





# The Robotic Interval Surgery, A Game-Changer in Optimal Debulking for Ovarian Cancer: A Systematic Review and Meta-Analysis

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**Purpose:** This study evaluates the role of robotic-interval debulking surgery (robotic IDS) compared to traditional laparotomy as the game-changer in surgical outcome and complications for ovarian cancer patients.

**Patients and Methods:** Following PRISMA guidelines, relevant literature published between 2014 and 2024 was retrieved from PubMed, Scopus, Google Scholar, EBSCOHost, and SAGE Journals. Out of 816 studies, four were included, assessed for bias using ROBINS-I and analyzed with random-effects meta-analysis with RevMan 5.4.

**Results:** A total of four studies involving 166 patients were analyzed. The findings indicate that robotic IDS has a significant result on achieving complete cytoreduction (OR of 6.67 [p = 0.0003]), reducing estimated blood loss (SMD of -0.71 [p = 0.02]), and shorter hospital stay (SMD of -1.58 [p < 0.00001]). The result also shows promising effects on intraoperative complications with an OR of 0.82 [p = 0.86] and postoperative complications with an OR of 0.40 [p = 0.11]. Conversely, there is a longer operative time in robotic IDS compared to laparotomy with a SMD of 0.40 [p = 0.26].

**Conclusion:** Robotic IDS advances surgical management of advanced-stage (stage III–IV) and recurrent ovarian cancer, offering improved cytoreduction rates, reduced blood loss, and shorter hospital stays. A promising effect was also observed on intraoperative and postoperative complications, although operative time was longer. Further research is needed to demonstrate clearer clinical advantages.

**Keywords:** laparotomy, ovarian cancer, robotic interval debulking surgery, surgical outcomes

## Introduction

Ovarian cancer remains one of the most lethal gynecologic malignancies, with an estimated 19,680 new cases and 12,740 deaths by 2024, varying across countries.<sup>1,2</sup> Primary surgery followed by adjuvant chemotherapy is the standard approach. However, achieving optimal cytoreduction (residual tumor < 1–2 cm) can be challenging in advanced-stage or poor medical conditions, prompting alternative strategies such as neoadjuvant chemotherapy (NAC) and interval debulking surgery (IDS).<sup>3</sup> In conditions where primary debulking surgery is not possible (or not being attempted at all) and only a biopsy is performed for diagnostic purposes, neoadjuvant chemotherapy (NAC) will be administered, and after 2–4 cycles and responses, secondary surgery or the so-called interval debulking surgery (IDS) between chemotherapy cycles may be possible.<sup>4</sup> Despite advances in treatment and surgical techniques, optimal cytoreduction remains a significant barrier to improved survival in ovarian cancer patients. Traditional laparotomy IDS after NAC has demonstrated advantages, including enhanced perioperative parameters and follow-up results. However, achieving a shorter recovery and complete cytoreduction remains a challenge due to tumor burden, surgical complexity, and variability in surgical expertise.<sup>5</sup> The emergence of robotic-assisted surgery offers the potential to enhance precision, reduce intraoperative and perioperative complications, and improve optimal debulking rates in interval surgery. Still, its comparative effectiveness against

conventional approaches remains unclear.<sup>6</sup> While previous meta-analyses have explored the benefits of robotic surgery compared to NAC in ovarian cancer, this study focuses specifically on comparing robotic interval debulking surgery and laparotomy. Therefore, this systematic review and meta-analysis aim to evaluate the role of robotic-assisted surgery in interval debulking and assess its impact on surgical outcomes, including complete cytoreduction, operative time, estimated blood loss, hospital stay, intraoperative complications, and postoperative complications.

## Materials and Methods

This systematic review was conducted in accordance with the guidelines recommended by the Cochrane Group and carried out following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 statement.<sup>7</sup> A detailed protocol has been previously registered in PROSPERO (CRD42025631453).

## Search Strategy

Two independent investigators performed thorough literature searches, with discrepancies resolved by a third investigator in a blinded. We initially searched PubMed, Scopus, EBSCOhost, and SAGE for studies published up to 20 December 2024. Additionally, an extensive search of gray literature was performed using Google Scholar. The search strategy incorporated keywords combined with boolean operators and Medical Subject Heading (MeSH) related to “ovarian cancer”, “robotic interval debulking surgery”, “surgical outcomes” including “complete cytoreduction”, “length of hospital stay”, “estimated blood loss”, “operative time”, “complication” and their synonym listed on [Supplementary Table S1](#). Subsequently, the retrieved results were deduplicated and screened against the pre-specified eligibility criteria.

## Study Eligibility Criteria

Inclusion criteria were set to filter observational studies investigating the outcome of robotic interval debulking surgery on ovarian cancer patients (FIGO stage I–IV) compared to laparotomy, with only studies published in the last ten years (2014–2024) included. Outcomes of interest are the surgical outcomes, including complete cytoreduction, length of hospital stay, estimated blood loss, operative time, and complications. Conversely, studies were excluded if any of the following criteria were met: (1) irretrievable full-text articles and (2) non-English articles.

## Data Extraction and Risk of Bias Assessment

Data extraction and risk of bias assessment were conducted by three independent reviewers (AJM, PLS, and ADN) using a pre-specified form, and discrepancies between authors were resolved by the fourth author (YMH). The extracted data included (1) first author and publication year, (2) study design, (3) country, (4) sample size, (5) stage of cancer, and (6) chemotherapy treatment. Any discrepancies were resolved through consensus with an independent third investigator. The primary outcomes in this study are surgical outcomes among ovarian cancer patients with both treatments. Surgical outcomes refer to clinical measures resulting from surgical procedures, including both short- and long-term effects, such as complete cytoreduction, length of hospital stay, estimated blood loss, operative time, and complications. When available, data on progression-free survival (PFS) and overall survival (OS) were collected to define the prospective oncologic outcomes of robotic interval debulking surgery (IDS). Included studies underwent methodological quality assessment using the Risk of Bias in Non-randomised Studies-of Interventions (ROBINS-I). However, quality assessment was not used as an exclusion criterion for the included studies.

## Statistical Analysis

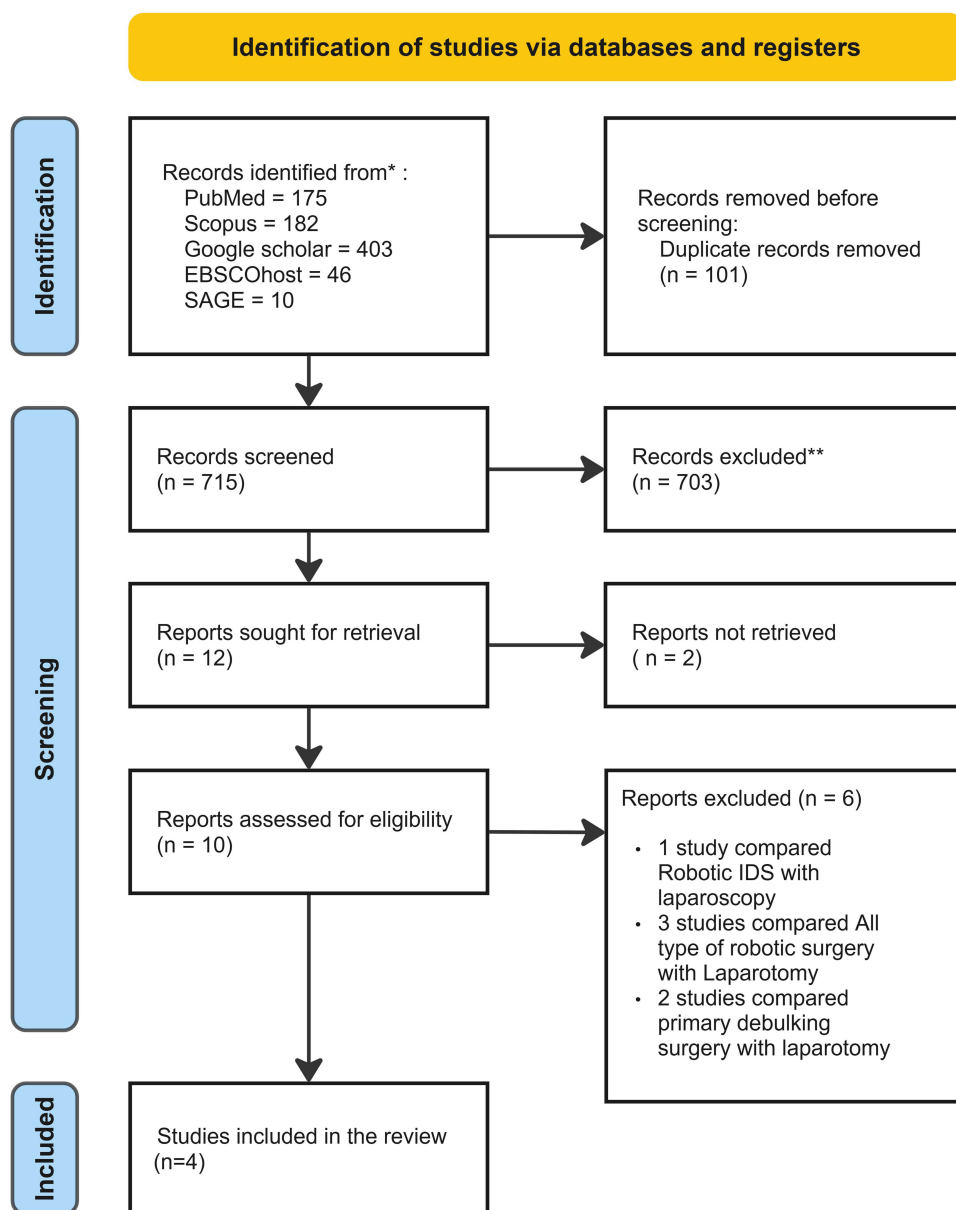
Dichotomous data, such as overall survival, were analyzed by pooling odds ratios (ORs) using the Mantel–Haenszel method. For continuous data, such as operative time, mean differences (MD) were pooled using inverse variance weighting. Continuous data are presented as means with standard deviations (SD). When the mean or SD was unavailable, the corresponding authors were contacted to request the missing information. A minimum of 3 authors were contacted to confirm the study scenario and obtain the necessary data. If there was no response or the data were not provided, the missing means and SD were estimated using a method based on the median, interquartile range (IQR), range, and sample size, as detailed in the formula by Wan et al.<sup>8</sup>

A meta-analysis was conducted using Review Manager v5.4 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen). A random-effects model was applied due to anticipated clinical heterogeneity. Heterogeneity among studies was evaluated using the chi-square test, the Cochran Q test, and the  $I^2$  statistic. The  $I^2$  values were categorized as follows: negligible (0–25%), low (25–50%), moderate (50–75%), and substantial (>75%) heterogeneity. Additionally, when the number of studies was sufficient ( $n \geq 10$ ), potential publication bias was assessed visually by inspecting funnel plots and quantitatively using Egger's test. A p-value of  $<0,05$  was considered statistically significant.

## Results

### Study Selection and Characteristics

We retrieved 816 relevant articles from the included databases and removed 101 duplicates. The remaining articles were screened by title and abstract, resulting in 10 records that were fully assessed for eligibility. Only four studies were considered suitable and were analyzed in this review (Figure 1).



**Figure 1** PRISMA flow chart. \*In this flowchart, records are tracked only through databases (no registers). \*\*Based on the study's exclusion criteria, articles that contained only a review or an abstract of grey literature were not included.

The origin of our analyzed studies varies with each study conducted in Western and East Asia regions, including Canada, the United Kingdom, Belgium, and Taiwan. Bias assessment revealed a low risk of bias for every domain assessed (Figures 2 and 3), with detailed characteristics summarized in Table 1. Studies involved a total of 221 participants, ranging from 50 to 71 years old, with advanced or recurrent ovarian cancer who had already received a cycle of neoadjuvant chemotherapy. The control group received traditional or laparotomy interval debulking surgery, while the intervention group received robotic interval debulking surgery.

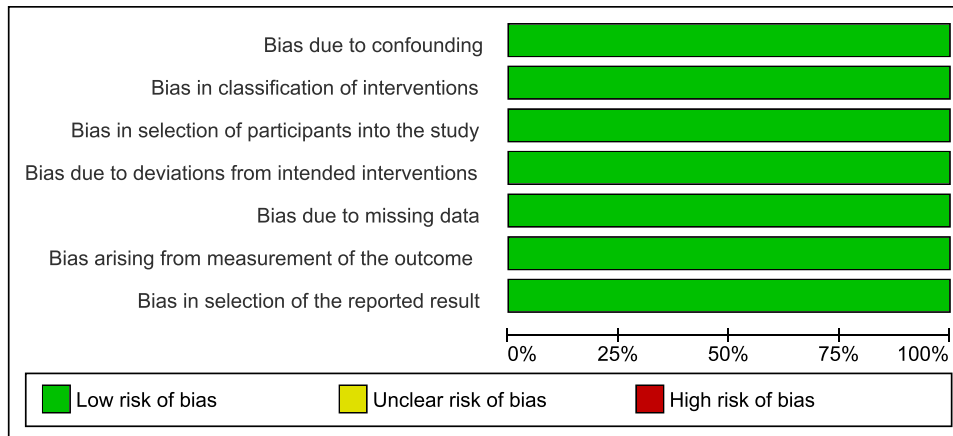


Figure 2 Risk of Bias Graph using ROBINS-I.

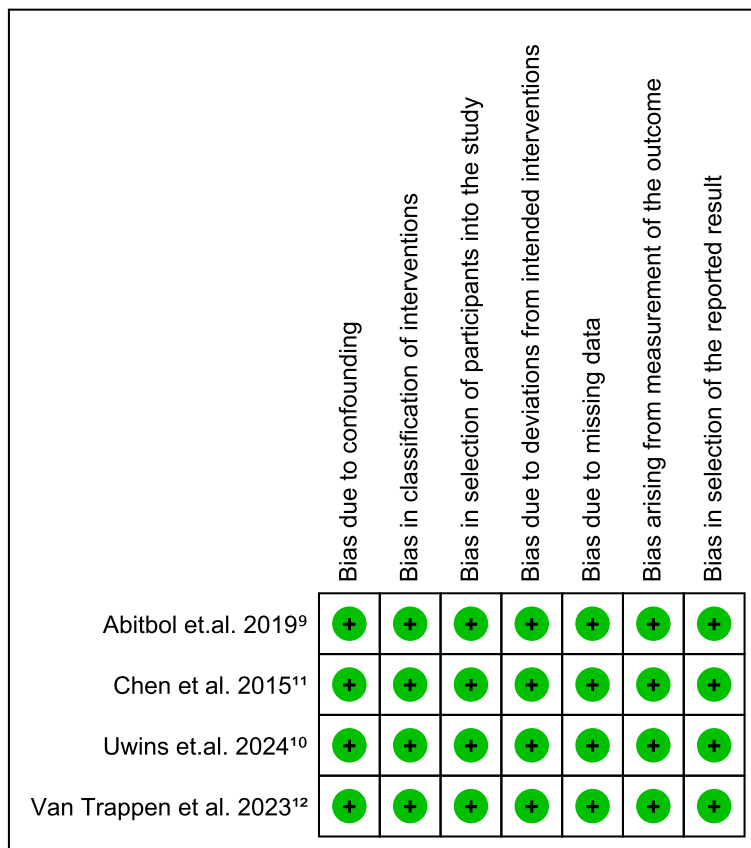


Figure 3 Risk of Bias Summary using ROBINS-I.

**Table 1** Characteristic Table of the Included Study

Author, Year	Study Design	Country	Sample Size (n)		Age, Mean (SD)		Stage of Cancer (FIGO stage)	Chemotherapy Treatment	Complete Cyto-reduction (n)		Operative Time (min) Mean (SD)		Blood Loss (mL) Mean (SD)		Hospital stay (days) Mean (SD)		Complication					
			R-IDS	L	R-IDS	L			R-IDS	L	R-IDS	L	R-IDS	L	R-IDS	L	R-IDS	L	Intraoperative (n)		Postoperative (n)	
																			R-IDS	L	R-IDS	L
Abitbol et.al 2019 <sup>9</sup>	Pilot cohort	Canada	57	22	64.1 (13.5)	65.4 (9.2)	Advanced ovarian cancer (stage III-IV)	Consisted of platinum and taxanes, and no patients were treated with bevacizumab in the first-line setting	47	9	312 (84)	213 (74)	135 (210)	505 (599)	2.1 (2.6)	8.6 (6.3)	N/A	N/A	N/A	N/A		
Chen et al 2015 <sup>10</sup>	Retrospective cohort	Taiwan	8	15	N/A	N/A	Recurrent ovarian cancer	Not mentioned but responsive to neoadjuvant chemotherapy	N/A	N/A	206.67 (147.73)	211.67 (204.47)	96.85 (43.32)	340.5 (216.5)	5.4 (2.3)	24.6 (17.3)	0	7	0	2		
Uwins et. al 2024 <sup>11</sup>	Prospective cohort study	UK	20	3	68 (23.71)		Advanced stage epithelial ovarian cancer (FIGO IIIc-IVb)	A minimum three cycle of carboplatin or combined carboplatin and paclitaxel or bevacizumab or PARP inhibitors	9	0	408 (422.86)	336 (63.18)	155 (139)	221.3 (231)	5.25 (4.6)	14.5 (10.42)	8	0	8	1		
Van Trappen et al 2023 <sup>12</sup>	Single-center retrospective case cohort study	Belgium	21	20	60.6 (13)	67.4 (11)	Advanced stage (FIGO-stage IIIc-IVa)	A minimum three cycle of Carboplatin-Paclitaxel in a three-weekly schedule.	N/A	N/A	149.99 (91.62)	145.67 (98.04)	312.5 (274)	337.5 (217)	4.1 (0.36)	6.2 (1.76)	4	3	4	9		

**Abbreviations:** R-IDS, Robotic-interval debulking surgery; L, Laparotomy; N/A, Not applicable; FIGO, International Federation of Gynecology and Obstetrics.

## Outcomes

### Complete Cytoreduction

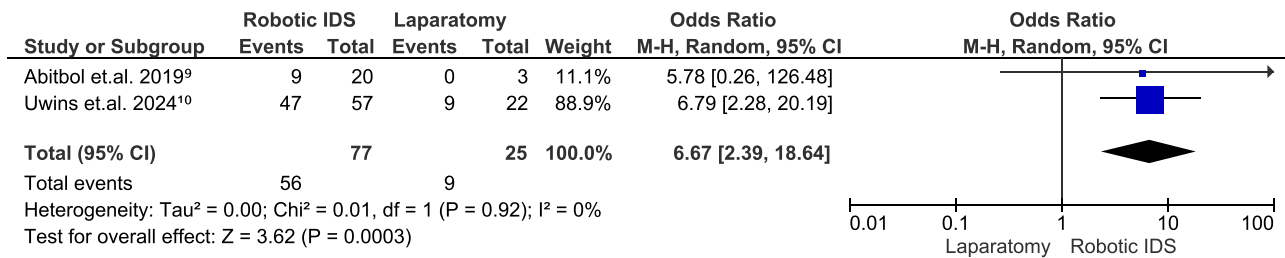
The only studies that included the analysis of complete cytoreduction were the ones by Abitbol et al 2019<sup>9</sup> and Uwins et al 2024.<sup>11</sup> According to Figure 4, with an OR=6.67 [95% CI: 2.39–18.64,  $p=0.0003$ ] the Robotic IDS shows a higher likelihood of having complete cytoreduction. This finding may significantly improve the course of the disease. Also, there was no evidence of significant heterogeneity ( $I^2=0\%$ ,  $p_{heterogeneity}=0.92$ )

### Operative Time

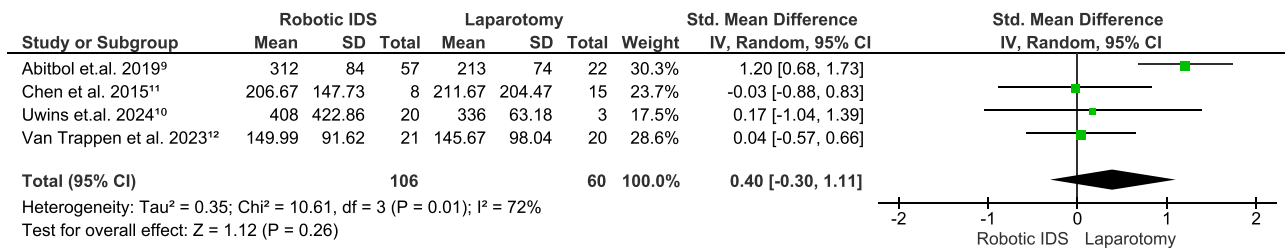
All four studies were included.<sup>9–12</sup> It was not statistically significant, and Figure 5 showed that laparotomy had a slightly faster time than the robotic IDS (SMD = 0.40 [95% CI: -0.30–1.11,  $p=0.26$ ]). This refers to the time needed from skin incision to skin closure, and the longer time needed is due to the complexity and precision required. As an addition, this study discovered a high level of heterogeneity ( $I^2=72\%$ ,  $p_{heterogeneity}=0.01$ )

### Estimated Blood Loss

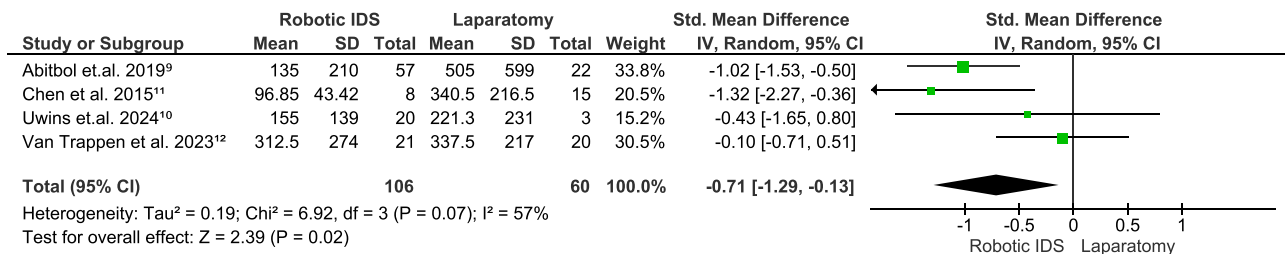
The effect of the intervention on estimated blood loss is shown in Figure 6. A meta-analysis revealed that, in comparison to laparotomy, those who used robotic IDS experienced less estimated blood loss (SMD = -0.71; 95% CI = -1.29 – -0.13,  $p=0.02$ ). Furthermore, it demonstrates statistical significance with moderate heterogeneity ( $I^2=57\%$ ,  $p_{heterogeneity}=0.07$ ). This suggests a moderate level of consistency in the findings across different studies, reinforcing the reliability of the observed effect.



**Figure 4** The Impact of Interval Debulking Surgery on Complete Cytoreduction in Ovarian Cancer Patients.



**Figure 5** The Impact of Interval Debulking Surgery on Operative Time in Ovarian Cancer Patients.



**Figure 6** The Impact of Interval Debulking Surgery on Estimated Blood Loss in Ovarian Cancer Patients.

### Hospital Stay

Figure 7 depicts a meta-analysis of hospital stay durations for robotic IDS and laparotomy. The pooled standardized mean difference (SMD) of -1.58 (95% CI: -1.96 to -1.20) suggests that robotic IDS use results in a significantly shorter hospital stay. Overall, the effect is very substantial ( $Z=8.10$ ,  $p<0.00001$ ) with no evidence of significant heterogeneity ( $I^2=0\%$ ,  $p_{heterogeneity}<0.94$ ). These results demonstrate that, compared with laparotomy, robotic IDS is more effective at minimizing hospital stays.

### Intraoperative Complications

Figure 8 presents a meta-analysis comparing intraoperative complication rates between robotic interval debulking surgery (IDS) and laparotomy. The odds ratio of 0.82 (95% CI: 0.10–6.99) indicates a trend toward fewer intraoperative complications with robotic IDS. However, this difference is not statistically significant ( $Z = 0.18$ ,  $p = 0.86$ ), and heterogeneity is moderate ( $I^2 = 54\%$ ,  $p_{heterogeneity} = 0.11$ ). These findings suggest that while robotic IDS may be associated with a lower likelihood of intraoperative complications compared to laparotomy, the evidence remains inconclusive, necessitating further investigation to establish definitive clinical benefits.

### Postoperative Complications

Figure 9 showcases a meta-analysis comparing postoperative complication rates between robotic and laparotomic interval debulking surgery (IDS). With an odds ratio of 0.40 (95% CI: 0.13–1.24), the results indicate a possible reduction in

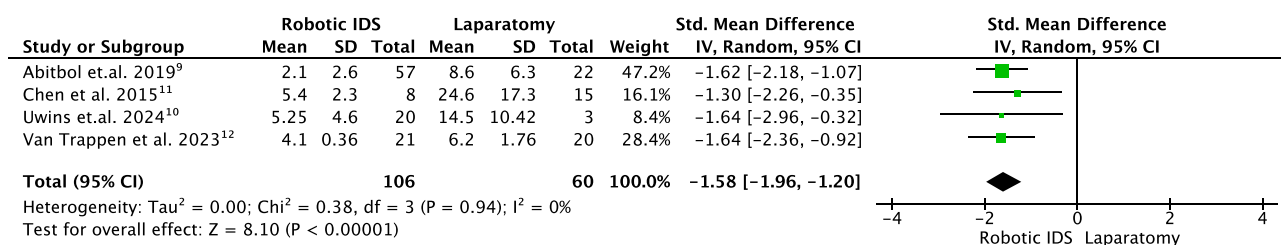


Figure 7 The Impact of Interval Debulking Surgery on Hospital Stay in Ovarian Cancer Patients.

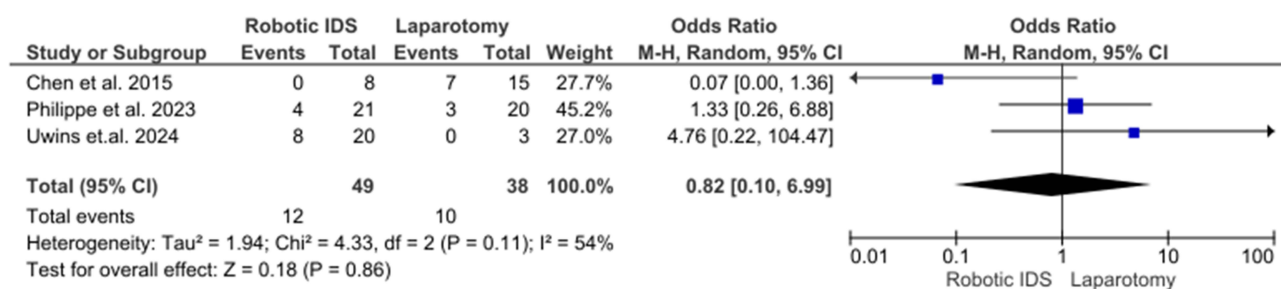


Figure 8 The Impact of Interval Debulking Surgery on Intraoperative Complication Rate in Ovarian Cancer Patients.

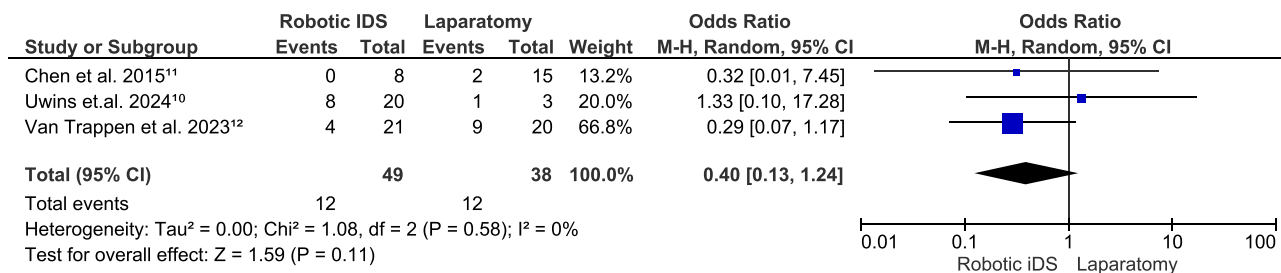


Figure 9 The Impact of Interval Debulking Surgery on Postoperative Complication Rate in Ovarian Cancer Patients.

postoperative complications associated with robotic IDS. Although statistical significance is not achieved ( $Z = 1.59$ ,  $p = 0.11$ ), the low heterogeneity ( $I^2 = 0\%$ ,  $p_{heterogeneity} = 0.58$ ) suggests consistency across studies.

## Discussion

### Principal Findings

Robotic interval debulking surgery (R-IDS) represents a significant advancement in the surgical management of advanced-stage ovarian cancer (Stage III–IV) and recurrent ovarian cancer, including improved complete cytoreduction rates, reduced blood loss, and shorter hospital stay. These benefits are supported by enhanced surgical precision through 3D visualization and superior instrument control. Recent advances in minimally invasive technology further strengthen this approach. Earlier single-port systems, such as the da Vinci Single-Site platform, offered cosmetic advantages but were limited by reduced dexterity and a non-articulating instrument. The newer da Vinci SP system addresses these limitations by delivering an articulating camera and three flexible EndoWrist SP instruments to improve triangulation and access in narrow pelvic spaces.<sup>13</sup> Despite these advantages, many patients remain unaware of the potential benefits of robotic-assisted surgery. Prior studies indicate that 75% of patients are eligible for robotic IDS, highlighting its feasibility as an alternative to conventional laparotomy in selected cases.<sup>4</sup>

The challenge lies in achieving optimal debulking in recurrent and advanced-stage ovarian cancer (Stage III to IV), particularly in cases with extensive disease involvement. Such procedures are often complex, potentially requiring extensive bowel resection, significant blood loss, and an increased risk of morbidity. In situations where primary debulking surgery is challenging, induction neoadjuvant chemotherapy may help reduce tumor size. If the tumor responds well after a few cycles, robotic IDS may become an accessible option.

Align with that, our meta-analysis's findings which were also supported by Psomiadou et al,<sup>14</sup> reveals robotic IDS is associated with a significantly reduced estimated blood loss (SMD =  $-0.71$ ; [95% CI =  $-1.29$ – $-0.13$ ],  $p = 0.02$ ) and hospital stay (SMD =  $-1.58$ ; [95% CI =  $-1.96$ – $-1.20$ ],  $p < 0.00001$ ). In addition, the majority of debulking surgeries achieved 80% complete cytoreduction, with a higher proportion in patients undergoing robotic IDS than in those receiving laparotomy (74.5% vs 53.1%), respectively.<sup>14</sup> Our results also align with those studies, with a significant result for robotic IDS (OR=6.67 [95% CI: 2.39–18.64,  $p=0.0003$ ]). Moreover, studies have revealed a lower prevalence of complications in the robotic IDS group.<sup>15</sup> Our findings show that the robotic IDS could reduce intraoperative ( $Z = 0.18$ ,  $p = 0.86$ ) and postoperative ( $Z = 1.59$ ,  $p = 0.11$ ) complications, but these differences were not statistically significant. Lastly, robotic IDS has a longer operative time than laparotomy in all studies and in our results, due to the complexity and precision required (SMD =  $0.40$  [95% CI:  $-0.30$ – $1.11$ ],  $p = 0.26$ ).

Furthermore, we were unable to provide prognostic factors, such as progression-free and overall survival, due to limited data. One included study reported that the overall survival was 42.8 months in the robotic IDS group, compared to 37.9 months in the laparotomy group.<sup>9</sup> However, these findings should be interpreted cautiously in the context of microscopic residual disease (MRD), which may persist even when no macroscopic disease is visible, particularly in the pelvis and mid-abdomen.<sup>16</sup> MRD in three or more anatomical areas has been shown to increase relapse risk significantly.<sup>16</sup> This consideration is highly relevant because, although robotic IDS is designed to enhance precision in cytoreduction, microscopic foci of disease may still escape detection intraoperatively. Integrating MRD data into the interpretation of survival outcome provides essential context, suggesting that even in cases of apparent optimal cytoreduction, the burden and distribution of MRD may influence long-term prognosis regardless of surgical approach.

### Implications in Clinical Practice

Robot-assisted interval surgery has significant clinical implications. By enhancing surgical precision, visualization, and patient recovery, this approach has the potential to improve the completeness of cytoreduction, a critical determinant of survival outcomes in advanced and recurrent ovarian cancer. Additionally, reduced surgical trauma may translate to reduced estimated blood loss and shorter hospital stays. If validated in clinical trials, robot-assisted interval debulking surgery could be adopted as a new standard of care, bridging the gap between maximal cytoreduction and minimally invasive robotic approaches, and ultimately improving both short- and long-term outcomes for women with ovarian cancer.

## Strength and Limitations

The main advantage of this study is that, to the best of our knowledge, it is the first meta-analysis that compares robotic interval debulking surgery and laparotomy in ovarian cancer. The bias risk associated with each included study was carefully assessed and found to be low, indicating the quality of the studies. Furthermore, this offers a more helpful perspective while making clinical decisions. There are a few restrictions that must be considered, though. First, some of the studies had quite diverse sample sizes. Second, the study was restricted to America, Europe, and Asia, suggesting that, at present, this kind of research is still uncommon, especially in middle- and lower-income countries, yet it offers a robust innovation. Third, the number of included studies in this analysis was limited because not all studies reported comparisons of interval debulking surgery with laparotomy in ovarian cancer populations, along with their surgical outcomes and follow-up profiles. However, follow-up profiles, including overall and progression-free survival, were reported in only one study. As a result, only a small number of variables could be analyzed using meta-analysis.

## Conclusion

This study revealed that robotic-assisted interval debulking surgery shows promising surgical outcomes in women with recurrent and advanced stages of ovarian cancer. The small number of included studies and the moderate risk of bias in the adequacy of follow-up cohort parameters should be considered when interpreting the findings. Additional research is required to validate these results.

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## Disclosure

The authors report no conflicts of interest in this work.

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