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REVIEW ARTICLE

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Oncological outcomes, safety, efficacy in high BMI patients, attitude, and cost of robotic surgery for endometrial cancer management: a systematic review

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ABSTRACT

Introduction: Endometrial cancer is one of the most widespread gynecological carcinomas, and its incidence is constantly increasing. Numerous non-genetic factors play a role in its development. Therefore, many patients present with major comorbidities. Robotic surgery is becoming a well-established method of endometrial cancer surgical management. It is considered especially beneficial in vulnerable populations, such as high BMI patients.

Material and methods: A systematic literature search was performed in the Web of Science, PubMed, and Scopus databases. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results: We screened 1135 articles altogether, with 19 studies included in the analysis. Robotic surgery is currently considered as effective and as safe as laparoscopic surgery and safer than open surgery. It correlates with fewer perioperative complications, lower blood loss, and longer operating time. Cost and public awareness remain major issues regarding robotic surgery. Therefore, educational interventions could be beneficial in raising awareness of this method of endometrial cancer management.

Keywords: robotic surgery, endometrial cancer, hysterectomy, high BMI patients

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Introduction

Endometrial cancer (EC) is one of the most significant gynecological cancers, and in numerous countries, it is the most common one [1]. There has been an increase in the incidence and mortality of EC over the last few years [2]. EC occurs in around 142,000 women per year and causes around 42,000 deaths worldwide [3]. The incidence of EC, contrary to other gynecologic cancers, is increasing [4]. EC is most common in post-menopausal women; the median age is estimated at 61 [5]. The most common non-genetic risk factors for EC are high BMI, hypertension, age, estrogen replacement therapy, diabetes mellitus, and adult-attained height. Smoking and coffee drinking, on the other hand, are thought to decrease the risk [6]. There is a significant correlation between obesity and endometrial cancer with an estimated risk ratio of 1.52 [7]. A major number of EC patients struggle with obesity, which may also influence the effectiveness of surgery as obese women might experience greater tumor size, longer OT, and more postoperative complications [8]. Surgeon bias often causes a lack of inclusion in clinical trials or different treatments for obese patients [9]. Pre-operative evaluation is also vital, as it should assess cardiorespiratory function, given the higher prevalence of hypertension and diabetes in high BMI patients [10]. Reduced functional residual capacity, increased neck fat, and reduced jaw movements should also be considered regarding anesthesia [11]. Transvaginal ultrasound is the primary method of diagnosing endometrial pathologies, of course, then followed by histological examination [12]. Staging of EC has been depicted by the International Federation of Gynecology and Obstetrics (FIGO) guidelines based on the anatomical scope of the neoplastic lesion and included criteria such as uterine or cervical extension, involvement of surrounding tissue, lymph nodes, or distant metastasis [13]. The FIGO 2023 EC staging system has included molecular classification, which allows the stratifying of EC risk beyond the limited traditional histopathological assessment [14]. Total hysterectomy or bilateral salpingo-oophorectomy are the practiced surgical approaches, either via OS or MIS, along with pelvic and para-aortic lymph node dissection [15]. Sentinel lymph node (SLN) mapping in EC is of utmost significance, especially regarding diagnosing micro-metastasis and avoiding lymphedema and lymphocele [16–17]. Currently, MIS is the preferred method, as it is associated with fewer complications and shorter hospitalization [18]. Myometrial infiltration remains the most significant prognostic factor; according to Markowska et al. [19], IA EC has a 5-year survival rate of 70%, and in IB, in which it metastasizes by both blood and lymph, it is as low as 34%. Currently, molecular tests are a standard in EC. Molecular classification allows patient-dedicated treatment. Adjuvant therapy is also a significant method of EC treatment [20]. However, surgery is still the primary treatment, but the incidence of EC cases in elderly patients or high BMI has been increasing, which leads to greater surgical risk [21]. The European Society of Gynecological Oncology (ESGO) recommends minimally invasive surgery for EC patients. That includes laparoscopic and robotic surgery (RS) [22]. The first laparoscopic surgery (LS) of EC was performed in 1988 [23]. The main disadvantage of this method was operating on patients with obesity. RS was first approved by the US Food and Drug Administration (FDA) in 2005 [24]. RS has been proven to decrease the risk of overall and peri-operative complications, as well as the duration of hospitalization, which is a major improvement for the elderly [25]. It took 10 years for the first robotic surgery in gynecology since its approval [26]. Since then, it has been becoming significantly more popular [27]. The main disadvantages of robotic surgery are the high cost of the robotic devices (2.6 million $ per unit) and the cost per use estimated at 200$ [28]. That states a major barrier that is still impossible to overcome by many low-income countries. Even in Poland, it was first adopted only 6 years ago, in 2018. Various studies have shown that women are prone to choosing RS, if available [29]. Therefore, it is vital to assess its current application in EC management.

This study aimed to systematically assess and review oncological outcomes, perioperative safety, efficacy in high BMI patients and artificial intelligence, as well as cost and patients' attitudes toward robotic surgery in the management of endometrial cancer.

Material and methods

A systematic literature search was performed in PubMed, Web of Science, and Scopus databases until July 2024. No beginning date or language restrictions were used. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search terms consisted of the following terms: outcome OR safety OR BMI OR attitude OR cost AND robotic OR robot-assisted OR DaVinci AND endometrial cancer. Reference lists of included studies were manually screened for any other eligible studies. The inclusion criteria were human studies, observational studies, prospective studies, cross-sectional studies, or randomized controlled trials in English. The exclusion criteria were other types of studies and studies in languages other than English. Following the initial screening, the pre-selected studies were further analyzed to assess final eligibility for the systematic review.

Data extraction

Data were extracted independently by two researchers (F. Ł and J. B) The following data were extracted: authors' names, type of article, year of publication, sample size, data collection method, and the results of questions inquiring about information on perioperative safety, efficacy in patients with high BMI, oncological outcomes, cost, patients' attitude regarding robotic surgery in management of endometrial cancer.

Results

A total of 1135 articles were identified through a systematic review of the literature (Fig. 1). After initial screening, 567 duplicates were excluded, and 568 titles and abstracts were further screened to evaluate eligibility. Leaving a total of 96 full-text publications, resulting in 79 studies being excluded from further assessment. Eventually, a total of 17 publications were included in the final analysis of this systematic review (Table 1).

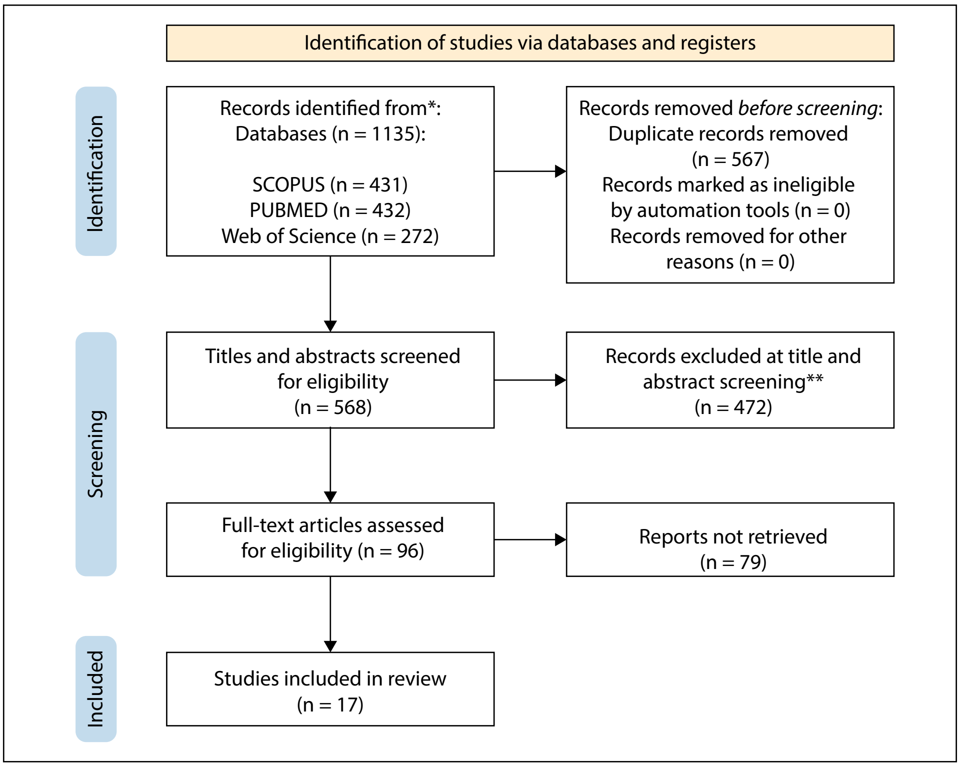

Figure 1. PRISMA flow chart of the screening process

Discussion

Oncological outcomes

A randomized controlled trial by Corrado et. al [30] found that in the next 46 months, 77 recurrences were observed: 15.0% and 13.1% had a recurrence in LS and RS groups, respectively (p = 0.539), and no disparities emerged between LS and RS in terms of disease-free survival (DFS) (p = 0.614) and overall survival (OS) (p = 0.171). A retrospective review in Korea (n = 268) reported that 24 patients (9.0%) suffered from disease recurrence, 6 (6.3%) in the RS group and 18 (10.4%) LS group, The recurrence rate was higher in the LS group, however, the difference was not statistically significant. (p = 0.371), there were eight (3.0 %) cancer-related deaths in the overall population: 1 (1.1 %) in the RS group and seven (4.0 %) in the LS group (p = 0.267), DFS (p = 0.721) and overall survival (p = 0.453) were similar in the two groups [31]. Bizzari et al. [32] (n = 549) reported no important disparity in SLN mapping or SLN bilateral detection between RS and LS groups (p = 0.892 and p = 0.507, respectively), there was no difference in median number of SLNs mapped and retrieved between the two approaches (2 in both groups, p = 0.650) and in site of SLN mapping (p = 0.057), however, patients in the RS groups were older (median 61 versus 64 years, p = 0.046) and had a higher BMI (median 26.0 vs. 34.8 kg/m^2, p < 0.001). A study by Ignatov et al. [33] (n = 337) found no major difference in recurrence 24.7% vs. 28.9% in the RS and LS groups, respectively (p = 0.459), 5-year DFS — 76.7% vs. 72.2% (p = 0.419) and an overall survival rate of 80.7% and 77%, respectively (p = 0.895). Cela et al. [34] conclude that RC SLN mapping is depicted by a high detection rate (78.26%), absence of complications, short OT (average: 160.5 ± 57.78 min), short hospitalization (average 2.52 ± 0.66 days), and significant use for high BMI patients. In fine, current literature data reveals that RS is at least as effective and safe in all aspects as LS. However, it implies that RS has some pivotal advantages regarding high BMI patients compared with other approaches.

Perioperative safety

A study conducted in Italy found that the average hospitalization after RS was shorter in comparison with LS — 3 vs. 4 days (p = 0.0001), the difference was even greater in patients aged 75-85, patients in the RS group suffered fewer intraoperative complications (4 vs. 6), fewer postoperative complications (1 vs. 3), the median

Table 1. Data extraction results

Authors' name	Type of article	Year of publication	Country	Study population	
Corrado et al. [30]	Randomized controlled trial	2021	Italy	n = 573	RS showed smaller loss of blood and longer operative times, neither approach turned out superior regarding survival outcomes.
Yoon et al. [31]	Retrospective study	2024	Korea	n = 268	Importantly lower estimated blood loss, surgical time, and hospital stay were found in the RS group, A significant difference in OS ($p = 0.029$) and RS ($p = 0.024$) in favor of robotics was shown as for survival curves.
Bizzarri et al. [32]	Retrospective study	2021	Italy	n = 549	Patients undergoing RS were older (median 61 vs. 64 years, $p = 0.046$) and of higher median BMI (26.0 versus 34.8 kg/m^2, $p < 0.001$). There was no difference in any SLN mapping or SLN bilateral detection between the LS and RS ($p = 0.892$ and $p = 0.507$ respectively).
Ignatov et al. [33]	Cohort study	2023	Germany	n = 337	The recurrence rate was equally distributed between the two groups ($p = 0.459$). Twenty-seven (24.7%) of 150 patients and 54 (28.9%) of 187 women in the SLNB and LND groups, respectively, were diagnosed with recurrent disease during the follow-up period. RR was found as efficient as LS regarding sentinel node biopsy in EC.
Cela et al. [34]	Retrospective study	2019	Italy	n = 23	No statistically significant difference was seen for blood loss, and no correlation for the detection time and the BMI between RS and LS groups.
Lavoue et al. [35]	Retrospective study	2014	Canada	n = 163	Patients undergoing RS had longer operating times (244 vs 217 minutes, $p = 0.009$) but RS correlated with fewer adverse events (17% compared with 60%, $p < 0.001$). The RS group had smaller estimated mean blood loss (75 vs. 334 mL, $p < 0.0001$) and shorter average hospital stay (3 vs. 6 days, $p < 0.0001$).
Wodzisławska et al. [36]	Retrospective study	2022	Poland	n = 134	Robotic surgery was associated with the shortest hospitalization time, an average of 1.96 days.
Pant et al. [37]	Retrospective study	2014	USA	n = 80	There were 11/47 (23 %) recurrences in the RS group and 8/33 (24 %) in the OS group. There were no important differences in progression-free or overall survival.
Sun et al. [38]	Prospective cohort study	2021	China	n = 40	Compared with the LS group, the RS group had significantly longer pre-surgical time, importantly shorter median operation time, significantly lower median blood loss, and lower vaginal cuff closure time. The median hospitalization length in the RS group was significantly lower than that in the LS group. There was no significant difference in the incidence of complications between the two groups. No recurrence events were observed in either of the groups.
Kadoch et al. [39]	Retrospective study	2024	Canada	n = 1329	Even in extreme obesity cases, robotic surgery remains a feasible option with manageable complications. Obesity does not compromise the safety of robotic endometrial cancer surgery. The learning curve was better in the RS group.

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Table 1 cont. Data extraction results

Authors' name	Type of article	Year of publication	Country	Study population	
Drymiotou et al. [40]	Retrospective study	2023	United Kingdom	n = 281	RS operating time was not affected by higher body mass index, there was no difference in the hospitalization length in the number and severity of complication rates between different BMI populations undergoing MIS.
Lindfors et al. [41]	Retrospective study	2020	Sweden	n = 217	Significantly lower estimated blood loss, surgical time, and hospital stay were found in the RS group. A significant difference in OS ($p = 0.029$) and RS ($p = 0.024$) in favor of robotics was shown in the univariable survival curves, using log-rank tests. No difference was found for disease-free survival.
Amirthanayagam et al. [42]	Prospective study	2023	United Kingdom	n = 53	RS was associated with a major improvement in pain and physical independence and no difference in overall QOL, pain, or physical independence scores was depicted. Patient-reported recovery and QOL after RS is higher in individuals with a BMI > 35 kg/m^2 and is not impacted by the severity of obesity.
Sofer et al. [43]	Retrospective study	2020	Israel	n = 138	RS was correlated with shorter hospital stays (mean 1.7 vs. 4.8 days; $p < 0.0001$) and fewer postoperative complications (Clavien-Dindo > 2, 5.2% vs. 19.7%; $p = 0.0008$), but longer operating theater time (3.8 vs. 2.8 h; $p < 0.001$). Costs are identical when at least 350 robotic surgeries are performed annually, not including the initial system costs, Overall, 5-year survival was 89.8% for the OS group vs. 94% for the RS group.
Brar et al. [44]	Cross-sectional study	2024	United Kingdom	n = 216	Significant differences in comfort with RS were obtained between the 18–24 and 45–64 (7.00 (5.00–8.00) vs. 5.00 (3.00–7.50), ($p = 0.049$), and the 18–24 and 65+ age category (2.00 (0.50–2.75), ($p = 0.006$)). Males were more comfortable with RS than females (7.50 (6.00–8.75) vs. 5.00 (4.00–7.00), ($p = 0.01$). Those with an undergraduate degree were significantly more comfortable than those educated to school level (7.00 (5.00–9.00) vs. 3.50 (5.00–8.00), ($p = 0.005$). In addition, medical participants were more comfortable than non-medical participants.
Bizoń et al. [45]	Cross-sectional study	2024	Poland	n = 79	Patients with a family history of neoplastic diseases indicate precision of movements as the most important reason for choosing robotic surgery ($p = 0.0035$). Patients after surgery procedures in the past named shorter hospitalization as a major benefit ($p = 0.0037$). Patients who chose robotic surgery for financial reasons stressed the cosmetic effect as a priority ($p = 0.0319$). Shorter hospitalization, less blood loss, enlarged view, and good visualization were statistically significant reasons for choosing robotic surgery ($p < 0.05$). Women who consider work, good material status, and well-being as the most important aspects of their lives cited the cosmetic effect as a benefit of robotic surgery ($p = 0.0029$ vs. $p = 0.0074$ vs. $p = 0.01745$, respectively).
Sultan et al. [46]	Cross-sectional study	2022	Saudi Arabia	n = 239	63.2 % showed a positive attitude towards robotic surgery and expected that using robots will improve surgical outcomes. 48.5% of the students expected that patients would not accept robotic surgeries. 51.1% were concerned that robots could replace surgeons and could make them less professional.

estimated blood loss (EBL) was higher in the LS group (p = 0.001) and the median surgery length was higher in the RS group (p = 0.0003) [34]. Lavoue et al. [35] (n = 113) reported that RS, in comparison with open surgery (OS) was associated with longer operation time (244 vs. 217 min, p = 0.009), reduced minor (grade 1 or 2) complications (17 % vs. 60 % respectively, p < 0.001), less mean EBL (75 vs. 334 mL, *p* < 0.0001), and decreased length of hospital stay (3 vs. 6 days, p < 0.001). A retrospective study by Wodzisławska et al. [36] (n = 134) found that the average operation time was 117 mins; for RS, 121 mins; for OS and 94 mins; for LS, hospitalization time was the shortest after LS — average: 1,96 days, then LS -2,45 days, and OS — 5,29 days (p < 0.001) [36]. Moreover, Pant el. reported a significant difference in hospitalization time in patients with high-grade EC after RS in comparison with OS (1.4 vs. 5.6 days, p = 0.0001), 15% of RS patients experienced operative complications vs. 55% of OS patients (p = 0.002) [37]. A study by Sun et al. [38] showed that the median hospitalization time in RS patients was 2 days vs. 3 days after LS (p = 0.021), median operating time (OT) was 95 mins. vs. 125 mins. (p = 0.006), RS was associated with lower EBL than LS — median 21 ml vs. 30 ml (p < 0.001). In general, current literature suggests that RS is associated with the smallest EBL, fewer complications, and shorter hospitalization time, which might be significant benefits for EC patients; therefore, it should be seriously considered in frail patients.

Robotic surgery for high BMI patients:

A study by Kadoch et al. [39] (n=1329) showed that women with a BMI over 40 had a longer OT than lower BMI groups (288 min vs. 270 min: *p* < 0.001), greater EBL, the median length of hospitalization remained similar across the three different BMI groups (p = 0.5), there were more postoperative complications in the group of > 40 BMI — 9.5%, compared to 8.9% and 8.0% in the other BMI groups (p = 0.8). Drymiotou et al. [40] reported that the proportion of obese and morbidly obese patients undergoing MIS increased thanks to RS implementation from 43.8% to 69.6% (p < 0.001), OT was not correlated with higher body mass index (*r* = 0.177, 95% CI −0.068 to 0.402), no difference in the length of hospitalization or of complication rates between obese, morbidly obese, and non-obese patients was found. An observational cohort study in Sweden for patients with at least 30 BMI (n = 217) reported lower EBL, less need for transfusions, shorter OT, and shorter hospitalization in the RS group in comparison with OS, there was also a significant reduction in complications in the RS group, the 5-year survival was 87.0% (95% CI 81.5–93.0) and 75.6% (95% CI 67.0–85.2), respectively [41]. A prospective study in the UK on patients with a BMI over 35 (n = 53) described the median self-reported time in the RS group cases to return to their pre-operative activity as 4 weeks (2–12 weeks), returning to regular activity did not correlate with BMI (univariable *p* = 0.610), and quality of life (QOL) scores were high post-operatively, with a median score of 188 out of a maximum score of 200 (range 166–194) at 2 weeks [42]. Current literature data suggests many significant advantages for RS in high BMI groups compared to LS and OS. Therefore, its implementation as a primary treatment method for these patients in the treatment of EC should be pondered.

Attitude toward robotic surgery

A study by Brar et al. [44] found that a shared understanding of RS needs to be revised, with major differences clear between the general public and physicians. Misconceptions regard control and safety. Malfunctioning robots were thought to harm patients, which could result in permanent damage or death. The potential for criminal acts to be performed by hackers was also raised [44]. Contrary to that, a questionnaire study directed to EC patients by Bizoń et al. [45] reported that RS achieved a score of 9.47 ± 1.46 (range 5–10) with a median level of 10 points. The benefits perceived by EC patients were shorter length of stay, less blood loss, enlarged view, and good visualization. Sultan et al. [46] that most medical students have a positive attitude towards RS and that robotic background correlates with younger median age (p < 0.030), earlier academic years (p < 0.001), higher GPA (p < 0.025), and more tech-savvy personality (p < 0.000) compared to those without background. To conclude, there is a substantial need for education and promotion of RS. The positive attitude of future doctors is promising. This area presents a potential for thorough research.

Cost

Healthcare costs constitute a major barrier for many people, especially in low-income countries. Therefore, the ubiquity of expensive treatment methods is virtually impossible. The cost of surgery is a significant consideration for oncological patients or hospitals as well. Yoon et al. [31] reported that the median cost per admission in EC patients was significantly higher for RS in comparison with LS (12,123 vs. 6,884 USD, p < 0.0001). A retrospective study by Sofer et al. [43] found that the mean cost per patient was comparable between RS and LS without the inclusion of initial cost and maintenance. Then, it was significantly higher for RS — 14,442$ vs. 8270$ ($p < 0.001$) [43]. All in all, RS cost might be an obstacle and reason for choosing LS. Hopefully, RS technology will become more common and hence more affordable.

Conclusions

RS appears to be a safe and effective method of EC treatment, especially propitious for specific groups, such as high BMI patients, in whom it significantly reduces the risk of complications, and morbidity, whereas LS might require greater dexterity. In general, surgeons are positive about RS as it provides good ergonomics. However, the common conception of RS needs to improve; there is a significant area for education in the matter. On the other hand, RS has some important drawbacks. For instance, its high cost, even in comparison with LS, might make it challenging to apply RS on a larger scale in developing countries. That constitutes a major barrier for a large population of EC patients around the world. In fine, RS should be continually analyzed and researched to provide the best possible outcomes for EC patients.

Article information and declaration

Author contributions: FŁ — conceptualization, methodology, software, check, investigation, visualization, supervision, project administration; FŁ, JB — formal analysis, resources, data curation, writing — rough preparation, review and editing FŁ, FŁ, JB; resources, FŁ, JB; data curation. All authors have read and agreed with the published version of the manuscript.

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References

1. Blair AR, Casas CM. Gynecologic cancers. Prim Care. 2009; 36(1): 115–30, ix, doi: 10.1016/j.pop.2008.10.001, indexed in Pubmed: 19231605.
2. Bendifallah S, Ballester M, Daraï E. [Endometrial cancer: Predictive models and clinical impact]. Bull Cancer. 2017; 104(12): 1022–1031, doi: 10.1016/j.bulcan.2017.06.017, indexed in Pubmed: 29110902.
3. Amant F, Moerman P, Neven P, et al. Endometrial cancer. The Lancet. 2005; 366(9484): 491–505, doi: 10.1016/s0140-6736(05)67063-8.
4. Siegel R, Miller K, Wagle N, et al. Cancer statistics, 2023. CA: A Cancer Journal for Clinicians. 2023; 73(1): 17–48, doi: 10.3322/caac.21763.
5. Yancik R. Population aging and cancer: a cross-national concern. Cancer J. 2005; 11(6): 437–441, doi: 10.1097/00130404-200511000-00002, indexed in Pubmed: 16393477.
6. Raglan O, Kalliala I, Markozannes G, et al. Risk factors for endometrial cancer: An umbrella review of the literature. Int J Cancer. 2019; 145(7): 1719–1730, doi: 10.1002/ijc.31961, indexed in Pubmed: 30387875.
7. Kitson S, Crosbie E. Endometrial cancer and obesity. The Obstetrician & Gynaecologist. 2019; 21(4): 237–245, doi: 10.1111/tog.12601.
8. Lau S, Buzaglo K, Vaknin Z, et al. Relationship between body mass index and robotic surgery outcomes of women diagnosed with endometrial cancer. Int J Gynecol Cancer. 2011; 21(4): 722–729, doi: 10.1097/IGC.0b013e318212981d, indexed in Pubmed: 21546874.
9. Giugale LE, Di Santo N, Smolkin ME, et al. Beyond mere obesity: effect of increasing obesity classifications on hysterectomy outcomes for uterine cancer/hyperplasia. Gynecol Oncol. 2012; 127(2): 326–331, doi: 10.1016/j.ygyno.2012.08.014, indexed in Pubmed: 22910692.
10. Bouwman F, Smits A, Lopes A, et al. The impact of BMI on surgical complications and outcomes in endometrial cancer surgery--an institutional study and systematic review of the literature. Gynecol Oncol. 2015; 139(2): 369–376, doi: 10.1016/j.ygyno.2015.09.020, indexed in Pubmed: 26407479.
11. Lamvu G, Zolnoun D, Boggess J, et al. Obesity: physiologic changes and challenges during laparoscopy. Am J Obstet Gynecol. 2004; 191(2): 669–674, doi: 10.1016/j.ajog.2004.05.077, indexed in Pubmed: 15343262.
12. Colombo, N., Creutzberg, C. Amant, F., Bosse, T., González-Martín, A., Ledermann, J., ... & Mirza, M. R. ESMO-ESGO-ESTRO Consensus Conference on Endometrial Cancer: Diagnosis, treatment and. ; 2016.
13. Rungruang B, Olawaiye AB. Comprehensive surgical staging for endometrial cancer. Rev Obstet Gynecol. 2012; 5(1): 28–34, indexed in Pubmed: 22582124.
14. Berek JS, Matias-Guiu X, Creutzberg C, et al. Endometrial Cancer Staging Subcommittee, FIGO Women's Cancer Committee. FIGO staging of endometrial cancer: 2023. J Gynecol Oncol. 2023; 34(5): e85, doi: 10.3802/jgo.2023.34.e85, indexed in Pubmed: 37593813.
15. Morrow CP, Bundy BN, Kurman RJ, et al. Relationship between surgical-pathological risk factors and outcome in clinical stage I and II carcinoma of the endometrium: a Gynecologic Oncology Group study. Gynecol Oncol. 1991; 40(1): 55–65, doi: 10.1016/0090-8258(91)90086-k, indexed in Pubmed: 1989916.
16. Rossi EC, Kowalski LD, Scalici J, et al. A comparison of sentinel lymph node biopsy to lymphadenectomy for endometrial cancer staging (FIRES trial): a multicentre, prospective, cohort study. Lancet Oncol. 2017; 18(3): 384–392, doi: 10.1016/S1470-2045(17)30068-2, indexed in Pubmed: 28159465.
17. Tanaka T, Terai Y, Ashihara K, et al. The detection of sentinel lymph nodes in laparoscopic surgery for uterine cervical cancer using 99m-technetium-tin colloid, indocyanine green, and blue dye. J Gynecol Oncol. 2017; 28(2): e13, doi: 10.3802/jgo.2017.28.e13, indexed in Pubmed: 27894166.
18. Walker J, Piedmonte M, Spirtos N, et al. Laparoscopy Compared With Laparotomy for Comprehensive Surgical Staging of Uterine Cancer: Gynecologic Oncology Group Study LAP2. Obstetrical & Gynecological Survey. 2010; 65(8): 503–505, doi: 10.1097/ogx.0b013e3181f07b6f.
19. Markowska A, Baranowski W, Pityński K, et al. Metastases and Recurrence Risk Factors in Endometrial Cancer-The Role of Selected Molecular Changes, Hormonal Factors, Diagnostic Methods and Surgery Procedures. Cancers (Basel). 2023; 16(1), doi: 10.3390/cancers16010179, indexed in Pubmed: 38201606.
20. Collins A, Jacob A, Moss E. Robotic-assisted surgery in high-risk surgical patients with endometrial cancer. Best Pract Res Clin Obstet Gynaecol. 2024; 92: 102421, doi: 10.1016/j.bpobgyn.2023.102421, indexed in Pubmed: 37980868.
21. Concin N, Matias-Guiu X, Vergote I, et al. ESGO/ESTRO/ESP guidelines for the management of patients with endometrial carcinoma. Int J Gynecol Cancer. 2021; 31(1): 12–39, doi: 10.1136/ijgc-2020-002230, indexed in Pubmed: 33397713.
22. Papadia A, Imboden S, Siegenthaler F, et al. Laparoscopic Indocyanine Green Sentinel Lymph Node Mapping in Endometrial Cancer. Ann Surg Oncol. 2016; 23(7): 2206–2211, doi: 10.1245/s10434-016-5090-x, indexed in Pubmed: 26790667.
23. Chopra H, Baig AA, Cavalu S, et al. Robotics in surgery: Current trends. Ann Med Surg (Lond). 2022; 81: 104375, doi: 10.1016/j.amsu.2022.104375, indexed in Pubmed: 36051814.
24. Raffone A, Travaglino A, Raimondo D, et al. Laparotomic versus robotic surgery in elderly patients with endometrial cancer: A systematic review and meta-analysis. Int J Gynaecol Obstet. 2022; 157(1): 1–10, doi: 10.1002/ijgo.13766, indexed in Pubmed: 34043235.

25. Advincula AP, Falcone T. Laparoscopic robotic gynecologic surgery. Obstet Gynecol Clin North Am. 2004; 31(3): 599–609, ix, doi: 10.1016/j.ogc.2004.05.004, indexed in Pubmed: 15450321.
26. Moon AS, Garofalo J, Koirala P, et al. Robotic Surgery in Gynecology. Surg Clin North Am. 2020; 100(2): 445–460, doi: 10.1016/j.suc.2019.12.007, indexed in Pubmed: 32169189.
27. Ballester M, Bendifallah S, Daraï E. [European guidelines (ESMO-ESGO-ESTRO consensus conference) for the management of endometrial cancer]. Bull Cancer. 2017; 104(12): 1032–1038, doi: 10.1016/j.bulcan.2017.10.006, indexed in Pubmed: 29173977.
28. Ind TEJ, Marshall C, Hacking M, et al. Introducing robotic surgery into an endometrial cancer service--a prospective evaluation of clinical and economic outcomes in a UK institution. Int J Med Robot. 2016; 12(1): 137–144, doi: 10.1002/rcs.1651, indexed in Pubmed: 25823472.
29. Randell R, Alvarado N, Honey S, et al. Impact of Robotic Surgery on Decision Making: Perspectives of Surgical Teams. AMIA Annu Symp Proc. 2015; 2015: 1057–1066, indexed in Pubmed: 26958244.
30. Corrado G, Vizza E, Perrone AM, et al. Comparison Between Laparoscopic and Robotic Surgery in Elderly Patients With Endometrial Cancer: A Retrospective Multicentric Study. Front Oncol. 2021; 11: 724886, doi: 10.3389/fonc.2021.724886, indexed in Pubmed: 34631553.
31. Yoon JH, Yun CY, Choi S, et al. Is robotic surgery beneficial for the treatment of endometrial cancer? A comparison with conventional laparoscopic surgery. J Cancer. 2024; 15(2): 533–538, doi: 10.7150/jca.88187, indexed in Pubmed: 38169547.
32. Bizzarri N, Restaino S, Gueli Alletti S, et al. Sentinel lymph node detection in endometrial cancer with indocyanine green: laparoscopic versus robotic approach. Facts Views Vis Obgyn. 2021; 13(1): 15–25, doi: 10.52054/FVVO.13.1.002, indexed in Pubmed: 33889857.
33. Ignatov A, Mészáros J, Ivros S, et al. Oncologic Outcome of Robotic-Assisted and Laparoscopic Sentinel Node Biopsy in Endometrial Cancer. Cancers (Basel). 2023; 15(24), doi: 10.3390/cancers15245894, indexed in Pubmed: 38136438.
34. Cela V, Sergiampietri C, Rosa Obino ME, et al. Sentinel-lymph-node mapping with indocyanine green in robotic-assisted laparoscopic surgery for early endometrial cancer: a retrospective analysis. Facts Views Vis Obgyn. 2020; 11(4): 323–328, indexed in Pubmed: 32322828.
35. Lavoue V, Zeng X, Lau S, et al. Impact of robotics on the outcome of elderly patients with endometrial cancer. Gynecol Oncol. 2014; 133(3): 556–562, doi: 10.1016/j.ygyno.2014.03.572, indexed in Pubmed: 24708920.
36. Wodzisławska A, Doniec J. Hospitalization time after laparotomy, laparoscopy and robotic procedures in patients with endometrial cancer. Lekarz Wojskowy. 2022; 100(2): 88–90, doi: 10.53301/lw/150268.
37. Pant A, Schink J, Lurain J. Robotic surgery compared with laparotomy for high-grade endometrial cancer. J Robot Surg. 2014; 8(2): 163–167, doi: 10.1007/s11701-013-0448-6, indexed in Pubmed: 27637526.
38. Sun H, Gao J, Jin Z, et al. Robotic single-site surgery versus laparoendoscopic single-site surgery in early-stage endometrial cancer: a case-control study. Wideochir Inne Tech Maloinwazyjne. 2021; 16(3): 597–603, doi: 10.5114/wiitm.2021.103955, indexed in Pubmed: 34691311.
39. Kadoch E, Brezinov Y, Levin G, et al. The impact of body mass index on robotic surgery outcomes in endometrial cancer. Gynecol Oncol. 2024; 185: 51–57, doi: 10.1016/j.ygyno.2024.01.051, indexed in Pubmed: 38368813.
40. Drymiotou S, Dokmeci M, Chandrasekaran D, et al. Impact of minimally invasive surgery on surgical outcomes for obese women with endometrial cancer following robotic surgery introduction; a single centre study. Int J Med Robot. 2023 [Epub ahead of print]: e2559, doi: 10.1002/rcs.2559, indexed in Pubmed: 37522379.
41. Lindfors A, Heshar H, Adok C, et al. Long-term survival in obese patients after robotic or open surgery for endometrial cancer. Gynecol Oncol. 2020; 158(3): 673–680, doi: 10.1016/j.ygyno.2020.05.684, indexed in Pubmed: 32527569.
42. Amirthanayagam A, Wood M, Teece L, et al. Impact of Patient Body Mass Index on Post-Operative Recovery from Robotic-Assisted Hysterectomy. Cancers (Basel). 2023; 15(17), doi: 10.3390/cancers15174335, indexed in Pubmed: 37686610.
43. Sofer A, Magnezi R, Eitan R, et al. Robotic vs. open surgery in obese women with low-grade endometrial cancer: comparison of costs and quality of life measures. Isr J Health Policy Res. 2020; 9(1): 60, doi: 10.1186/s13584-020-00412-2, indexed in Pubmed: 33138857.
44. Brar G, Xu S, Anwar M, et al. Robotic surgery: public perceptions and current misconceptions. J Robot Surg. 2024; 18(1): 84, doi: 10.1007/s11701-024-01837-6, indexed in Pubmed: 38386115.
45. Bizoń M, Olszewski M, Grabowska A, et al. Robotic surgery in endometrial cancer: first Polish experience. J Robot Surg. 2024; 18(1): 14, doi: 10.1007/s11701-023-01752-2, indexed in Pubmed: 38216814.
46. Sultan I, Bardi MF, Baatta AM, et al. Medical Students' Attitude Towards Robotic Surgery: A Cross-Sectional Survey. J Med Educ Curric Dev. 2022; 9: 23821205211066483, doi: 10.1177/23821205211066483, indexed in Pubmed: 35036565.