. (2017). Comparison of cost and operative outcomes of robotic hysterectomy compared to laparoscopic hysterectomy across different uterine weights. Journal of Robotic Surgery. 11(4): 433-9. doi: https://doi.org/10.1007/s11701-017-0674-4

Mowat A, Maher C, Ballard E. (2016). Surgical outcomes for low-volume vs high-volume surgeons in gynecology surgery: a systematic review and meta-analysis. American Journal of Obstetrics and Gynecology. 215(1): 21-33. doi: https://doi.org/10.1016/j.ajog.2016.02.048

Mueller E, Kenton K, Tarnay C, et al. (2012). Abdominal colpopexy: comparison of endoscopic surgical strategies (ACCESS). Contemporary Clinical Trials. 33(5): 1011-8. doi: https://doi.org/10.1016/j.cct.2012.05.007

Nash K, Feinglass J, Zei C, et al. (2012). Robotic-assisted laparoscopic myomectomy versus abdominal myomectomy: a comparative analysis of surgical outcomes and costs. Archives of Gynecology and Obstetrics. 285(2): 435-40. doi: https://doi.org/10.1007/s00404-011-1999-2

Neary KC, Mormino MA, Wang H. (2017). Suture button fixation versus syndesmotic screws in supination–external rotation type 4 injuries: a cost-effectiveness analysis. American Journal of Sports Medicine. 45(1): 210-7. doi: https://doi.org/10.1177/0363546516664713

Neumann PJ, Cohen JT, Weinstein MC. (2014). Updating cost-effectivenes: the curious resilience of the $50,000-per-QALY threshold. New England Journal of Medicine. 371(9): 796-7. doi: https://doi.org/10.1056/nejmp1405158

Nezhat C, Lavie O, Hsu S, et al. (2009). Robotic-assisted laparoscopic myomectomy compared with standard laparoscopic myomectomy: a retrospective matched control study. Fertility and Sterility. 91(2): 556-9. doi: https://doi.org/10.1016/j.fertnstert.2007.11.092

NHS. (2022). Hysterectomy: why it's necessary. National Health Service. Available at: https://www.nhs.uk/conditions/hysterectomy/why-its-done/ [Accessed 21 Jun 2024].

NHS Digital. (2021). Hysterectomies on patients by age. National Health Service England. Available at: https://digital.nhs.uk/supplementary-information/2021/hysterectomies-on-patients-by-age [Accessed 21 Jun 2024].

NHS Digital. (2023). Hospital admitted patient care activity, 2022-23: procedures and interventions. National Health Service England. Available at: https://digital.nhs.uk/data-and-information/publications/statistical/hospital-admitted-patient-care-activity/2022-23 [Accessed 21 Jun 2024].

NHS England. (2023). 2021/22 National Cost Collection data publication. National Health Service. Available at: https://www.england.nhs.uk/publication/2021-22-national-cost-collection-data-publication/ [Accessed 19 Aug 2024].

NHS Improvement. (2020). Archived reference costs: 2017/18 reference costs. National Health Service. Available at:

https://webarchive.nationalarchives.gov.uk/ukgwa/20200501111106/https://improvement.nhs.uk/resources/reference-costs/ [Accessed 19 Aug 2024].

NICE. (2021). Prostate cancer: diagnosis and management [Published: 09 May 2019; Last updated: 15 December 2021]. NICE guideline NG131. National Institute for Health and Care Excellence. Available at: https://www.nice.org.uk/guidance/ng131/chapter/Recommendations#assessment-and-diagnosis [Accessed 19 Aug 2024].

Nygaard IE, McCreery R, Brubaker L, et al. (2004). Abdominal sacrocolpopexy: a comprehensive review. Obstetrics and Gynecology. 104(4): 805-23. doi: https://doi.org/10.1097/01.aog.0000139514.90897.07

Office for National Statistics. (2022). Population and household estimates, Wales: Census 2021. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/populationandhouseholdestimateswales/census2021 [Accessed 21 Jun 2024].

Palomba S, Zupi E, Falbo A, et al. (2007). A multicenter randomized, controlled study comparing laparoscopic versus minilaparotomic myomectomy: reproductive outcomes. Fertility and Sterility. 88(4): 933-41. doi: https://doi.org/10.1016/j.fertnstert.2006.12.047

Pan K, Zhang Y, Wang Y, et al. (2016). A systematic review and meta-analysis of conventional laparoscopic sacrocolpopexy versus robot-assisted laparoscopic sacrocolpopexy. International Journal of Gynecology and Obstetrics. 132(3): 284-91. doi: https://doi.org/10.1016/j.ijgo.2015.08.008

Paraiso MFR, Jelovsek JE, Frick A, et al. (2011). Laparoscopic compared with robotic sacrocolpopexy for vaginal prolapse: a randomized controlled trial. Obstetrics and Gynecology. 118(5): 1005-13. doi: https://doi.org/10.1097/aog.0b013e318231537c

Paraiso MFR, Ridgeway B, Park AJ, et al. (2013). A randomized trial comparing conventional and robotically assisted total laparoscopic hysterectomy. American Journal of Obstetrics and Gynecology. 208(5): 368.e1-e7. doi: https://doi.org/10.1016/j.ajog.2013.02.008

Paraiso MFR, Walters MD, Rackley RR, et al. (2005). Laparoscopic and abdominal sacral colpopexies: a comparative cohort study. American Journal of Obstetrics and Gynecology. 192(5): 1752-8. doi: https://doi.org/10.1016/j.ajog.2004.11.051

Patel M, O'Sullivan D, Tulikangas PK. (2009). A comparison of costs for abdominal, laparoscopic, and robot-assisted sacral colpopexy. International Urogynecology Journal. 20(2): 223-8. doi: https://doi.org/10.1007/s00192-008-0744-2

Paul-Dehlinger R, Vappereau A, Le Bras A, et al. (2024). Cost-effectiveness of robot-assisted total hysterectomy for benign pathologies compared to laparoscopic surgery: a retrospective study with propensity score. Journal of Gynecology Obstetrics and Human Reproduction. 53(9): 102821. doi: https://doi.org/10.1016/j.jogoh.2024.102821

Pellegrino A, Damiani GR, Fachechi G, et al. (2017). Cost analysis of minimally invasive hysterectomy vs open approach performed by a single surgeon in an Italian center. Journal of Robotic Surgery. 11(2): 115-21. doi: https://doi.org/10.1007/s11701-016-0625-5

Pickett CM, Seeratan DD, Mol BWJ, et al. (2023). Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database of Systematic Reviews. CD003677(8). doi: https://doi.org/10.1002/14651858.CD003677.pub6

RCS. (2023). Robotic-assisted surgery: a pathway to the future. Royal College of Surgeons of England. Available at: https://www.rcseng.ac.uk/standards-and-research/standards-and-guidance/good-practice-guides/robotic-assisted-surgery/ [Accessed 25 Apr 2024].

Rogers RG, Nolen TL, Weidner AC, et al. (2018). Open sacrocolpopexy and vaginal apical repair: retrospective comparison of success and serious complications. International Urogynecology Journal. 29(8): 1101-10. doi: https://doi.org/10.1007/s00192-018-3666-7

Rutstein SE, Siedhoff MT, Geller EJ, et al. (2016). Cost-effectiveness of laparoscopic hysterectomy with morcellation compared with abdominal hysterectomy for presumed myomas. Journal of Minimally Invasive Gynecology. 23(2): 223-33. doi: https://doi.org/10.1016/j.jmig.2015.09.025

Sarlos D, Kots L, Stevanovic N, et al. (2012). Robotic compared with conventional laparoscopic hysterectomy: a randomized controlled trial. Obstetrics and Gynecology. 120(3): 604-11. doi: https://doi.org/10.1097/aog.0b013e318265b61a

Sesti F, Capobianco F, Capozzolo T, et al. (2008). Isobaric gasless laparoscopy versus minilaparotomy in uterine myomectomy: a randomized trial. Surgical Endoscopy. 22(4): 917-23. doi: https://doi.org/10.1007/s00464-007-9516-1

Sheng Y, Hong Z, Wang J, et al. (2023). Efficacy and safety of robot-assisted laparoscopic myomectomy versus laparoscopic myomectomy: a systematic evaluation and meta-analysis. World Journal of Surgical Oncology. 21(1): 230. doi: https://doi.org/10.1186/s12957-023-03104-8

Shepherd JP, Kantartzis KL, Ahn KH, et al. (2014). Cost analysis when open surgeons perform minimally invasive hysterectomy. JSLS: Journal of the Society of Laparoscopic & Robotic Surgeons. 18(4): e2014.00181. doi: https://doi.org/10.4293/jsls.2014.00181

Soto E, Luu TH, Liu X, et al. (2017). Laparoscopy vs. robotic surgery for endometriosis (LAROSE): a multicenter, randomized, controlled trial. Fertility and Sterility. 107(4): 996-1002.e3. doi: https://doi.org/10.1016/j.fertnstert.2016.12.033

Stringer NH, Walker JC, Meyer PM. (1997). Comparison of 49 laparoscopic myomectomies with 49 open myomectomies. The Journal of the American Association of Gynecologic Laparoscopists. 4(4): 457-64. doi: https://doi.org/10.1016/s1074-3804(05)80039-8

Subramanian S, Clark MA, Isaacson K. (2001). Outcome and resource use associated with myomectomy. Obstetrics and Gynecology. 98(4): 583-7. doi: https://doi.org/10.1016/s0029-7844(01)01523-x

Unger CA, Walters MD, Ridgeway B, et al. (2015). Incidence of adverse events after uterosacral colpopexy for uterovaginal and posthysterectomy vault prolapse. American Journal of Obstetrics and Gynecology. 212(5): 603.e1-7. doi: https://doi.org/10.1016/j.ajog.2014.11.034

Verrelli L, Merlot B, Chanavaz-Lacheray I, et al. (2024). Robotic surgery for severe endometriosis: a preliminary comparative study of cost estimation. Journal of Minimally Invasive Gynecology. 31(2): 95-101.e1. doi: https://doi.org/10.1016/j.jmig.2023.11.002

Wang R, Hacker MR, Richardson M. (2021). Cost-effectiveness of surgical treatment pathways for prolapse. Female Pelvic Medicine & Reconstructive Surgery. 27(2): e408-13. doi: https://doi.org/10.1097/SPV.0000000000000948

Watanabe T, Yamamoto S, Gotoh M, et al. (2017). Cost-effectiveness analysis of long-term intermittent self-catheterization with hydrophilic-coated and uncoated catheters in patients with spinal cord injury in Japan. Lower Urinary Tract Symptoms. 9(3): 142-50. doi: https://doi.org/10.1111/luts.12122

Welk B, Al-Hothi H, Winick-Ng J. (2015). Removal or revision of vaginal mesh used for the treatment of stress urinary incontinence. JAMA Surgery. 150(12): 1167-75. doi: https://doi.org/10.1001/jamasurg.2015.2590

Wijk L, Nilsson K, Ljungqvist O. (2018). Metabolic and inflammatory responses and subsequent recovery in robotic versus abdominal hysterectomy: a randomised controlled study. Clinical Nutrition. 37(1): 99-106. doi: https://doi.org/10.1016/j.clnu.2016.12.015

Wright JD, Ananth CV, Tergas AI, et al. (2014). An economic analysis of robotically assisted hysterectomy. Obstetrics and Gynecology. 123(5): 1038-48. doi: https://doi.org/10.1097/aog.0000000000000244

Wright KN, Jonsdottir GM, Jorgensen S, et al. (2012). Costs and outcomes of abdominal, vaginal, laparoscopic and robotic hysterectomies. JSLS: Journal of the Society of Laparoscopic & Robotic Surgeons. 16(4): 519-24. doi: https://doi.org/10.4293/108680812x13462882736736

Xu X, Ivy JS, Patel DA, et al. (2010). Pelvic floor consequences of cesarean delivery on maternal request in women with a single birth: a cost-effectiveness analysis. Journal of Women's Health. 19(1): 147-60. doi: https://doi.org/10.1089/jwh.2009.1404

Appendix 1 – Evidence review methods

We searched for evidence that could be used to answer the review question: what is the clinical and cost effectiveness of robot-assisted benign gynaecological surgery compared to standard care?

The criteria used to select evidence for the appraisal are outlined in Appendix 2. These criteria were developed following comments from the Health Technology Wales (HTW) Assessment Group and UK experts.

The systematic search followed HTW's standard rapid review methodology. A search was undertaken of Medline, Embase, CINAHL, KSR Evidence, Cochrane Library, and the International Network of Agencies for Health Technology Assessment (INAHTA) HTA database. Additionally, searches were conducted of key websites and clinical trials registries. The searches were carried out between 23 April 2024 and 8 May 2024, with an update search of Medline, Embase, CINAHL, KSR Evidence, Cochrane Library, and INAHTA HTA database conducted between 30 July 2024 and 1 August 2024.

An initial basic exploratory literature search identified a potentially large number of relevant studies. We therefore conducted a literature search in evidence 'layers', with the first 'layer' being restricted to systematic reviews, meta-analyses, RCTs and health economics, and the second 'layer' containing everything else. The second layer was only sifted in cases where one of the more commonly performed surgeries had insufficient evidence available from the first 'layer' search.

Appendix 3 gives details of the search strategy used for Medline. Search strategies for other databases are available on request.

Appendix 4 – i.e., the PRISMA diagram summarises the selection of articles for inclusion in the review.

Appendix 2 – Inclusion and exclusion criteria for evidence included in the review

	Inclusion criteria	Exclusion criteria
Population	Women in whom gynaecological surgery is indicated for a benign condition (including, but not limited to, women with endometriosis, uterine fibroids, pelvic organ prolapse, and those undergoing preventative surgery for increased familial risk of cancer). Women' should be taken to include those who do not identify as women but who have female pelvic organs	Malignant conditions (cancer)
Intervention	Robot-assisted laparoscopy (including, but not limited to, - Da Vinci [Intuitive], Versius [CMR], Hugo [Medtronic])	
Comparison/ Comparators	• Conventional laparoscopy • Open surgery • Vaginal surgery	
Outcome measures	• Duration of surgery • Duration of hospital stay • Surgery-related adverse events (intra-operative or post-operative). These will be grouped according to severity (e.g. Grade 3/4 events grouped together) • Conversion to open surgery or conventional laparoscopy from robot-assisted laparoscopy • Blood loss • Transfusion rates associated with surgery • Re-intervention • Recurrence rate • Health-related quality of life (EQ-5D) • Patient satisfaction • Surgeon satisfaction • Resource use and cost	
Study design	We will prioritise the following study types, in the order listed: • Systematic reviews of randomised controlled trials. • Randomised controlled trials. • Non-randomised comparative trials. • Single-arm (no control group) trials that report any relevant outcome.	

	Inclusion criteria	Exclusion criteria
	We will only include evidence from “lower priority” sources where this is not reported by a “higher priority” source. This could be because higher priority evidence: • Does not cover all relevant populations • Does not compare the technology of interest to all relevant comparators • Does not cover all outcomes of interest • Reports over short-term follow up periods, and longer follow up data is required to facilitate decision making. Where relevant and well-conducted systematic reviews exist we will use these by: • Reporting or adapting their reported outcome measures where these are fully relevant to the scope of our review, and appropriate synthesis methods have been used • Using these reviews as a source of potentially relevant studies where the review cannot be used as a source of outcome data We will prioritise systematic reviews in terms of the sources of evidence they include, using the order described above.	
Search limits	No search date limits	
Other factors	Where the evidence allows, we will report outcomes separately according to list any factors identified as potentially influential on outcomes such as: • Type of surgery • Pre and post menopause • BMI (obesity)	

Appendix 3 – Medline strategy

Medline

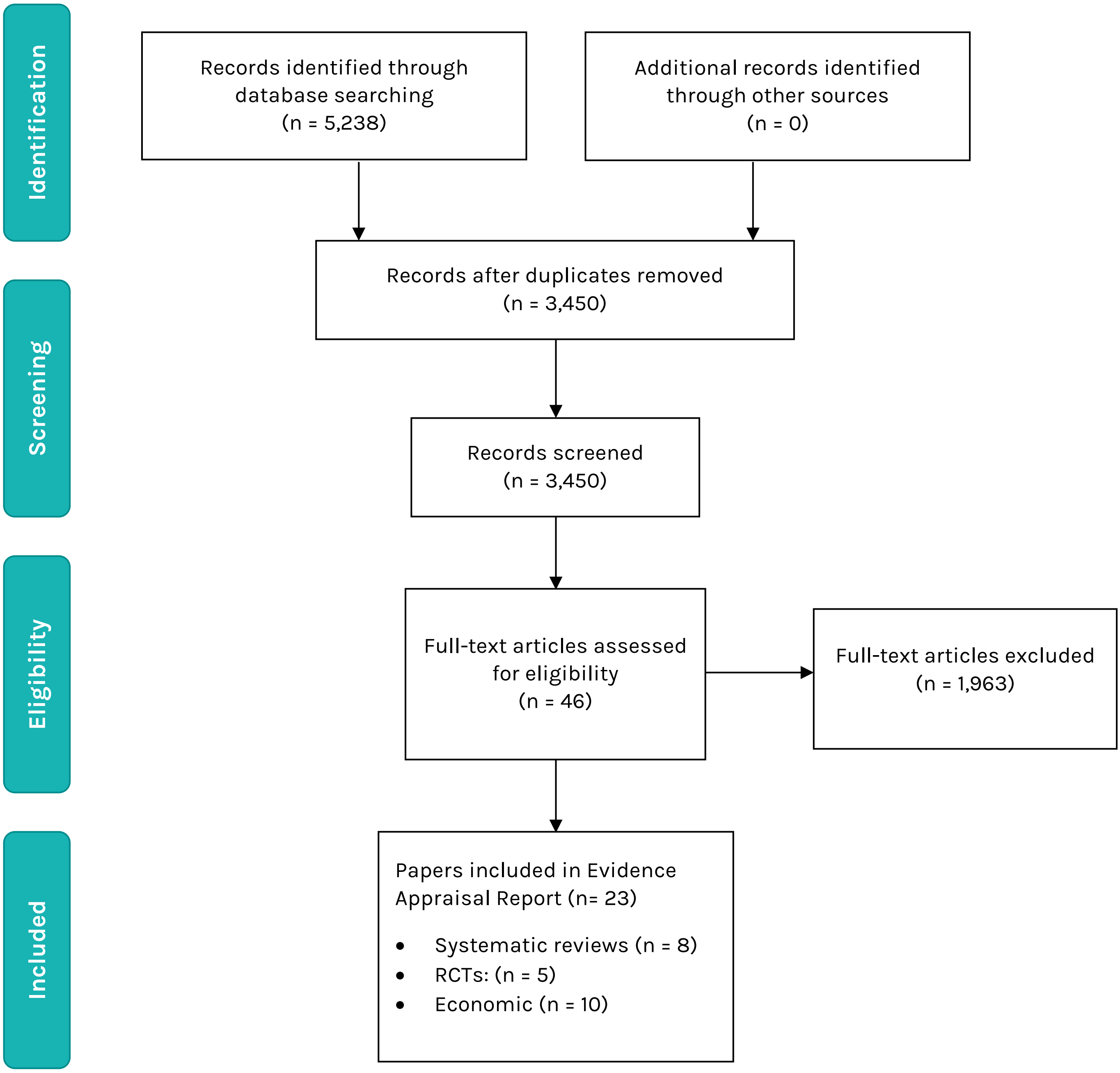
Ovid MEDLINE(R) ALL <1946 to July 30, 2024>		
Robotic stem		
1	robotic surgical procedures/	18909
2	robotics/	29468
3	(robot* adj1 assist*).tw,kf.	25347
4	(robot* adj5 (surger* or surgical* or laparoscop* or approach*)).tw,kf.	30332
5	(robot* adj5 (excis* or resect*)).tw,kf.	3256
6	robot*.kf.	28598
7	(da vinci* or versius* or senhance* or avatera* or hintori*).tw,kf.	4729
8	((hugo* or dexter*2) and robot*).tw,kf.	115
9	or/1-8	67612
Gynaecologic stem		
10	*Gynecology/ or Gynecology/su [Surgery]	16328
11	exp Gynecologic Surgical Procedures/	93516
12	((gynecol* or gynaecol*) adj2 (surgery or surgeries or surgical)).tw,kf.	11708
13	*Genital Diseases, Female/ or Genital Diseases, Female/su [Surgery]	15010
14	(benign gynaecol* or benign gynecol*).tw,kf.	1923
15	(colposcop* or colpotom* or hysteroscop* or salpingostom*).tw,kf.	19526
16	(hysterectom* or colpohysterectom* or colpo-hysterectom* or ovariohysterectom*).tw,kf.	46497
17	(trachelectom* or cervicectom*).tw,kf.	929
18	(ovariectom* or oophorectom* or oophorotom* or oviarotom* or ovarectom* or ovarotom* or salpingectom* or salpingo-oophorectom* or salpingooophorectom* or tubectom* or annexectom* or adnexectom*).tw,kf.	46900
19	((uterus or uterin* or womb or ovar* or fallopian or oviduct*) adj3 (excis* or resect* or remov* or ablat* or extirpat* or exsect*)).tw,kf.	8352
20	(myomectom* or fibroid* or fimbriectom*).tw,kf.	12297
21	(endomet* adj5 ablation).tw,kf.	1611
22	endometriosis.tw,kf.	30585
23	*Uterus/ or Uterus/su [Surgery]	41284
24	*Ovary/ or Ovary/su [Surgery]	37966
25	*Fallopian Tubes/ or Fallopian Tubes/su [Surgery]	9760
26	*Endometriosis/ or Endometriosis/su [Surgery]	23997
27	((tubal or fallopian) adj2 (sterilisat* or sterilizat* or ligation)).tw,kf.	3668
28	Sterilization Reversal/	1030
29	((fallopian or tubal) adj2 (reanast?mos* or re-anast?mos*)).tw,kf.	267
30	((sterilisat* or sterilizat*) adj2 revers*).tw,kf.	630
31	(sacral colpopex* or sacrocolpopex* or sacropex*).tw,kf.	1844
32	*Pelvic Organ Prolapse/ or Pelvic Organ Prolapse/su [Surgery]	5416
33	*Uterine Prolapse/ or Uterine Prolapse/su [Surgery]	5447
34	((pelvic or vagin* or uter*) adj2 prolaps*).tw,kf.	11270
35	exp *Vaginal Fistula/ or exp Vaginal Fistula/su [Surgery]	4556
36	((vagin* or vesicovagin* or cystovagin* or rectovagin*) adj3 fistula*).tw,kf.	5120
37	or/10-36	299077
Robotics and gynaecological surgery		
38	9 and 37	3703
39	(robot* adj3 (((gynecol* or gynaecol*) adj2 (surgery or surgeries or surgical)) or (benign gynaecol* or benign gynecol*) or (colposcop* or colpotom* or hysteroscop* or salpingostom*) or (hysterectom* or colpohysterectom* or colpo-hysterectom* or ovariohysterectom*) or (trachelectom* or cervicectom*) or (ovariectom* or oophorectom* or oophorotom* or oviarotom* or ovarectom* or ovarotom* or salpingectom* or salpingo-oophorectom* or salpingooophorectom* or tubectom* or annexectom* or adnexectom*) or ((uterus or uterin* or womb or ovar* or fallopian or oviduct*) adj3 (excis* or resect* or remov* or ablat* or extirpat* or exsect*)) or (myomectom* or fibroid* or fimbriectom*) or (endomet* adj5 ablation) or endometriosis or ((tubal or fallopian) adj2 (sterilisat* or sterilizat* or ligation)) or	1976

	((fallopian or tubal) adj2 (reanast?mos* or re-anast?mos*)) or ((sterilisat* or sterilizat*) adj2 revers*) or (sacral colpopex* or sacrocolpopex* or sacropex*) or ((pelvic or vagin* or uter*) adj2 prolaps*) or ((vagin* or vesicovagin* or cystovagin* or rectovagin*) adj3 fistula*))).tw,kf.	
Set combination		
40	38 or 39	3768
41	exp animals/ not humans/	5243854
42	40 not 41	3758
43	limit 42 to english language	3617
Draft HTW systematic review filter		
44	systematic review.pt.	268374
45	systematic reviews as topic/	13661
46	((systematic$ or evidence$) adj (review$1 or overview$1)).tw,kf,kw.	349082
47	meta-analysis.pt.	205222
48	exp meta-analysis as topic/	30424
49	(meta-analy$ or metaanaly$ or metanaly$).tw,kf,kw.	316193
50	exp review literature as topic/	25744
51	or/44-50	543454
52	(medline or pubmed or medlars).ab.	368262
53	embase.ab.	178353
54	cochrane.ab,jw.	155886
55	(cinahl or cinhal).ab.	53043
56	(psychlit or psyclit or psychinfo or psycinfo).ab.	67465
57	science citation index.ab.	3985
58	cancerlit.ab.	640
59	british nursing index.ab.	436
60	hmic.ab.	410
61	current contents.ab.	1278
62	or/52-61	415074
63	reference list$.ab.	23414
64	bibliograph$.ab.	24071
65	(handsearch$ or hand-search$).ab.	11677
66	relevant journals.ab.	1409
67	manual search$.ab.	6662
68	(search adj (strategy or criteria)).ab.	27424
69	(search$ adj4 literature).ab.	110481
70	or/63-69	179090
71	review.pt.	3360024
72	((selection or inclusion or exclusion) adj criteria).ab.	214323
73	data extraction.ab.	37339
74	71 and (72 or 73)	85750
75	51 or 62 or 70 or 74	735993
76	comment.pt.	1039049
77	letter.pt.	1264724
78	editorial.pt.	700396
79	or/76-78	2267160
80	75 not 79	713875
Draft HTW guidelines & HTA filter		
81	exp Evidence-Based Medicine/	77134
82	practice guideline/	31896
83	guideline/	16388
84	exp guidelines as topic/	174598
85	guideline$.ti,kf.	114891
86	exp technology assessment, biomedical/	12407
87	((technology adj (apprais$ or assess$)) or HTA or HTAs).tw,kf,kw.	12270
88	rapid review*.ti,kf,kw.	1519
89	(evidence* adj2 (base* or synthes*)).ti,ab,kf,kw.	217849
90	or/81-89	514633
SIGN RCT filter		

91	Randomized Controlled Trials as Topic/	172074
92	randomized controlled trial/	617974
93	Random Allocation/	107462
94	Double-Blind Method/	179644
95	Single-Blind Method/	33775
96	Clinical Trial/	540257
97	clinical trial, phase i.pt.	26217
98	clinical trial, phase ii.pt.	41718
99	clinical trial, phase iii.pt.	23075
100	clinical trial, phase iv.pt.	2518
101	controlled clinical trial.pt.	95579
102	randomized controlled trial.pt.	617974
103	multicenter study.pt.	351072
104	clinical trial.pt.	540257
105	exp Clinical Trials as Topic/	394904
106	or/91-105	1619094
107	(clinical adj trial$).tw.	520197
108	((singl$ or doubl$ or treb$ or tripl$) adj (blind$3 or mask$3)).tw.	206894
109	PLACEBOS/	35979
110	placebo$.tw.	258525
111	(random$ adj allocat$).tw.	42182
112	(allocat$ adj2 random$).tw.	47020
113	or/107-112	839405
114	106 or 113	2001414
115	case report.tw.	433381
116	letter/	1264724
117	historical article/	370962
118	or/115-117	2048588
119	114 not 118	1957028
SIGN Economics filter		
120	Economics/	27539
121	"costs and cost analysis"/	52018
122	Cost allocation/	2019
123	Cost-benefit analysis/	95262
124	Cost control/	21691
125	Cost savings/	12862
126	Cost of illness/	32712
127	Cost sharing/	2795
128	"deductibles and coinsurance"/	1882
129	Medical savings accounts/	549
130	Health care costs/	45235
131	Direct service costs/	1217
132	Drug costs/	17705
133	Employer health costs/	1098
134	Hospital costs/	12119
135	Health expenditures/	24890
136	Capital expenditures/	2003
137	Value of life/	5828
138	exp economics, hospital/	25919
139	exp economics, medical/	14440
140	Economics, nursing/	4013
141	Economics, pharmaceutical/	3143
142	exp "fees and charges"/	31482
143	exp budgets/	14234
144	(low adj cost$).mp.	98889
145	(high adj cost$).mp.	29731
146	(health?care adj cost$).mp.	18736
147	(fiscal or funding or financial or finance).tw.	218614
148	(cost adj estimate$).mp.	2890

149	(cost adj variable$).mp.	209
150	(unit adj cost$).mp.	3281
151	(economic$ or pharmacoeconomic$ or price$ or pricing).tw.	445675
152	or/120-151	1007672
CADTH Economics filter		
153	Economics/	27539
154	exp "Costs and Cost Analysis"/	272007
155	Economics, Nursing/	4013
156	Economics, Medical/	9286
157	Economics, Pharmaceutical/	3143
158	exp Economics, Hospital/	25919
159	Economics, Dental/	1922
160	exp "Fees and Charges"/	31482
161	exp Budgets/	14234
162	budget*.ti,ab,kf.	38439
163	(economic* or cost or costs or costly or costing or price or prices or pricing or pharmacoeconomic* or pharmaco-economic* or expenditure or expenditures or expense or expenses or financial or finance or finances or financed).ti,kf.	299424
164	(economic* or cost or costs or costly or costing or price or prices or pricing or pharmacoeconomic* or pharmaco-economic* or expenditure or expenditures or expense or expenses or financial or finance or finances or financed).ab. /freq=2	413406
165	(cost* adj2 (effective* or utilit* or benefit* or minimi* or analy* or outcome or outcomes)).ab,kf.	229449
166	(value adj2 (money or monetary)).ti,ab,kf.	3243
167	exp models, economic/	16429
168	economic model*.ab,kf.	4506
169	markov chains/	16318
170	markov.ti,ab,kf.	31216
171	monte carlo method/	33102
172	monte carlo.ti,ab,kf.	63885
173	exp Decision Theory/	13756
174	(decision* adj2 (tree* or analy* or model*)).ti,ab,kf.	44090
175	or/153-174	959746
Set combination		
176	80 or 90 or 119 or 152 or 175	4115159
177	43 and 176	943
178	43 not 177	2674

Appendix 4 – Flow diagram outlining selection of relevant evidence sources (for systematic reviews, meta-analyses, RCTs and health economic evidence)



Appendix 5 – Full sources of evidence and outcome data

Table A1 – Included systematic reviews: design and characteristics

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
Albright et al. (2016)	Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	Pooled analysis of 3 RCTs (Lönnerfors et al. 2015, Paraiso et al. 2013, Sarlos et al. 2012) Studies to October 2014	Adult females undergoing hysterectomy for benign disease only patients who underwent laparoscopic hysterectomy because they were deemed ineligible for the vaginal approach were included. Patients randomised to robotic hysterectomy who were deemed eligible for vaginal approach were excluded	Total n = 221: - Robot-assisted hysterectomy: n = 111 - Conventional laparoscopic hysterectomy: n = 110 Type of robot: NR Follow up: ranged from 6 weeks to 4 months Fibroids were the most common indication, present in about 42% to 59% of patients across studies Previous abdominal surgery: 55.6% to 89.6% of women Mean age of participants: 43.8 to 47.0 years Mean BMI of participants: 25.7 years to 31.4 Mean uterine weight: 190.0 to 301.0 g Studies conducted in: Switzerland, USA and Sweden	Expanded Accordion Severity Grading System Class 3 and 4 (severe requiring procedural intervention) and Class 5 and 6 (severe with organ-system failure or death) peri-operative complications (defined as any deviations from the normal course of surgery or postoperative period)	Quality of studies reported using the Cochrane RoB tool
Chang et al. (2022)	Robot-assisted sacrocolpopexy	Open sacrocolpopexy	Indirect RCT evidence in an NMA.	5 of the RCTs included women with prolapse POP-Q stage 2 or greater	n = 486 Type of robot: NR	Operative time, estimated blood loss, recurrence, and	Indirect evidence from direct RCT evidence of robot-assisted

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
			Unclear which RCTs were used for each outcome, but the NMA included 6 RCTs by Anger et al. (2014), Coolen et al. (2017), Costantini et al. (2016), Freeman et al. (2013), Illiano et al. (2019), and Paraiso et al. (2011) Studies to April 2021	4 RCTs excluded women if they were severely obese 3 RCTs excluded women if they have previously undergone previous prolapse repair	Follow up: ranged from 12 months to 4 years Studies in NMA were conducted in: USA, Italy, UK and the Netherlands	post-operative complication	sacrocolpopexy versus conventional laparoscopic sacrocolpopexy, and conventional laparoscopic sacrocolpopexy versus open sacrocolpopexy Cochrane Collaboration RoB tool used to assess RoB
Chen et al. (2024)	Robot-assisted myomectomy	Conventional laparoscopic myomectomy	Pooled analysis of up to 23 comparative observational studies (mainly retrospective case-control studies) published between January 2000 and January 2023	Women with uterine myomas	n = 6,357 Type of robot used in the studies was NR Mean age of participants: 33.5 years to 43 years Median age of participants: 33.5 to 48 years Mean BMI of participants: 20.39 to 35 Median BMI of participants: 21.6 to 31.0	Operating time	Quality assessment conducted with NOS
		Open myomectomy	Pooled analysis of up to 17 comparative observational			Operating time, estimated blood loss, blood	

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
			studies (mainly retrospective case-control studies) published between January 2000 and January 2023		Mean uterine weight: 116 to 850.1 g Median uterine weight: 75 to 482.86 g Studies were conducted in USA, Canada, Turkey, China, Italy, South Korea, Belgium, Mexico, India Follow up time NR 7 studies reported seniority of the surgeons. 5 studies reported surgeons had 5 to 10 years of experience of robot-assisted gynaecological surgery and 5 to 25 years of laparoscopic surgery	transfusions, complications, length of hospital stay	
Lawrie et al. (2019)	Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	Evidence from July 2010 to January 2018 Pooled analysis of up to 5 RCTs by Deimling et al. (2017), Green et al. (2013), Lönnerfors et al. (2015), Paraiso et al. (2013) and Sarlos et al. (2012)	Women requiring surgery for benign or malignant gynaecological disease at any age (only reported studies of benign conditions in this table)	n = 765: - Robot-assisted surgery: n = 408 - Other surgical approach: n = 357 7 RCTs were single-centre Studies were conducted in USA, Switzerland, Sweden and Italy Women participating in robot-assisted hysterectomy to conventional laparoscopic surgery were on average in their mid-40s,and 52 years old compared to open hysterectomy; women	Length of hospital stay, re-admission, re-intervention, conversion to another surgical approach, blood transfusions, pain, QoL	Certainty of outcomes assessed using GRADE IT conducted where possible
		Open hysterectomy	Systematic review of 1 RCT by Wijk et al. (2018)			Complications, QoL, re-admission	

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
	Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	Pooled analysis of up to 4 RCTs by Anger et al. (2014), Costantini et al. (2016), Paraiso et al. (2011) and Sarlos et al. (2012)		undergoing robot-assisted sacrocolpopexy were on average about 60 years old; women undergoing endometrial resection for endometriosis were on average 34 years old BMI was not significantly different between any of the study arms and reported means and medians ranged between 24 and 32 kg/m^2 Indications for hysterectomy: mainly uterine fibroids or abnormal bleeding Indications for sacrocolpopexy: mainly symptomatic pelvic organ prolapse Most women undergoing robot-assisted sacrocolpopexy or endometriosis had previous abdominal surgery Most surgeons were experienced and had performed 10-20 or more relevant robot-assisted surgeries Type of robot: NR	Conversion to another surgical approach, length of stay, QoL	
	Robot-assisted surgery for endometriosis	Conventional laparoscopic surgery for endometriosis	Systematic review of 1 RCT by Soto et al. (2017)			Total operative time, estimated blood loss, conversion to another surgical approach., complications, re-admission, pain, QoL	
Lenfant et al. (2023)	Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy Vaginal hysterectomy	S1 RCT by Lönnerfors et al. (2015) in the systematic review	Studies were excluded if they included children, and if the surgery involved alternative	n = 122 Type of robot: da Vinci Conducted in Sweden	Estimated blood loss, operative time, conversion to open surgery,	Certainty assessed with RoB-2 and NOS

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
			Evidence from January 2010 to December 2020	surgical techniques (i.e. single-port). Women were included if they had a need for total hysterectomy to treat a benign indication, had a uterus size ≤ 16 gestational weeks, had uterus/vagina size enabling vaginal retrieval, allowing for coring, when necessary, and had no desire for additional pregnancies	The least-experienced robotic surgeon had performed 49 robotic hysterectomies before the study Median age of women in the RCT were 46 years old in controls and 47 years in the robot-assisted group Median BMI was 24.9 in controls and the robot-assisted surgery group 56% of controls and 54% of those undergoing robotic surgery had previous abdominal surgery	complications, length of stay, hospital re-admission, re-intervention	
Maher et al. (2023)	Robot-assisted sacrocolpopexy	Conventional laparoscopic sacrocolpopexy	Data to March 2022 Pooled analysis of up to 3 RCTs by Anger et al. (2014), Illiano et al. (2019) and Paraiso et al. (2011).	Included people undergoing surgery for symptomatic apical vaginal prolapse Studies of very high RoB were excluded Studies were required to have at least 6 months follow up and at least 20 women in each arm	n = 245 Women had symptomatic apical vaginal prolapse (either primary or recurrent). 1 RCT included women who had the uterus present, 1 RCT included women with vault (post-hysterectomy) prolapse, 1 RCT included women with uterine/vault prolapse Mean age: 55 to 70 years Follow up: 1 to 2 years Studies conducted in USA Type of robot: NR	Total operating time, estimated blood loss, blood transfusions, serious complications, recurrence, re-intervention, pain, QoL, patient satisfaction	Certainty of the evidence assessed with GRADE ITT analysis done where possible

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
Pickett et al. (2023)	Robot-assisted hysterectomy	Conventional laparoscopic hysterectomy	Data to December 2022 Pooled analysis of up to 3 RCTs by Deimling et al. (2017), Paraiso et al. (2013) and Sarlos et al. (2012)	In the RCT by Sarlos et al. (2012), uterine weight had to be less than 500 g. Other 2 RCTs did not use uterine size as an exclusion criterion Patients were excluded from some of the studies if they were pregnant, had a pelvic organ prolapse allowing for a vaginal approach, were anticipated to undergo combined surgical procedures (other than coincidental appendectomy), or who were morbid obesity (BMI > 44) or need for concomitant bowel resection One of the RCTs stated that women were included if they had an indication for hysterectomy because of benign lesions if vaginal hysterectomy was expected to be difficult because of myomas or nulliparity	n = 296 Mean age of women in robotic-surgery group: 42.3 years to 46.3 years Mean age of women in conventional laparoscopic surgery group: 43.2 years to 45.8 years Type of robot: da Vinci 1 RCT stated that experienced surgeons with 75 to 400 hours of laparoscopic surgery and at least 20 hours of robotic surgery took part in the study Studies conducted in USA and Switzerland	Total operating time, complications, time taken to return to normal activities	Certainty of the evidence assessed with GRADE ITT analysis done where possible
Sheng et al. (2023)	Robot-assisted myomectomy	Conventional laparoscopic myomectomy	Data to January 2023	Controlled studies of patients diagnosed with uterine fibroids and	n = 45,702: Robotic surgery group: n = 11,618 Conventional laparoscopic surgery: n = 34,084	Estimated blood loss, blood transfusions,	Quality of studies assessed using NOS

Review	Intervention	Comparator	Design, search period	Eligibility criteria	Trial/patient characteristics	Outcome measures	Comments
			15 retrospective controlled observational studies	undergoing myomectomy	Studies conducted in USA, Taiwan, Turkey, Italy, Korea and Mexico Mean age ranged from 36.4 years to 47 years Mean BMI ranged from 21.9 to 28.6 kg/m^2 Type of surgery NR	conversion to open surgery, complications, length of hospital stay	

Abbreviations: BMI, body mass index; g, grams; GRADE, Grading of Recommendations, Assessment, Development, and Evaluations; ITT, intention-to-treat; kg, kilograms; m, metre; NMA, network meta-analysis; NOS, Newcastle-Ottawa Scale; NR, not reported; POP-Q, Pelvic Organ Prolapse Quantification System; QoL, quality of life; RCT, randomised controlled trial; RoB, risk of bias, RoB2, Cochrane Handbook risk of bias tools for randomised trials

Table A2 – Randomised controlled trials: design and characteristics

Study reference	Setting	Participants	Intervention(s)	Comparator	Outcomes	Comments
Hotton et al. (2023)	France	n = 369 Women with malignant gynaecological conditions (54% uterine cancer, 43% cervical cancer, 3% ovarian cancer)	Robot-assisted hysterectomy and/or lymphadenectomy Type of robot: not reported	Conventional laparoscopic hysterectomy and/or lymphadenectomy	Ergonomics	Did not include women with benign gynaecological conditions
Illiano et al. (2019)	Not reported	n = 100 Women with symptomatic prolapse stage III and IV, according to the Pelvic Organ Prolapse quantification Women were excluded if they had severe obesity, heart failure (NYHA class III-IV), stage III-IV of chronic obstructive pulmonary disease, more than 2 previous abdominal surgical procedures and other contraindications to major surgery and/or general anaesthesia	Robot-assisted sacrocolpopexy Type of robot: da Vinci Xi	Conventional laparoscopic sacrocolpopexy	Quality of life	Data from this study were incorrect for quality of life in the systematic review by Maher et al. (2023)
Lönnerfors et al. (2015)	Sweden	n = 122 Women with uterine size ≤16 gestational weeks scheduled to undergo minimally invasive hysterectomy because of benign disease	Robot-assisted hysterectomy Type of robot: da Vinci	Conventional laparoscopic hysterectomy, vaginal hysterectomy	Estimated blood loss, operating time, length of hospital stay	Data from this study were incorrect for estimated blood loss, operating time and length of hospital stay in the systematic review by Lenfant et al. (2023)
Paraiso et al. (2011)	USA	n = 78 Women with stage 2–4 post-hysterectomy vaginal prolapse Patients were excluded if they were not candidates for general anaesthesia, had a history of prior sacrocolpopexy, suspicious	Robot-assisted sacrocolpopexy Type of robot: da Vinci	Conventional laparoscopic sacrocolpopexy	Patient satisfaction	Data from this study were incorrect for patient satisfaction in the systematic review by Maher et al. (2023)

Study reference	Setting	Participants	Intervention(s)	Comparator	Outcomes	Comments
		adnexal masses, a history of pelvic inflammatory disease, morbid obesity, or had a history of prior or concomitant surgery for rectal prolapse				
Sarlos et al. (2012)	Switzerland	n = 100 Indications were benign lesions if vaginal hysterectomy was expected to be difficult because of myomas or nulliparity and if the uterus weight was estimated to be less than 500 g.	Robot-assisted hysterectomy Type of robot: da Vinci	Conventional laparoscopic hysterectomy	Estimated blood loss	Data from this study were incorrect for estimated blood loss in the systematic review by Lenfant et al. (2023)

Appendix 6 – HTW cost analysis

1. Background and objective

An economic analysis was developed to estimate the costs and outcomes associated with robot-assisted benign gynaecological surgery compared to standard care.

The economic analysis focused specifically on hysterectomy and sacrocolpopexy, as these indications had the strongest evidence base for robot-assisted surgery. Outcomes were considered where statistically significant differences were seen between robot-assisted surgery and the comparator in the clinical literature review.

A cost-consequence analysis was developed which compared robot-assisted hysterectomy to laparoscopic hysterectomy, and robot-assisted sacrocolpopexy to laparoscopic and open sacrocolpopexy. The model captured costs and outcomes for the surgical period and immediate hospital stay, as no evidence of long-term benefits was identified in the literature.

2. Methods

2.1 Model approach

The model was developed using Microsoft Excel to compare the costs and outcomes of surgical options for benign gynaecological conditions. The analysis took the perspective of the Welsh NHS and personal social services (PSS). Three comparisons were conducted in the analysis to evaluate the cost-consequence of robot-assisted surgery against the following strategies:

1. Conventional laparoscopic hysterectomy
2. Conventional laparoscopic sacrocolpopexy
3. Abdominal open sacrocolpopexy

The model considered costs and outcomes of the surgical period and immediate hospital stay only. As such, no discounting was considered in the analysis.

2.2 Effectiveness data

Outcomes that showed statistically significant differences between surgical options were considered in the current analysis. Details of the considered outcomes are provided in Table A3. For more information on the studies used in the economic analysis, please refer to Section 5.

Hysterectomy data were informed from meta-analyses by Pickett et al. (2023) and Lawrie et al. (2019), while laparoscopic sacrocolpopexy data were informed from a meta-analysis by Maher et al. (2023). Effectiveness for laparoscopic arms were derived using a weighted average of reported outcomes from included studies.

Outcomes for open sacrocolpopexy were derived from the network meta-analysis by Chang et al. (2022). Effectiveness for the open arm were derived using a weighted average of reported outcomes from included studies, where reported. Complications considered for open sacrocolpopexy varied from mild, including nausea and vomiting, to more severe, such as sepsis, excessive blood loss requiring transfusion and bowel perforation. However, complications were grouped together in all studies included in Chang et al. (2022).

The effect of using robotic surgery was applied as reported in the meta-analyses per outcome.

Table A3 – Effectiveness outcomes included in the economic analysis

Outcome	Standard care		Effect of robotic-assisted surgery		Source
	Mean	SE	Mean	SE	
Operating time (minutes)					
Laparoscopic hysterectomy	104.37	6.33	+44.13	19.79	Pickett et al. (2023)
Laparoscopic sacrocolpopexy	189.97	5.44	+43.71	11.95	Maher et al. (2023)
Open sacrocolpopexy	121.45	12.15[a]	+1.66	0.45	Chang et al. (2022)
Length-of-stay (days)					
Laparoscopic hysterectomy	1.49	0.10	-0.30	0.12	Lawrie et al. (2019)
Blood loss (ml)					
Open sacrocolpopexy	216.29	21.63[a]	-2.07	0.72	Chang et al. (2022)
Complications (%)					
Open sacrocolpopexy	27.87%	0.03[a]	0.76[b]	1.04	Chang et al. (2022)

Abbreviations: SE, standard error
[a] SE assumed 10% of the mean
[b] Odds ratio applied to the percentage of complications in the comparator (standard care) arm.
All modelled with a normal distribution, with the exception of the odds ratio which is modelled with a lognormal distribution

2.3 Costs

The costs considered reflect the perspective of the analysis, thus only costs that are relevant to the UK NHS & PSS were included. Where possible, all costs were estimated in 2023 prices. Where costs were reported in a different cost year, they were inflated to 2023 prices using the NHS cost inflation index (Jones et al. 2022).

Costs within the model have been sourced from NHS Reference costs 2022-23 (NHS England 2023) to account for costs of each procedure, provided in Table A4. As no costs could be sourced for robot-assisted sacrocolpopexy from NHS Reference costs 2022-23, it has been assumed to have an equivalent cost to laparoscopic sacrocolpopexy. For patients admitted to hospital, a daily cost of £460 associated with staying on a general ward was applied to their length of stay, informed by excess bed day costs reported in the NHS National Cost Collection reference costs (2017/18) (NHS Improvement 2020).

Table A4 – Procedure costs applied in the analysis

Gynaecological indication	Surgical approach	Mean costs	SE[a]	Source
Hysterectomy	Laparoscopic	£6,275	£628	NHS England (2023)
	Robot-assisted	£6,914	£691	
Sacrocolpopexy	Laparoscopic	£7,315	£732	
	Open	£8,487	£849	
	Robot-assisted	£7,315	£732	

Abbreviations: SE, standard error
[a] Assumed 10% of the mean
All modelled with a gamma distribution

Costs of the robotic systems themselves have focused on the two systems which are believed to currently be in use across NHS Wales. Costs of the da Vinci Single Xi and Versius robotic systems were provided by their respective manufacturers, Intuitive Surgical and CMR Surgical. The da Vinci Single Xi system costs £1.6 million and the Versius system £1.2 million, with annual maintenance costs of £140,000 and £120,000, respectively. An average cost for both systems was used in the base case analysis. The average cost of the robot and maintenance was assumed to be spread over 7 years, with an assumed 300 benign gynaecological surgeries being undertaken by the robots per year. This aligns with evidence identified in the economic review and information provided by experts during our appraisal process. This resulted in an average cost of £1,038 per patient for the purchase of the robot. It should be noted that although an average cost of systems has been assumed in the base case analysis, the clinical evidence within the economic model is based solely on the use of da Vinci robots. Therefore, the applicability of evidence to the Versius systems is uncertain. Scenario analyses explore using costs of each of the systems in the analysis independently.

In addition to the robotic purchase price, each procedure is associated with instrument costs. A cost of £590 per procedure was provided from Intuitive Surgical, and instrument costs for the da Vinci system have been sourced from a study by Bennett (2012). Costs of £1,000 cited in the paper refer to the cost of disposables for the da Vinci Si model. For the purposes of this analysis, it has been assumed that disposable costs across da Vinci systems are comparable, and so an inflated cost of £1,257 has been derived. An average cost of £924 has been applied in the base case analysis to represent the instrument costs of robotic surgery.

3. Results

3.1 Base case results

The base case results of the analysis are provided in Table A5. The results show that using robot-assisted surgery compared to laparoscopic hysterectomy, laparoscopic sacrocolpopexy and open sacrocolpopexy is expected to increase costs by £2,462, £1,962, and £790 per patient, respectively.

Compared to laparoscopic hysterectomy, robotic-assisted surgery is also expected to increase operating time by 44.13 minutes and decrease length of stay by 0.3 days. Robotic-assisted sacrocolpopexy is expected to increase operating time by 43.71 minutes and 1.66 minutes when compared to laparoscopic and open approaches, respectively. It is also associated with a reduced blood loss of 2.07ml and a reduced rate of complications by 6.59% when compared to open sacrocolpopexy.

Table A5 – Base case results

Outcome	Comparator	Robotic-assisted surgery	Incremental
Costs			
Laparoscopic hysterectomy	£6,961	£9,423	+£2,462
Laparoscopic sacrocolpopexy	£7,315	£9,277	+£1,962
Open sacrocolpopexy	£8,487	£9,277	+£790
Operating time (minutes)			
Laparoscopic hysterectomy	104.37	148.50	+44.13
Laparoscopic sacrocolpopexy	189.97	233.67	+43.71
Open sacrocolpopexy	121.45	123.11	+1.66
LOS (days)			
Laparoscopic hysterectomy	1.49	1.19	-0.30
Blood loss (ml)			
Open sacrocolpopexy	216.29	214.22	-2.07
Complications (%)			
Open sacrocolpopexy	27.87%	21.27%	-6.59%

3.2 Scenario analyses

Several scenarios were tested to assess the impact of key model assumptions. Table A6 provides detail on the impact that each tested scenario had on modelled results. As all modelled scenarios impact the cost of the robotic systems only, presented results demonstrate the impact on the cost of the robotic-assisted surgery arm and incremental costs.

The first two scenarios explored the cost of the individual systems. As the evidence used to inform the cost-consequence analysis was conducted on trials using the da Vinci systems only, we cannot assume that the clinical results of the analysis can be comparable to the Versius systems. Despite this, an average cost of the systems has been assumed in the base case analysis. Scenarios 1 and 2 explore using the cost of the da Vinci system only and the cost of the Versius system only, respectively.

As there are a number of sites in Wales which already have robotic systems installed, Scenario 3 explores the situation whereby there are no upfront robotic costs. In this scenario, annual maintenance costs and instrument costs are still applied as these will still be required following robotic system installation. It should be noted that although this scenario reflects no initial purchase cost, the robotic systems have a lifespan after which they require being replaced and so this scenario isn't truly representative of expected future costs.

In the base case analysis, it has been assumed that a robotic system will carry out 300 benign gynaecological surgeries per year, based on expert opinion and our economic literature review. However, in practice, a single robot would be used across multiple indications and so the expected number of surgeries would likely vary. It is uncertain how many surgeries a single robot would carry out in Wales, however, Scenarios 4 and 5 explore an estimated upper and lower number of surgeries conducted per year.

Scenario 4 assumes that a robot will only carry out 150 surgeries per year. This value has been sourced from NICE guidance 131 for prostate cancer (NICE 2021), using the minimum number of surgeries they recommend for employing robotic assistance. It has been assumed under this scenario that this number would apply across indications.

Scenario 5 assumes that a robot will carry out 735 surgeries per year. This value has been derived from estimates by Life Sciences Hub Wales (2023) that the introduction of the three CMR Surgical robotic systems in Wales is expected to benefit 1,300 patients. This averages about 435 surgeries per robot per year. Since the system is not commissioned for use in benign conditions, it is assumed that this number excluded the benign gynaecological surgeries modelled in the base case analysis. Therefore, a value of 735 has been derived for the number of surgeries performed per year by a single robot.

Table A6 – Scenario analysis results

Scenario	Description	Cost Input (per person)	Resulting cost against comparator		
			Laparoscopic hysterectomy	Laparoscopic sacrocolpopexy	Open sacrocolpopexy
Base Case	-	Robot: £1,038 Instrument: £924	RAS: £9,423 Inc.: +£2,462	RAS: £9,277 Inc.: +£1,962	RAS: £9,277 Inc.: +£790
1	Cost of da Vinci robot applied only	Robot: £1,162 Instrument: £1,257	RAS: £9,881 Inc.: +£2,920	RAS: £9,734 Inc.: +£2,419	RAS: £9,734 Inc.: +£1,247
2	Cost of Versius robot applied only	Robot: £914 Instrument: £590	RAS: £8,966 Inc.: +£2,005	RAS: £8,819 Inc.: +£1,504	RAS: £8,819 Inc.: +£332
3	No upfront robotic system cost	Robot: £371	RAS: £8,757 Inc.: +£1,796	RAS: £8,610 Inc.: +£1,295	RAS: £8,610 Inc.: +£123
4	150 annual robotic surgeries	Robot: £2,076	RAS: £10,461 Inc.: +£3,500	RAS: £10,315 Inc.: +£3,000	RAS: £10,315 Inc.: +£1,828
5	735 annual robotic surgeries	Robot: £424	RAS: £8,809 Inc.: +£1,848	RAS: £8,662 Inc.: +£1,347	RAS: £8,662 Inc.: +£175

Abbreviations: Inc., incremental; RAS, robot-assisted surgery
Robotic price provided in the table includes the purchase and annual maintenance costs.

Across all conducted scenarios, the cost burden of robotic-assisted surgeries is higher than that of the comparator. Performing fewer surgeries results in the largest incremental costs between modelled arms as the upfront cost of the robot is spread over fewer procedures. Applying no upfront purchase price of the robot results in the lowest incremental costs between modelled arms. However, even with no capital costs, it is still expected that robotic-assisted surgery will cost more than the modelled comparators.

These scenarios, therefore, highlight that base case results are robust to key changes in modelling assumptions and that it is likely that the robotic-assisted surgery is a cost-incurring surgical method.

3.3 Probabilistic sensitivity analysis results

A probabilistic sensitivity analysis (PSA) was conducted to assess the combined parameter uncertainty in the model. In this analysis, values used in the base case were replaced with values drawn from distributions around the mean. The results of 10,000 runs of the PSA are presented in Table A7.

Table A7 – Probabilistic sensitivity analysis results

Outcome	Comparator	Robotic-assisted surgery	Incremental
Costs			
Laparoscopic hysterectomy	£6,962	£9,421	£2,459
Laparoscopic sacrocolpopexy	£7,321	£9,273	£1,953
Open sacrocolpopexy	£8,490	£9,273	£790
Operating time (minutes)			
Laparoscopic hysterectomy	104.34	148.18	43.84
Laparoscopic sacrocolpopexy	189.97	233.54	43.57
Open sacrocolpopexy	121.47	123.14	1.66
Length of stay (days)			
Laparoscopic hysterectomy	1.49	1.19	-0.30
Blood loss (ml)			
Open sacrocolpopexy	216.22	214.15	-2.07
Complications (%)			
Open sacrocolpopexy	18.89%	13.94%	-4.95%

The PSA estimated that using robotic surgery compared to laparoscopic hysterectomy could mean cost savings from £1,320 to cost increases of £6,109. The cost burden of robotic sacrocolpopexy compared to laparoscopic sacrocolpopexy ranged from savings of £2,122 to increases of £5,970, whilst the equivalent cost burden when compared to open sacrocolpopexy resulted in savings of £4,000 to increases of £5,158. Average results were similar to the base case analysis results and demonstrate that costs are likely to be increased against all comparator surgeries.

4. Limitations

The cost-consequence analysis was limited due to the availability of evidence in the published literature. The limitations of the clinical evidence, therefore, apply to the economic analysis as well, such as the evidence captured generally being older. Although the meta-analyses used to inform the economic analysis were published between 2019 – 2023, the published dates of the studies within these meta-analyses vary from 2010 – 2019. The economic analysis reflects the effectiveness of robotic assisted surgery on the included studies and does not capture any potential advancements since.

Although the clinical evidence is conducted on da Vinci robots, the economic analysis has applied an average cost of the da Vinci robots and Versius robots in the base case analysis. There are likely differences between the systems, such as the size, as the Versius robot is much smaller and transportable. As such, it is uncertain whether the results from the da Vinci systems can be assumed to apply for the Versius systems. A separate cost analysis has been provided whereby the costs of the systems are provided independently of one another.

Additionally, the model explores a payment option for the robotic system spread over 7 years. While other payment options have been discussed with the manufacturers, it is uncertain which approach Wales would adopt. However, the 7-year option appears to be the most common in other economic analyses.

The economic analysis is also unable to capture benefits to surgeons, such as the ergonomics of the robots, discussed in Section 5.20.

Appendix 7 – FTWW Submission Form on RABGS

General information

HTW appraisal topic	Robotic Assisted Begin Gynaecological Surgery
Name of organisation	Fair Treatment for the Women of Wales (FTWW)
Health/medical conditions/social care need represented	Non-cancerous gynaecological conditions
Contact name for this submission	Debbie Shaffer
Role of contact person	Director of Policy & Research
Address	c/o FTWW, Office 5, Plas Eirias Business Centre, Abergele Road, Colwyn Bay, Conwy, North Wales, LL29 8BF
Phone	01492 510332
Email	info@ftww.org.uk
Website	www.ftww.org.uk
Date of submission	7 August 2024

The health condition

1. Describe any sources you used to gather information for this submission.

- Report from Welsh Government's 2017-18 Endometriosis Task & Finish Group: https://www.gov.wales/endometriosis-care-review
- The Women's Health Wales Coalition 2022 report: https://www.ftww.org.uk/2021/wp-content/uploads/2022/05/Womens-Health-Wales-Quality-Statement-English-FINAL.pdf
- Mothers for Mothers report on reproductive challenges and infertility: https://mothersformothers.co.uk/blog/the-impact-of-infertility-on-your-mental-health/
- Endometriosis Cymru: https://endometriosis.cymru/
- Endometriosis UK: https://www.endometriosis-uk.org/personal-stories
- Surgical challenges and complications:
  - https://www.mayoclinic.org/tests-procedures/myomectomy/about/pac-20384710
  - https://www.nhs.uk/conditions/pelvic-organ-prolapse/treatment/
  - https://www.ijrcog.org/index.php/ijrcog/article/view/12125
- Benefits of robotic assisted surgery: https://utswmed.org/conditions-treatments/gynecologic-robotic-surgery/#:~:text=Benefits%20of%20Gynecologic%20Robotic%20Surgery,Less%20scarring

- Royal Collage O&G guidance: https://www.rcog.org.uk/guidance/browse-all-guidance/scientific-impact-papers/robotic-surgery-in-gynaecology-scientific-impact-paper-no-71/
- Royal College of O&G 'Left for Too Long' report 2022: https://www.rcog.org.uk/about-us/campaigning-and-opinions/left-for-too-long-understanding-the-scale-and-impact-of-gynaecology-waiting-lists/

2. What is the health condition and how does it affect the day-to-day lives of patients/individuals, their families, carers, etc?

'Benign, or non-cancerous, gynaecological conditions' is an umbrella term that incorporates a vast range of conditions including, but not limited to, endometriosis, adenomyosis, pelvic prolapse, uterine fibroids, benign ovarian tumours and vesicovaginal fistula. Whilst distinct diagnoses, they often share an array of symptoms including pain and feelings of pressure, nausea, sickness,, cramping, vaginal bleeding, fatigue, and fertility issues.

Pain - including pelvic pain or pressure, vaginal pain, lower back pain or pressure, pain during sex, painful periods, painful bowel movements, pain whilst urinating – can hugely impact quality of life for the girls, women, and people registered female at birth affected. The pain and / or heavy blood loss they experience can result in absence from school and not being able to fulfil their educational or career potential. It can lead them to losing jobs, reliance on welfare payments, prevent them from being able to undertake routine, social, and leisure activities, prevent them from being actively involved in family life and friendships, and can create significant challenges to romantic relationships. All told, this places an enormous amount of psychological and emotional pressure on them, their loved ones, and wider networks.

For some, the physical, mental, and societal challenges of having to cope with an invisible – often embarrassing or taboo – set of symptoms can lead to poor self-esteem, guilt, shame, social and professional isolation, relationship and family breakdown, anxiety, and depression. Some withdraw completely. The resulting impact of loneliness and social isolation on health and longevity is well-evidenced, on top of the challenges of trying to manage chronic symptoms. Very sadly, research suggests that the risk of suicidality is raised in those living with chronic illness, including chronic pain. https://pubmed.ncbi.nlm.nih.gov/33128664/

Fertility can also be affected. Many patients with non-cancerous gynaecological conditions experience difficulties getting pregnant, maintaining a pregnancy, or infertility. Reproductive challenges can be physically and emotionally demanding, financially draining, and time-pressured. On occasion, they can culminate in the breakdown of relationships, causing significant upheaval in a person's life. Failure to conceive and/or experiencing early miscarriage can be devastating and, for some, the effect on mental health is significant. The loss of a person's ability to have children can impact their self-identity, self-worth and even self-purpose. Sometimes, the treatments offered to those with a non-cancerous gynaecological diagnosis can, in themselves, cause infertility, for example in those undergoing hysterectomy or oophorectomy to resolve pain and heavy bleeding.

3. How is the health condition currently diagnosed or assessed and what are the current or traditional treatments?

Despite their prevalence and impact, obtaining a definitive diagnosis of a non-cancerous gynaecological condition can be challenging. Poor knowledge of gynaecological conditions and the wide range of symptoms, such as pain and feelings of pressure, nausea, sickness, fertility issues, cramping, vaginal bleeding and fatigue, can make it difficult to pinpoint a precise cause. However, there is much evidence to suggest that patients reporting symptoms like these can also find that their impact is not well understood by healthcare professionals. Symptoms might be attributed to a psychological cause or seen as 'normal'. This can lead to significant diagnostic delay.

Many female patients give distressing accounts of repeated attempts to explain symptoms, to get healthcare professionals to take them seriously and to arrive at a final diagnosis that then opens up a treatment pathway. This means that patients can live for years with debilitating health issues without a clear understanding of why it is happening to them and what can help. Patients often find themselves relying on their powers of self-advocacy which is, in itself, a barrier to care for those who don't speak English as a first language, who have different communication needs, or have a learning disability. The need to repeatedly self-advocate, whilst seriously unwell, places a tremendous burden on patients, detracts from their daily lives and relationships, and can lead to deteriorating physical health, mental health and emotional wellbeing. It also prolongs the period of time that patients must continue to live with symptoms that make daily life difficult.

Assuming patients are referred on for further investigations, access to adequate imaging, a technique commonly used to locate fibroids/cysts etc can be problematic. Waiting times are long, and the images obtained are not always conclusive. Sometimes the personnel carrying out the imaging are not able to, for example, identify endometriosis beyond the ovary, and patients may be required to attend several appointments before suitable images are obtained.

In some cases, such as with endometriosis and ovarian tumours, a diagnosis can only be reached with secondary care procedures like surgery (most commonly a diagnostic laparoscopy) to locate and/or assess potential lesions, cysts, tumours, or adhesions (internal scar tissue), and perform biopsies where appropriate. However, a diagnostic laparoscopy isn't always successful in establishing a cause of the patients' symptoms. Endometriosis lesions in particular can be difficult to locate or identify, especially if operations are not undertaken by those with additional training in visualising the disease. The result is that patients with this condition may go undiagnosed even following surgery, something that can have a hugely detrimental impact on their confidence, self-esteem, and psychological wellbeing, as well as their ability to manage physical symptoms.

Delayed diagnosis is often cited by women as a key reason for deteriorating quality of life. Sadly, many report having symptoms dismissed or trivialised by those around them, including healthcare professionals, something they find frustrating, distressing and disempowering. Patients can feel unseen and unheard, like their pain is meaningless. Being seen as 'dramatic', 'difficult' or 'crazy' by those around them can harm a person's perception of themselves and have hugely negative consequences for personal and professional relationships.

Without a diagnosis, it can be incredibly challenging to secure reasonable adjustments in the workplace, resulting in many leaving employment. Equally, if patients aren't confident that they will be taken seriously, they can put off seeking medical advice for other health issues or simply disengage from health interventions altogether, such as breast or cervical screening. This can have potentially disastrous results.

Assuming a diagnosis is reached, this can be met by initial relief at having found the ‘answer’. However, this is often followed by anxiety about the future. Patients commonly report poor support and information from healthcare providers at this point.

Post-diagnosis, treatment will often involve surgery. Some of the most frequently performed operations for non-cancerous gynaecological conditions include hysterectomy, oophorectomy, myomectomy, surgical treatment of endometriosis (ablation and / or excision) and sacrocolpopexy. All of these will require considerable work-up, general anaesthetic, and sufficient recovery time, with a strong supportive network needed at home to avoid post-operative complications. Unfortunately, some non-cancerous gynaecological conditions are chronic in nature and may require more than one operation and / or ongoing medical management.

4. What are the challenges associated with current practice and what does this mean for patients, individuals, their families, carers, etc?

There is evidence to suggest that some of the challenges associated with gynaecological operations can be attributed to inadequate training in minimal access surgery and insufficiently advanced laparoscopic skills for gynaecologists to confidently identify and treat disease, particularly endometriosis, which can take on a multitude of appearances and be difficult to visualise, locate, or treat optimally. Lesions can sometimes be missed, resulting in more surgery for patients and the continuation of debilitating symptoms.

Surgery may also lead to complications such as bleeding and blood clots, infection, bladder and bowel damage, vaginal problems, and post-operative adhesions. Our understanding is that repeated diathermy or ablation (‘burning’) of pelvic tissues has the potential to create more internal scarring which, for some patients, might increase their risk of developing complications like bowel obstruction, and make subsequent surgeries more challenging. Even with the best outcomes, surgery will require significant recovery periods if patients are not to cause themselves harm. This be can be difficult for those needing to go back to work and / or without adequate support around them.

A huge challenge in current practice concerns a widespread inequity of service provision, knowledge, and understanding, particularly when it comes to conditions that primarily concern women and people registered female at birth. There are notable disparities in care between men and women in Wales, with numerous reports evidencing how women’s reporting of symptoms can be dismissed or normalised, with patients often expected to self-manage with inadequate support.

In part, a lack of appropriate diagnoses and treatment plans can be attributed to the fact that women have historically been excluded from clinical trials, and the tendency to base diagnostic criteria for health issues affecting males and females on white men. This extends further into lack of prioritisation and funding awarded to medical research which prioritises health conditions disproportionately or exclusively impacting females. In practice, the result is failure to develop consistent, equitable care pathways for patients. Gynaecology is particularly poorly-served, not least because, outside of cancer services, it is typically described as ‘benign’, which the RCOG finds has contributed to its not being prioritised or taken seriously.

In short, societal attitudes towards 'women's health' extend into healthcare settings, compounding the difficulties patients face when engaging in services across primary and secondary care.

In England and Scotland, these equity issues are being addressed by the implementation of women's health strategies. Work is underway to develop a NHS Wales Women's Health Plan but we are quite some way behind. Patients in Scotland and England also have access to robotic assisted surgery for endometriosis and other gynaecological conditions. It is of great concern that women in Wales are unfairly treated; from the perspective of patients, 'unfairness' in healthcare generally is difficult to justify.

The health technology or model of care and support

5. What difference did/could the health technology make to the lives of patients and what outcomes matter most to them, their families, etc?

Robotic assisted surgery holds the potential to improve patient experiences and outcomes in the following ways:

- By improving visualisation of complex disease, thereby potentially reducing the chance of patients requiring further surgeries, improving diagnostic rates and subsequent access to appropriate treatment.
- By improving access to areas of the pelvis which might, ordinarily, be hard to reach.
- By decreasing levels of surgeon fatigue which can arise during long, complex operations, thereby improving the prospect of effective treatment and potentially reducing the risk of unintended damage or harm.
- By potentially reducing the risk of post-operative pain and complications that arise from adhesion-formation.
- By increasing the surgical options available to patients, potentially opening up access so that more patients can be seen in a timely manner.
- Bringing Wales in line with the rest of the UK in terms of equitable access to treatment options, therefore ensuring Welsh patients aren't at an unfair disadvantage

6. Additional information you believe would be helpful for HTW to consider.

Our understanding is that the robot is not a replacement for surgical skill but an enhancement. Gynaecologists will still require advanced laparoscopic skills and minimal access training to provide the best experience and outcomes for patients and we know that this isn't always a given in Wales.

Employing the robot for non-cancerous gynaecology operations needs to go alongside more robust and ongoing training for gynaecologists in the region. Conversations with healthcare professionals lead us to believe that effective use of the robot will require some aspects of training be delivered away from patients / clinical lists in the first instance, so NHS / health boards would need to ensure that this is accommodated and viewed as a long-term investment in improving patient experience, especially for those with complex disease. This goes hand in hand with attitudinal change, where gynaecology is properly prioritised and women's symptoms, their impact on quality of life and the economic burden of not doing so, is taken seriously.

Investing in the robot and training alongside it is also an important consideration in terms of succession planning and recruitment to the gynaecology workforce in Wales. We know that gynaecology services are often under-resourced and with limited capacity, resulting in increasing waiting lists. Demonstrating a commitment to training and innovation, including the provision of the robot, could well improve recruitment and retention in Wales which, in turn, would also lead to better outcomes for patients.

7. Summarise the key points of your submission in up to 5 statements.

- Women, girls, and those registered female at birth, with 'benign' or non-cancerous gynaecological conditions are a vastly under-served community. Women are often unseen and unheard by the healthcare systems that are meant to protect their health and wellbeing, spending years undiagnosed while experiencing painful, debilitating symptoms that have life-altering implications.
- Increasing the options that gynaecology patients have is an important part of improving patient experiences and addressing widespread inequities in service provision. However, providing patients with adequate and accessible information so that they can make informed choices about their care is absolutely essential.
- Making available enhanced training and technology for gynaecology services in Wales could improve recruitment and retention of associated healthcare professionals, reducing waiting times and improving patient experience. Long waits are associated with deteriorating health and poorer outcomes, including for those whose fertility is being compromised.
- Investing in new technology and training in gynaecology is important to signal a change in mindset on the part of healthcare providers, demonstrating that it is a specialty worthy of prioritisation, and the patients affected are being taken seriously. However, innovation in new technology should not be seen as a panacea – improving Wales's skillset in gynaecology services, across *all* healthcare settings, is vital to reduce variation and inequity of experience and outcome, with or without the robot.