



GLOBAL VALUE DOSSIER
FOR MINIMALLY INVASIVE SURGERY (MIS)
HYSTERECTOMY

Medtronic
Further, Together

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1. Hysterectomy

1.1. Overview of procedure

Hysterectomy is one of the most commonly performed surgical procedures in women. In the US approximately 600,000 hysterectomies are performed annually, with over one-third of women having had the procedure by age 60 years.¹ Similarly in Germany in 2006 over 150,000 hysterectomies were performed; where 81% of all hysterectomies were performed for benign indications; but for vaginal hysterectomies this figure was lower at 55%, hysterectomies for malignancy were typically performed via the abdominal approach (Table 1-1).² The number of procedures performed in other countries are similar at an estimated 100,000 per year in the UK, 60,000 in France and 30,000 per year in Australia.³ Common indications for hysterectomy include endometrial or cervical cancer, ovarian cancer, fibroids, endometriosis, pelvic pain and abnormal vaginal bleeding.

Analysis of trends in the number and type of hysterectomies performed in the US over the period 2003–2010, showed that the actual number of hysterectomies performed declined, but that the proportion of hysterectomies performed laparoscopically increased from approximately 10% in 2003 to approximately 30% in 2010 (Figure 1-1).⁴

Hysterectomy is classified as either subtotal (also known as supracervical), total or radical. Subtotal hysterectomy involves the removal of the upper part of the uterus but not the cervix, in total hysterectomy the whole uterus and cervix are removed and in radical hysterectomy the uterus and tissue on either side of the uterus (parametrium), cervix and the top part of the vagina are removed. Radical hysterectomy is typically only performed for cervical malignancy.

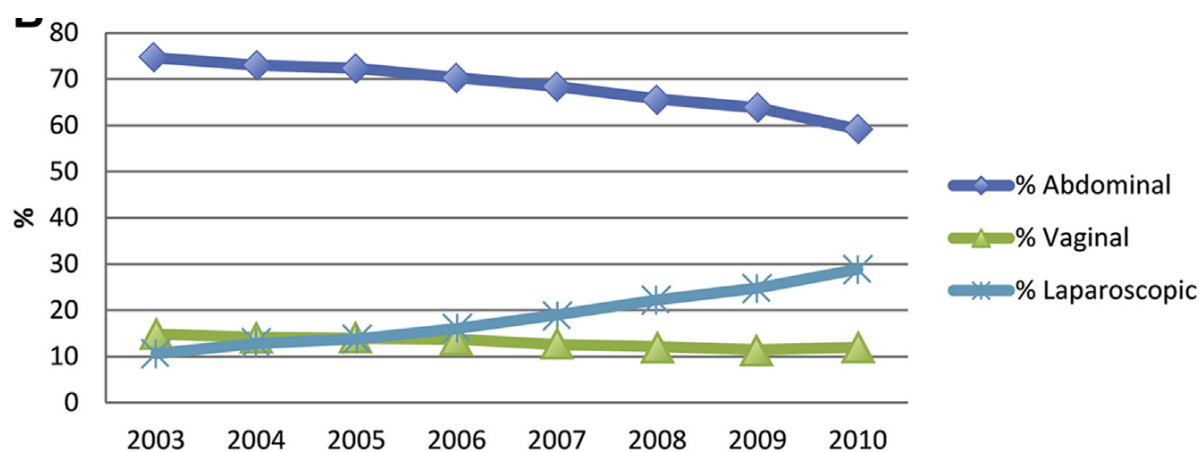
Table 1-1 Hysterectomy and indications for hysterectomy performed in Germany 2005–2006

Type of operation	N	Indication for hysterectomy, %					
		Malignant neoplasm of female genital organs	Endometrial adenomatous hyperplasia	Carcinoma in situ of female genital organs	Neoplasias of uncertain/unknown origin	Other malignant primary tumors	Benign diseases of female genitals
Abdominal hysterectomy	120,485	88.7	39.0	22.5	75.0	86.7	31.3
LAVH	17,090	2.3	9.1	6.8	5.8	1.0	6.0
Laparoscopic hysterectomy	14,967	0.7	2.3	1.7	3.8	0.5	5.8
Laparoscopic hysterectomy, conversion to abdominal hysterectomy	1,707	0.2	0.6	0.1	1.4	0.3	0.6
Vaginal hysterectomy, conversion to abdominal hysterectomy	1,616	0.2	0.9	0.6	0.3	0.2	0.6
Vaginal hysterectomy	144,628	5.5	47.4	67.4	11.7	3.6	54.5
Unclear or missing data	4,522	2.3	0.8	1.0	2.1	7.7	1.3
Total	305,015	12.1	1.7	2.1	1.9	0.9	81.4

LAVH, laparoscopically assisted vaginal hysterectomy

Source: Stang *et al.* 2011²

Figure 1-1 Proportion of abdominal, laparoscopic and vaginal hysterectomies performed in the US 2003–2010

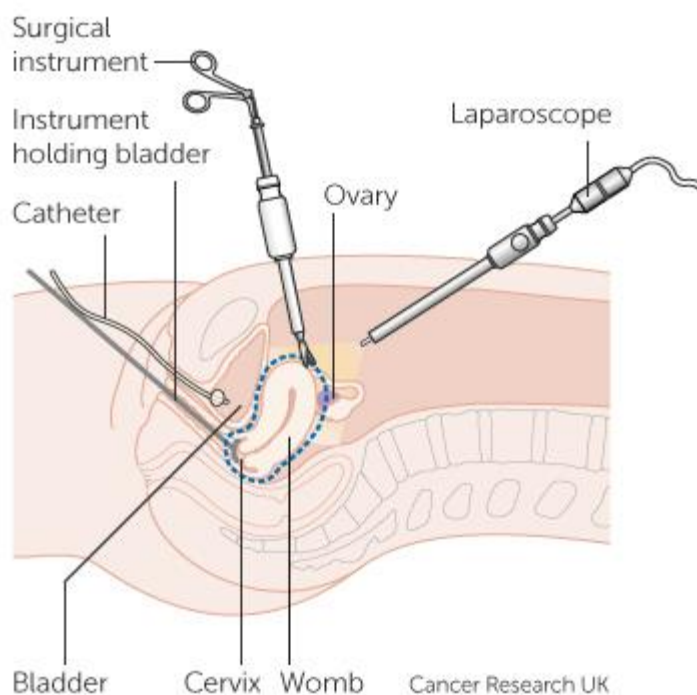


Source: Lee *et al.* 2014⁴

Overview of common surgical procedures

Laparoscopic hysterectomy: Laparoscopic hysterectomy is similar to laparoscopically-assisted vaginal hysterectomy in that part of the procedure is performed laparoscopically and part performed vaginally; however, here the ligation of the uterine vessels is performed laparoscopically. For the procedure the patient is placed in the dorsal lithotomy position. A peri-umbilical incision is made and following placement of a trocar and the laparoscope two incisions are made lateral and inferior to the optical trocar within the oblique muscles. An initial inspection of the pelvic region is then made and a uterine manipulator inserted to push the uterus upwards. In the procedure, the utero-ovarian ligaments and fallopian tubes are first identified and dissected, followed by dissection of the left and right round ligament, then the anterior leaf of the broad ligament, followed by the endopelvic fascia and cardinal ligaments, taking care to avoid damaging the bladder. Several alternative methods can be used to dissect the ligaments including for example electrocautery, ultrasonic dissection or radiofrequency vessel sealing. The uterus is then separated from the vagina by cutting along the colpotomy ring and then removed through the vagina, followed by closure of the vaginal cuff laparoscopically and irrigation of the vaginal cuff to check for bleeding.

Figure 1-2 Laparoscopic hysterectomy



Source: Cancer Research UK (available at: <http://www.cancerresearchuk.org/about-cancer/type/womb-cancer/treatment/surgery/surgery-to-remove-womb-cancer>)

Laparoscopically assisted vaginal hysterectomy: Here part of the procedure is performed laparoscopically and part is performed vaginally; the laparoscopic component does not involve the division of the uterine vessels. This procedure requires an incision to be made in the vagina, through which the uterus is removed.

Total laparoscopic hysterectomy: The entire procedure is performed laparoscopically (including suturing of the vaginal vault), the vaginal component of the procedure is limited to the removal of the uterus.

Vaginal hysterectomy: Vaginal hysterectomy is typically performed for benign indications or carcinoma *in situ* of the cervix and/or uterus. It is generally considered unsuitable for patients with endometriosis or pelvic pain or for patients with a narrow pubic arch. For the procedure the patient is placed in the dorsal lithotomy position, the cervix is then exposed using a weighted posterior vaginal retractor, two further right-angle retractors are then used to elevate the vaginal wall and expose the cervix. An incision is then made in the vaginal wall and the uterus detached from the bladder, followed by the opening of the posterior peritoneum and dissection of the lower part of the uterus, cutting and ligating the uterine arteries, opening the anterior peritoneum, dissecting the upper part of the uterus, which involves clamping and ligating the round and ovarian ligaments, reconstruction of the pelvic floor and then closing of the vaginal wall.

Guidelines on laparoscopic hysterectomy

American College of Obstetricians and Gynecologists (ACOG) opinion on the route of hysterectomy for benign disease 2009⁵

- Vaginal hysterectomy is the approach of choice whenever feasible, based on its well documented advantages and lower complication rates
- Laparoscopic hysterectomy is an alternative to abdominal hysterectomy for those patients in whom a vaginal hysterectomy is not indicated or feasible
- Experience with robot-assisted hysterectomy is limited at this time; more data are necessary to determine its role in the performance of hysterectomy

2011 American Association of Gynecologic Laparoscopists (AAGL) Position Statement: route of hysterectomy to treat benign uterine disease⁶

- It is the position of the AAGL that most hysterectomies for benign disease should be performed either vaginally or laparoscopically and that continued efforts should be taken to facilitate these approaches

2010 Society of Obstetricians and Gynecologists of Canada

- Vaginal hysterectomy is generally considered the first choice of surgical approach for most benign indications for hysterectomy, as it is associated with lower rates of morbidity, fewer post-operative complications, and a faster recovery time than abdominal hysterectomy (grade I A)

2015 American College of Obstetricians and Gynecologists (ACOG) and Society of Gynecologic Oncology (SGO) practice bulletin endometrial cancer⁷

- Minimally invasive surgery should be embraced as the standard surgical approach for comprehensive surgical staging in women with endometrial cancer (Level A)
- Robotic-assisted laparoscopic stage is a feasible and safe alternative to traditional laparoscopy in women with endometrial cancer (Level B)
- Vaginal hysterectomy may be an appropriate treatment for early-stage endometrioid endometrial cancer in select patients who are at high risk of surgical morbidity (Level C)

2013 European Society for Medical Oncology clinical practice guidelines for diagnosis, treatment and follow-up of endometrial cancer⁸

- Laparoscopy seems to provide equivalent results in terms of disease-free survival and overall survival compared with laparotomy, with further benefit: shorter hospital stay, less use of pain killers, lower rate of complications and improved quality of life

1.2. Clinical and economic outcomes with open versus minimally invasive hysterectomy

Key findings

Clinical outcomes

- **Length of Stay:** In studies conducted across a broad range of settings laparoscopic hysterectomy was associated with a significantly ($p < 0.05$) shorter mean (or median) length of stay than abdominal hysterectomy (Figure 1-3).^{25,30,31,33,34} Total laparoscopic hysterectomy and total vaginal hysterectomy were associated with similar outcomes in terms of LoS and complication rates^{25,28}
- **Operating time:** Operating time for total laparoscopic hysterectomy procedures were consistently longer compared with abdominal hysterectomy (Figure 1-4)^{28,31,33,35,30,34,32,22} and in several instances this time difference was significant^{31,30,32}
- **Surgical site infection:** In a meta-analysis of 34 trials comparing laparoscopic versus abdominal hysterectomy the risk for wound or abdominal wall infection was significantly lower with laparoscopic hysterectomy than with abdominal hysterectomy ($p = 0.012$)¹⁹
- **Blood loss:** In the majority of studies, laparoscopic hysterectomy was associated with less blood loss than abdominal hysterectomy, with several studies reporting significantly less blood loss (Figure 1-5)^{31,33,34}
- **Blood transfusion:** Two meta-analyses and one study reported no significant difference between laparoscopic and abdominal hysterectomy in terms of the proportion of patients requiring blood transfusion^{19,21,33}; however, two studies reported that a significantly lower proportion of patients undergoing laparoscopic (or laparoscopically assisted) hysterectomy required blood transfusions than those undergoing abdominal hysterectomy^{26,31}
- **Readmission rates:** Only one study examined readmission rates, this study showed no significant difference in 30-day re-admission rates between total abdominal hysterectomy and laparoscopically assisted vaginal hysterectomy²⁶
- **Return to normal activities:** In a large scale meta-analysis of 34 RCTs laparoscopic hysterectomy and vaginal hysterectomy were associated with significantly quicker return to normal activities compared with abdominal hysterectomy¹⁹
- **Peri-operative complications:** Several studies, as well as a meta-analysis showed that the incidence of peri-operative complications was lower with laparoscopic hysterectomy than with abdominal hysterectomy^{21,33}
- **Post-operative complications:** The incidence of post-operative complications was consistently found to be lower with laparoscopic hysterectomy than with abdominal hysterectomy^{20,26,33,30,32}
- **Post-operative pain:** From 1–4 weeks post-surgery in stage I endometrial cancer patients pain scores were significantly lower with total laparoscopic hysterectomy than with total abdominal hysterectomy²⁴

Economic outcomes

- **Total costs:** There was some inconsistencies between settings in terms of total costs. In European and Australian studies total costs for laparoscopic

hysterectomy were lower than for abdominal hysterectomy; however, in US studies, findings were inconsistent

- **European costs:** In studies conducted in Europe (Netherlands and Spain), total hospital costs for laparoscopic hysterectomy were lower than for abdominal hysterectomy; however, statistical significance was not reported (Figure 1-6)^{40,41}
- **Australian costs:** In Australian studies total hospital costs for laparoscopic hysterectomy were consistently lower than for abdominal hysterectomy (Figure 1-7)^{38,39}
- **US costs:** In one US study, total hospital charges were highest for laparoscopically-assisted vaginal hysterectomy, followed by abdominal hysterectomy; vaginal hysterectomy was associated with the lowest total hospital charges (Figure 1-8).³⁷ In a second US study, laparoscopic hysterectomy was associated with higher intra-operative costs but lower post-operative costs than abdominal hysterectomy³⁶
- **Savings due to clinical benefits:** The lower total costs reported in European and Australian studies were attributable to lower post-operative hospital costs,^{38,39,40,41} likely driven by shorter LoS and lower complication rates

Other findings

Impact of SSI: Laparoscopic hysterectomy is associated with a lower incidence of SSI than open hysterectomy.⁹ SSI is associated with 3–5 fold longer LoS, a 2-fold increase in direct costs and a 3-fold increase in risk for hospital readmission.⁹ An estimated one-third of post-operative deaths are related in some way to SSI and SSI increases 30-day cost by over USD 5,400 compared with matched patients without SSI¹⁰

Risk for SSI: In patients with endometrial cancer undergoing surgery, risk factors for superficial SSI included obesity, American Society of Anesthesiologists (ASA) score >2, anemia and laparotomy¹⁰

Cost of transfusion: Two studies reported significantly higher transfusion rates with abdominal hysterectomy. The cost of transfusion ranges from USD 522–1,183 per unit of blood¹¹, transfusion also prolongs hospital stay by ≥ 2 days¹²

Utilization: In the US there has been a shift towards increased utilization of minimally invasive approaches for hysterectomy (from 2006–2009), which has been accompanied by a decrease in the incidence of intraoperative and postoperative complications and an increase in operative costs, but no increase in overall mean costs¹³

Age: The observation that laparoscopic versus open surgery for endometrial cancer is associated with lower mortality and complication rates is consistent across all age groups.¹⁴

Obesity: Obese patients are more likely to undergo total abdominal hysterectomy and less likely to undergo total vaginal hysterectomy and laparoscopically assisted hysterectomy. Higher BMI is also associated with longer operating times for total abdominal hysterectomy, total vaginal hysterectomy, laparoscopically-assisted vaginal hysterectomy and total laparoscopic hysterectomy¹⁵

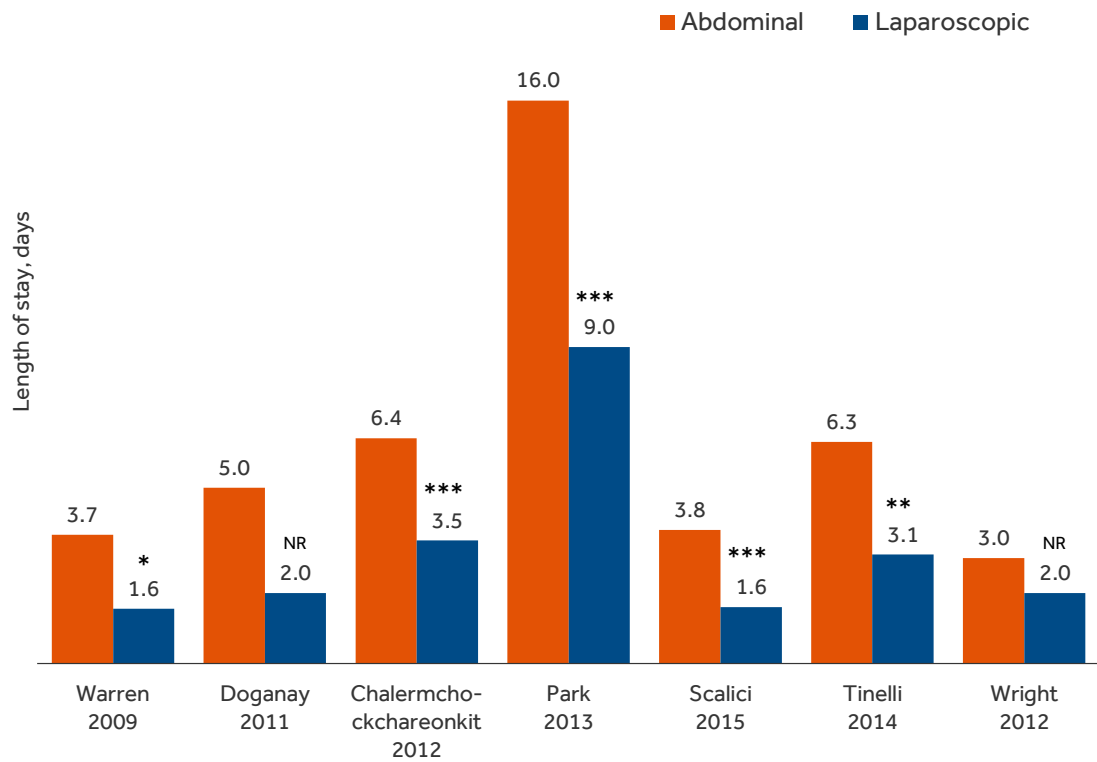
Learning curve: High surgeon volume is associated with shorter operating time.¹⁶ Laparoscopic hysterectomy performed by high volume surgeons was associated with a lower risk for perioperative complications,^{16,17} SSI¹⁷ and less blood loss¹⁶

Learning curve: In Australia, total hospital costs for laparoscopic hysterectomy were influenced by surgeon volume/experience, such as after a learning curve, the total costs for laparoscopic hysterectomy were significantly lower than for abdominal hysterectomy (Figure 1-7)³⁹

Surgeon volume: Laparoscopic hysterectomy performed by high volume surgeons is associated with lower costs than when performed by low and intermediate volume surgeons.¹⁷

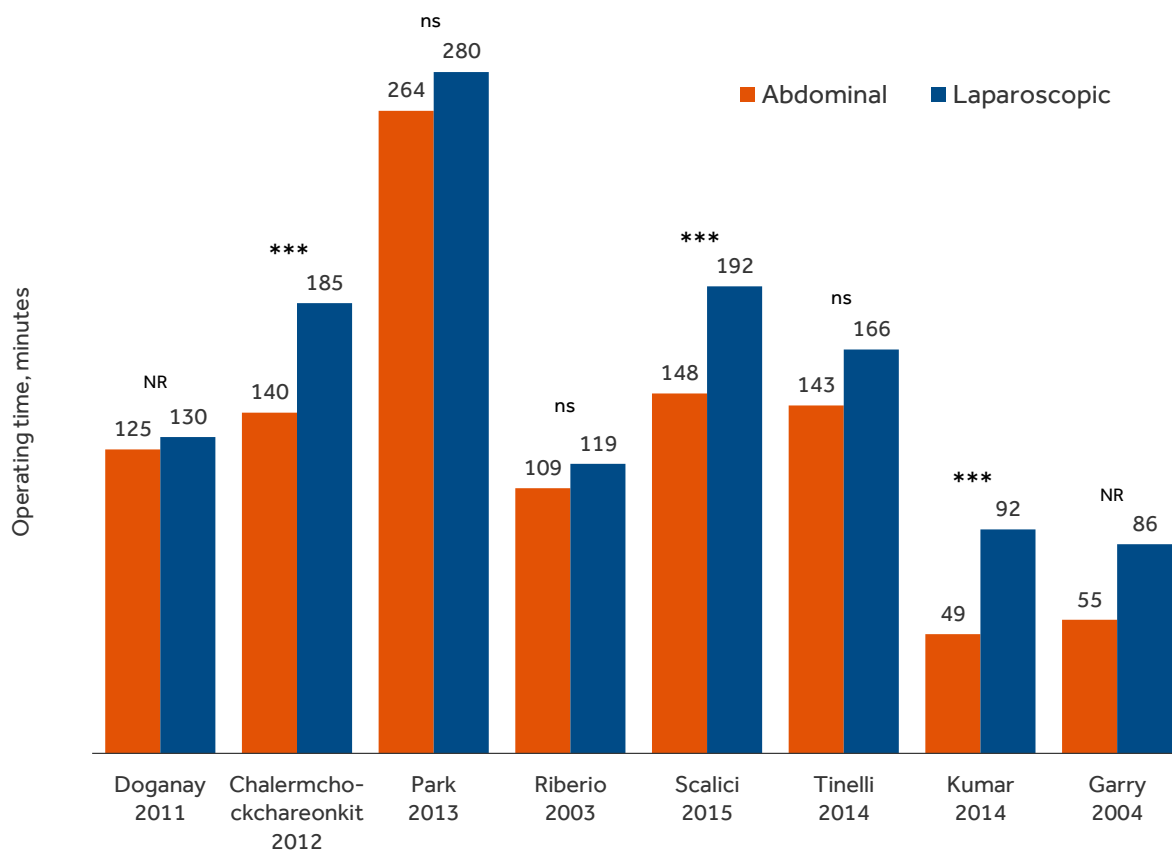
Tissue trauma: Abdominal hysterectomy is associated with more tissue trauma than vaginal hysterectomy and total laparoscopic hysterectomy, as evidenced by significantly higher levels of markers including IL-6 and creatine phosphokinase.¹⁸

Figure 1-3 LoS for abdominal hysterectomy versus laparoscopic hysterectomy



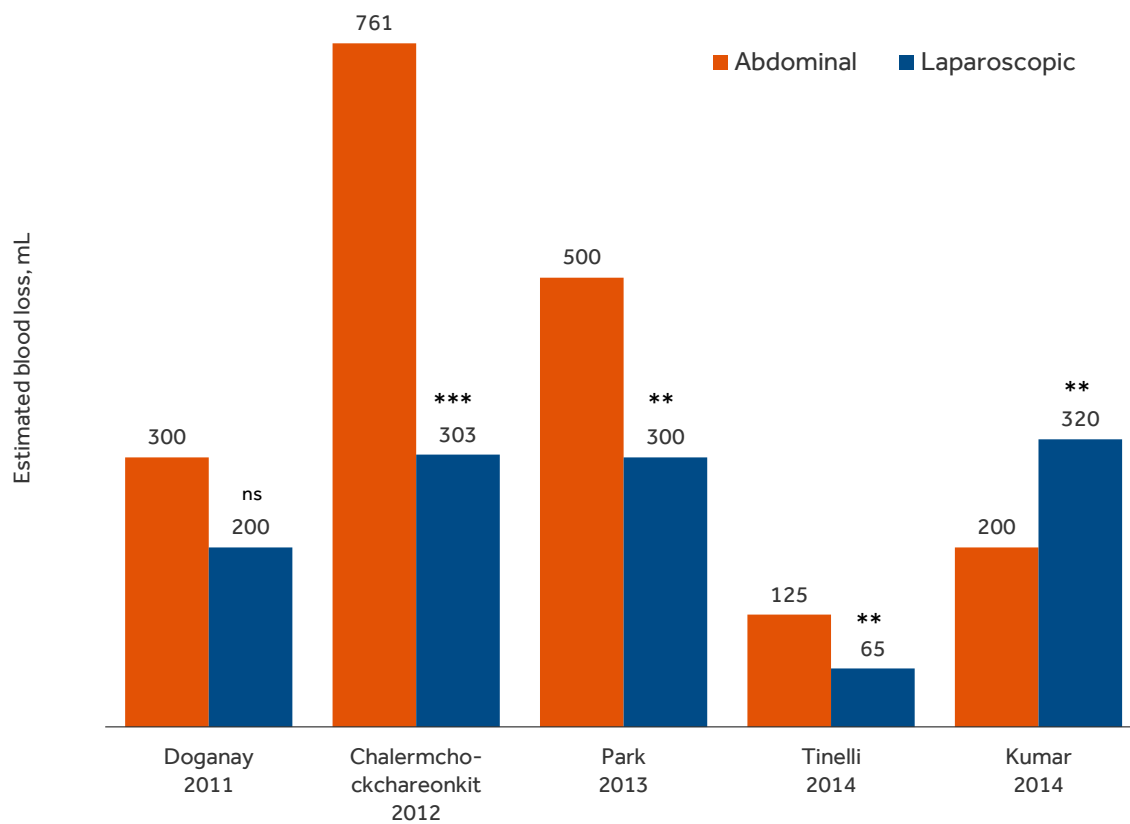
*p<0.05; **p<0.01; ***p<0.001; LoS, length of stay; NR, not reported; ns, not significant

Figure 1-4 Operating time with abdominal hysterectomy versus laparoscopic hysterectomy



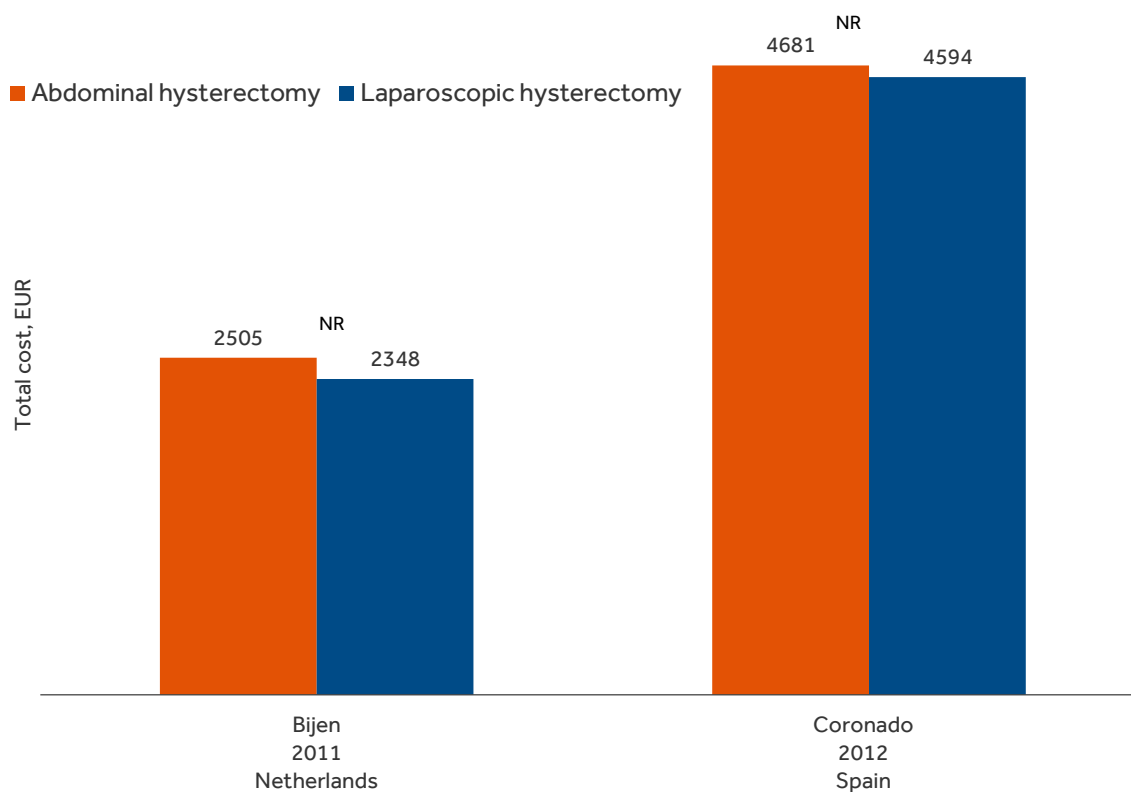
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-5 Estimated blood loss with abdominal hysterectomy versus laparoscopic hysterectomy



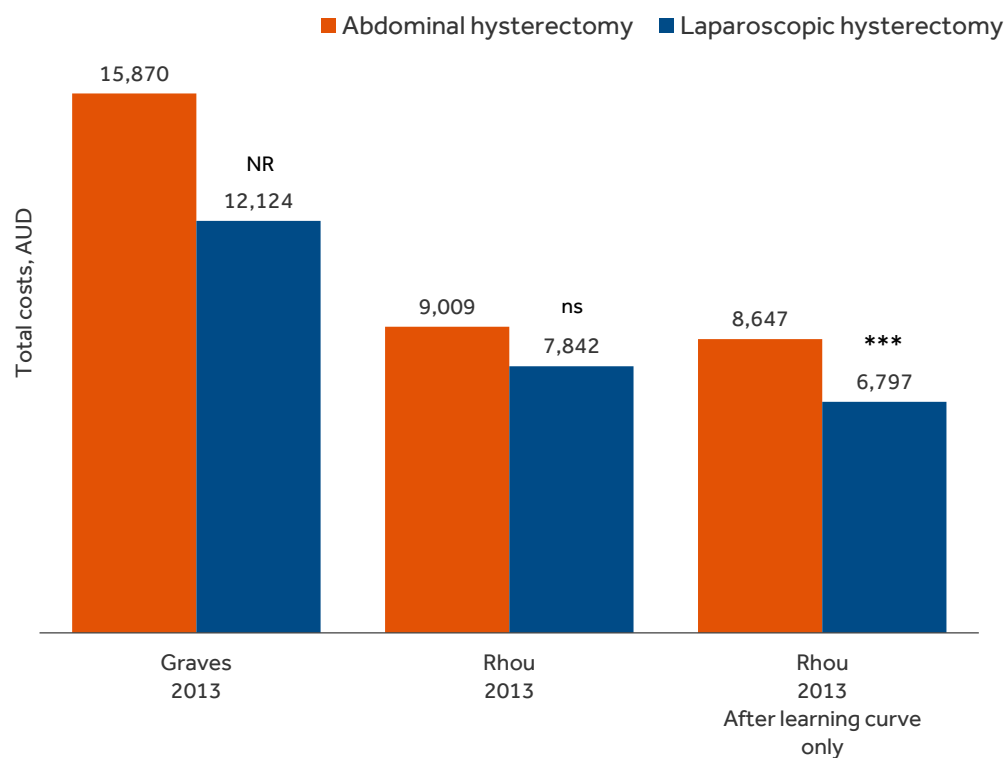
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-6 Total hospital costs for abdominal versus laparoscopic hysterectomy in studies conducted in Europe



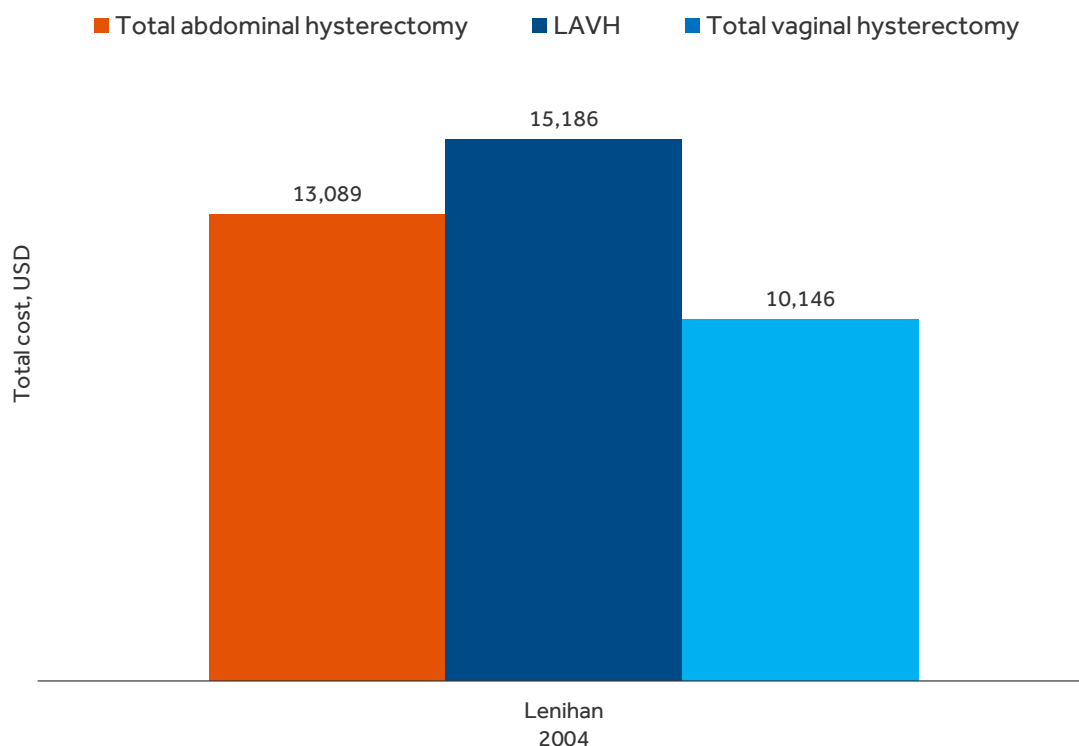
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-7 Total hospital costs for abdominal versus laparoscopic hysterectomy for studies performed in Australia



*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-8 Total hospital charges for total abdominal hysterectomy, laparoscopically-assisted hysterectomy and total vaginal hysterectomy in the United States



LAVH, laparoscopically –assisted vaginal hysterectomy

1.1.1. Clinical and economic evidence tables

A summary of clinical evidence on minimally invasive hysterectomy (total laparoscopic hysterectomy, laparoscopically-assisted vaginal hysterectomy and total vaginal hysterectomy) compared with abdominal hysterectomy from published meta-analyses and published studies is shown in Table 1-2 and Table 1-3, respectively. A summary of economic evidence from published cost studies is shown in Table 1-4.

In the following tables outcomes where $p < 0.05$ are underlined.

Table 1-2 Summary of meta-analyses comparing laparoscopic versus open hysterectomy								
Authors	Details	Procedures	Outcome	OR (95% CI)	P value			
Nieboer et al. 2009 ¹⁹	34 RCTs, n=4,495 patients	Vaginal hysterectomy versus abdominal hysterectomy and laparoscopic hysterectomy	Vaginal hysterectomy versus abdominal hysterectomy					
			<u>Return to normal activities, days</u>	<u>-9.47 (-12.57, -6.37)^a</u>	<u><0.00001</u>			
			<u>Estimated blood loss, mL</u>	<u>-11.93 (-70.70, 46.84)^a</u>	<u>0.69</u>			
			<u>Transfusion</u>	<u>1.31 (0.46, 3.72)</u>	<u>0.61</u>			
			<u>Length of stay, days</u>	<u>-1.07 (-1.22, -0.92)^a</u>	<u><0.00001</u>			
			Laparoscopic hysterectomy versus abdominal hysterectomy					
			<u>Return to normal activities, days</u>	<u>-13.63 (-15.42, -11.84)^a</u>	<u><0.00001</u>			
			<u>Operating time, minutes</u>	<u>0.27 (-23.39, 23.93)^a</u>	<u>0.98</u>			
			<u>Estimated blood loss, mL</u>	<u>-45.26 (-72.68, -17.85)^a</u>	<u>0.0012</u>			
			<u>Transfusion</u>	<u>0.78 (0.51, 1.19)</u>	<u>0.25</u>			
			<u>Wound/abdominal wall infection</u>	<u>0.31 (0.12, 0.77)</u>	<u>0.012</u>			
			<u>LoS, days</u>	<u>-2.01 (-2.17, -1.86)^a</u>	<u><0.00001</u>			
			Wang et al. 2013 ²⁰	9 RCTs, n=1,263 patients	Total laparoscopic hysterectomy versus total abdominal hysterectomy for early stage endometrial cancer	Peri-operative		
						<u>Intra-operative complications</u>	<u>0.98 (0.62, 1.55)</u>	<u>0.919</u>
Post-operative								
<u>Major complications</u>	<u>0.53 (0.29, 0.98)</u>	<u>0.042</u>						
<u>Mortality</u>	<u>0.96 (0.66, 1.40)</u>	<u>0.835</u>						
<u>Total complications</u>	<u>0.59 (0.42, 0.82)</u>	<u>0.002</u>						
Walsh et al. 2009 ²¹	3 RCTs, n=201 patients	Total abdominal hysterectomy versus laparoscopic hysterectomy for benign disease	Peri-operative					
			<u>Operating time, minutes</u>	<u>22 (5, 39)^a</u>	<u>0.01</u>			
			<u>Estimated blood loss, mL</u>	<u>-183 (-346, -21)^a</u>	<u>0.03</u>			
			<u>Peri-operative complications</u>	<u>0.19 (0.07, 0.50)</u>	<u>0.0008</u>			
			Post-operative					
			<u>LoS, days</u>	<u>-2.5 (-5.1, 0.01)^a</u>	<u>0.05</u>			
			<u>Major complications</u>	<u>1.35 (0.32, 5.73)</u>	<u>0.68</u>			
			<u>Minor complications</u>	<u>0.12 (0.04, 0.35)</u>	<u>0.0001</u>			
	<u>Blood transfusion</u>	<u>0.27 (0.05, 2.55)</u>	<u>0.31</u>					

For odds ratios values below 1.00 favor laparoscopic/vaginal hysterectomy, values above 1.00 favor abdominal hysterectomy

^aWeighted mean difference, positive values favor abdominal hysterectomy, negative values favor laparoscopic/vaginal hysterectomy
CI, confidence interval; LoS, length of stay; OR, odds ratio; RCT, randomized controlled trial

Table 1-3 Summary of key clinical studies comparing open versus laparoscopic hysterectomy									
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value versus open		
Garry et al. 2004²² and Sculpher et al. 2004²³	United Kingdom and South Africa	2 parallel multicenter RCTs, n=1,346 Abdominal trial, n=292 abdominal hysterectomy, n=584 laparoscopic Vaginal trial; n=168 vaginal hysterectomy, n=336 laparoscopic	Laparoscopic versus abdominal hysterectomy and laparoscopic versus vaginal hysterectomy for non-malignant (1996–2000)	Abdominal trial	Abdominal	Laparoscopic			
				Mean operating time, minutes	55.2	85.9	NR		
				Major bleeding	2.4%	4.6%	NR		
				Vaginal trial			Laparoscopic	Vaginal	
				Mean operating time, minutes		76.5	46.6	NR	
				Major bleeding		5.1%	2.9%	NR	
Baker et al. 2013²⁴	Multinational	Post-hoc analysis of the LACE RCT data, n=353 total abdominal; n=407 total laparoscopic hysterectomy	Abdominal versus total laparoscopic hysterectomy for stage I endometrial cancer (2005–2010)	Post-operative					
				Mean (SD) pain score		Abdominal	Laparoscopic		
				<u>Week 1</u>		<u>2.48 (2.13)</u>	<u>1.62 (2.01)</u>	<u><0.0001</u>	
				<u>Week 4</u>		<u>0.89 (1.5)</u>	<u>0.63 (1.34)</u>	<u>0.01</u>	
				<u>Month 3</u>		<u>0.54 (1.26)</u>	<u>0.48 (1.39)</u>	<u>0.59</u>	
				<u>Month 6</u>		<u>0.45 (1.27)</u>	<u>0.27 (0.98)</u>	<u>0.04</u>	
Warren et al. 2009²⁵	United States	Retrospective database analysis, n=8754 open abdominal, n=3,520 laparoscopic, n=3,130 vaginal hysterectomy	Open abdominal versus laparoscopic and vaginal hysterectomy (2005–2006)	Post-operative	Abdominal	Laparoscopic	Vaginal	Laparoscopic	Vaginal
				<u>Any infection</u>	<u>18%</u>	<u>15%</u>	<u>14%</u>	<u><0.05</u>	<u><0.05</u>
				<u>Mean (SD) LoS, days</u>	<u>3.66 (1.83)</u>	<u>1.56 (1.48)</u>	<u>2.21 (1.50)</u>	<u><0.05</u>	<u><0.05</u>
Leiserowitz et al. 2009²⁶	United States	Retrospective database, n=978 laparoscopically-assisted vaginal; n=11,765 total	Laparoscopic vaginal versus abdominal hysterectomy for endometrial	Post-operative	TAH	LAVH			
				<30 day readmission	5.9%	5.3%	0.8360		
				Complications					
				<u>Wound complication</u>	<u>5.5%</u>	<u>2.3%</u>	<u>0.0016</u>		
				<u>Blood transfusion</u>	<u>13.8%</u>	<u>6.1%</u>	<u><0.0001</u>		

Table 1-3 Summary of key clinical studies comparing open versus laparoscopic hysterectomy									
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value versus open		
		abdominal hysterectomy	cancer (1997–2001)	In hospital mortality <30 day mortality	0.4% 0.2%	0.1% 0.1%		0.2431 0.8525	
Hanwright et al. 2013²⁷	United States	Retrospective database analysis, n=4,4107 laparoscopic assisted vaginal hysterectomy (LAVH) and n=2,083 total laparoscopic hysterectomy	Laparoscopic assisted vaginal hysterectomy versus total laparoscopic hysterectomy for any indication (2006–2010)	Perioperative Mean (SD) Length of surgery, hours Post-operative Overall complications Wound complications Medical complications Reoperation Mean (SD) LoS, days		LAVH <u>2.20 (1.14)</u> 7.0% 2.2% 5.4% 1.3% 1.36 (1.61)	TLH <u>2.66 (1.25)</u> 6.3% 1.8% 4.9% 1.7% 1.18 (1.35)	LAVH vs. TLH <u><0.001</u> 0.353 0.227 0.420 0.199 0.055	
Doganay et al. 2011²⁸	Turkey	Retrospective single center chart review, n=4,398 abdominal, n=1,944 vaginal, n=138 total laparoscopic hysterectomy	Open abdominal versus total laparoscopic and vaginal hysterectomy for benign indications (2001–2009)	Peri-operative Major complications Minor complications Median (range) operating time, minutes Median (range) blood loss, mL Post-operative Median (range) LoS, days	Abdominal 3.6% 2.7% 125 (35–240) 300 (80–1,800) 5 (3–40)	TLH 2.8% 0.7% 130 (70–260) 200 (50–650) 2 (1–15)	Vaginal 2.7% 1.4% 95 (30–108) 250 (50–800) 2 (5–20)	TLH NR NR NR <0.07 NR	Vaginal NR NR NR NR <0.01
Wright et al. 2012²⁹	United States	Retrospective database analysis, n=1,610 abdominal hysterectomy, n=217 laparoscopic hysterectomy, n=67 robotic hysterectomy (not presented)	Abdominal versus laparoscopic (not presented) radical hysterectomy for cervical cancer (2006–2010)	Peri-operative Intraoperative complication Post-operative Any complication Surgical site complications Medical complications Transfusion Re-operation Median LoS, days LoS >3 days	Abdominal 5.8% 15.8% 3.4% 8.8% 15.0% 0.4% 3 44.3%	Laparoscopic 5.1% 9.2% 3.2% 3.2% 5.1% 0 2 11.1%		NR NR NR NR NR NR NR NR	

Table 1-3 Summary of key clinical studies comparing open versus laparoscopic hysterectomy							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value versus open
				Non-routine discharge	1.3%	0.9%	NR
				Mortality	1.3%	0	NR
Scalici et al. 2015³⁰	United States	Retrospective database analysis, n=1,269 exploratory laparotomy, n=807 minimally invasive surgery	Exploratory laparotomy versus minimally invasive surgery for endometrial cancer (2006–2010)	Peri-operative <u>Mean (SD) operating time, minutes</u> Post-operative <u>Mean (SD) LoS, days</u> <u>Complications</u>	Open <u>148 (68)</u> <u>3.8 (2.1)</u> <u>31.3%</u>	MIS <u>192 (84)</u> <u>1.6 (1.2)</u> <u>12.0%</u>	<u><0.001</u> <u><0.0001</u> <u><0.0001</u>
Chalermchockchareonkit et al. 2012³¹	Thailand	Retrospective chart review, n=115 laparoscopic hysterectomy, n=388 abdominal hysterectomy	Abdominal versus laparoscopic hysterectomy for severe pelvic endometriosis (2002–2007)	Peri-operative Conversion <u>Mean (SD) surgical time, minutes</u> <u>Estimated blood loss, mL</u> <u>Blood loss ≥500 mL</u> <u>Blood loss ≥1,000 mL</u> <u>Blood transfusion</u> Post-operative <u>Mean (SD) LoS, days</u> <u>Complications</u> <u>Post-operative fever</u> Organ injuries Bladder injury Ureteric injury Bowel injury	Abdominal — <u>140 (52)</u> <u>761 (633)</u> <u>59%</u> <u>26%</u> <u>31%</u> <u>6.4 (3.0)</u> <u>49%</u> <u>28%</u> 5% 0.5% 0.8% 4%	Laparoscopic 4.3% <u>185 (49)</u> <u>303 (255)</u> <u>20%</u> <u>4%</u> <u>7%</u> <u>3.5 (1.1)</u> <u>18%</u> <u>10%</u> 0.9% 0.9% 0 0	<u><0.001</u> <u><0.001</u> <u><0.001</u> <u><0.001</u> <u><0.001</u> <u><0.001</u> <u><0.001</u> <u><0.001</u> 0.06 NR NR NR
Kumar et al. 2014³²	United States	Single center retrospective cohort study, n=141 mini-laparotomy, n=352 laparoscopy	Mini-laparotomy versus laparoscopy for gynecologic	Peri-operative <u>Mean (range) blood loss, cc</u> <u>Mean (range) operating time, minutes</u>	Mini-laparotomy <u>20 (1, 350)</u> <u>49 (16, 125)</u>	Laparoscopic <u>32 (1, 300)</u> <u>92 (20, 311)</u>	<u>0.003</u> <u>0.000</u>

Table 1-3 Summary of key clinical studies comparing open versus laparoscopic hysterectomy							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value versus open
			conditions (2002–2011)	Conversion	6%	7%	0.639
				Post-operative			
				Re-operation	3%	1%	0.116
				ED visit	6%	6%	0.228
				Hospitalization	6%	6%	0.765
				Wound complication	4%	0%	0.008
Park et al. 2013³³	South Korea	Retrospective single center analysis, n=115 laparoscopic radical hysterectomy; n=188 open radical hysterectomy	Laparoscopic versus open radical hysterectomy for stage IB2 and IIA2 cervical cancer (1997–2011)	Peri-operative Median (range) operating time, minutes <u>Median (range) blood loss, mL</u> Transfusion Intraoperative complication	Open (radical) 264 (110–505) <u>500 (50–2,000)</u> 44.7%	Laparoscopic 280 (145–580) <u>300 (50–2,000)</u> 46.9%	0.080 <u>0.003</u> 0.708 0.269
				Post-operative <u>Post-operative complication</u> <u>Median (range) LoS, days</u>		<u>6.1%</u> <u>9 (5–33)</u>	<u>0.036</u> <u>0.001</u>
					<u>16 (4–69)</u>		
Tinelli et al. 2014³⁴	Italy	Multicenter analysis in obese patients, n=45 laparoscopic, n=30 laparotomic hysterectomy	Laparoscopic versus laparotomy in obese women with endometrial cancer (2004–2013)	Peri-operative <u>Mean (SD) blood loss, mL</u> Mean (SD) operating time, minutes Post-operative <u>Mean (SD) LoS, days</u> Post-discharge Cancer recurrence	Open <u>125 (32)</u> 143 (25) <u>6.3 (1.1)</u> 6.6%	Laparoscopic <u>65 (15)</u> 166 (21) <u>3.1 (0.4)</u> 8.8%	<0.01 0.08 <0.01 0.08
Riberio et al. 2003³⁵	Brazil	RCT, n=20 total abdominal hysterectomy, n=20 vaginal hysterectomy,	Total abdominal versus vaginal versus	Peri-operative <u>Mean operating time, minutes</u>	TAH <u>109</u>	Laparoscopic 119 Vaginal <u>78</u>	Laparoscopic ns Vaginal <u><0.001</u>

Table 1-3 Summary of key clinical studies comparing open versus laparoscopic hysterectomy							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value versus open
		n=20 laparoscopic hysterectomy	laparoscopic hysterectomy				

LACE, laparoscopic approach to cancer of the endometrium; LAVH, laparoscopically-assisted vaginal hysterectomy; MIS, minimally invasive surgery; TLH, total laparoscopic hysterectomy

Table 1-4 Summary of key studies comparing economic outcomes of open versus laparoscopic hysterectomy										
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	MIS	P value		
Warren et al. 2009 ²⁵	United States	Retrospective database analysis, n=8754 open abdominal, n=3,520 laparoscopic, n=3,130 vaginal hysterectomy	Open abdominal versus laparoscopic and vaginal hysterectomy (2005–2006)	USD (year not stated)	Mean (SD) overall cost (adjusted)	11,390 (125)	Laparoscopic 11,508 (174)	Vaginal 10,177 (178)	ns	<0.05
					Mean (SD) inpatient cost (adjusted)	11,739 (75)	11,860 (129)	10,392 (178)	ns	<0.05
					Mean (SD) outpatient cost (adjusted)	NA	9,426 (339)	7,627 (304)	NR	NR
Wright et al. 2012 ²⁹	United States	Retrospective database, n=1,610 abdominal, n=217 laparoscopic, n=67 robotic hysterectomy (not presented)	Abdominal versus laparoscopic versus robotic (not presented) radical hysterectomy for cervical cancer (2006–2010)	USD (year not stated)	Median cost	9,618	11,774		NR	
Barnett et al. 2010 ³⁶	United States	Cost comparison of robotic, versus laparoscopic versus open hysterectomy using decision analytic model	Robotic versus laparoscopic versus open hysterectomy (robotic not presented here)	USD (2008)	Intraoperative					
					Anesthesia professional fee	923		1,385	NR	
					Surgeon professional fee					
					Operating room time	1,186	1,351		NR	
					Operating room fees	1,600	2,326		NR	
					Anesthesia set up	341	341		NR	
					Operating room set up	1,381	1,085		NR	
					Disposable instruments	198	1,138		NR	
					Post-operative					
					Post-operative anesthesia care unit	404	216		NR	
Room, board, transfusions and pharmacy	4,044	704		NR						
Recovery										
Lost wages and caregiver	4,405	2,677		NR						
Lenihan et al. 2004 ³⁷	United States	Retrospective cohort study, of total abdominal, and	Total abdominal versus total vaginal and	USD	Total hospital charges	13,089	LAVH 15,186	TVH 10,146	<0.001	
						5.7	3.2	5.3	NR	

Table 1-4 Summary of key studies comparing economic outcomes of open versus laparoscopic hysterectomy									
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	MIS	P value	
		total vaginal and laparoscopically assisted vaginal hysterectomy	laparoscopically assisted vaginal hysterectomy (2001–2003)		Time to return to normal activity, weeks	5.9	3.8	5.0	NR
					Time to return to work, weeks	4.6	2.4	3.8	NR
					Family time off, days				
Sculpher et al. 2004²³	United Kingdom	Cost-effectiveness analysis based on two parallel trial, one comparing laparoscopic versus vaginal hysterectomy and laparoscopic versus abdominal hysterectomy	Laparoscopic hysterectomy and laparoscopic hysterectomy for benign indications	GBP (1999–2000)	Vaginal trial Mean theatre cost Hospital “hotel” cost Other post-operative cost Follow-up cost at 6 weeks Follow-up cost at 4 months Follow-up cost at 1 year Total cost		Vaginal 396 591 18 89 47 112 1,253	Laparoscopic 807 589 14 144 37 64 1,654	NR NR NR NR NR NR NR
					Abdominal trial Mean theatre cost Hospital “hotel” cost Other post-operative cost Follow-up cost at 6 weeks Follow-up cost at 4 months Follow-up cost at 1 year Total cost	453 692 13 128 88 146 1,520	788 548 21 193 39 115 1,706	NR NR NR NR NR NR NR	
Graves et al. 2013³⁸	Australia	Cost-effectiveness model using RCT data	Total abdominal versus total laparoscopic hysterectomy	AUD (2011)	Surgery costs Total costs	6,755 15,870	7265 12,124		NR
Rhou et al. 2013³⁹	Australia	Retrospective review in a tertiary hospital in a matched cohort	Total laparoscopic versus fast track open hysterectomy	AUD (year not stated)	<u>Intraoperative costs</u> <u>Post-operative cost</u> Total cost <u>Cost post learning curve</u>	<u>2,776</u> <u>6,233</u> 9,009 <u>8,647</u>	<u>3,877</u> <u>3,965</u> 7,842 <u>6,797</u>	<u>0.001</u> <u>0.001</u> 0.068 <u>0.001</u>	
Bijen et al. 2011⁴⁰	The Netherlands	Cost-effectiveness based on RCT, n=185	Total laparoscopic versus abdominal hysterectomy for early stage	EUR (2008)	Operative procedure Hospital stay Additional homecare	372 (169) 2,133 (1,175) 1,072 (1,508)	1,173 (345) 1,175 (995) 1,105 (1,928)	NR NR NR	

Table 1-4 Summary of key studies comparing economic outcomes of open versus laparoscopic hysterectomy								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	MIS	P value
		laparoscopic, n=94 open	endometrial cancer					
Coronado et al. 2012⁴¹	Spain	Single center study of costs and outcomes, n=84 laparoscopic, n=192 open and n=71 robotic (not presented here)	Robotic versus laparoscopy versus laparotomy hysterectomy for endometrial cancer (2003–2011)	EUR (year not stated)	Mean (SD) surgical cost Mean (SD) hospitalization cost Mean (SD) total cost	1145 (206) 4384.5 (2932.9) 4680.7 (1860.3)	2334.5 (334.1) 2694.3 (2547.5) 4594.3 (1447.8)	NR NR NR

LAVH, laparoscopically-assisted vaginal hysterectomy; MIS; minimally invasive surgery; NR, not reported; RCT, randomized controlled trial; SD, standard deviation; TVH, total vaginal hysterectomy

1.3. References

- ¹ Whiteman MK, Hillis SD, Jamieson DJ, Morrow B, Podgornik MN, Brett KM, Marchbanks PA. Inpatient hysterectomy surveillance in the United States, 2000–2004. *Am J Obstet Gynecol*. 2008 Jan;198(1):34.e1-7 ([PMID: 17981254](#))
- ² Stang A, Merrill RM, Kuss O. Hysterectomy in Germany: a DRG-based nationwide analysis, 2005–2006. *Dtsch Arztebl Int*. 2011 Jul;108(30):508-14 ([PMID: 21904583](#))
- ³ Garry R. Health economics of hysterectomy. *Best Pract Res Clin Obstet Gynaecol*. 2005 Jun;19(3):451-65 ([PMID: 15985258](#))
- ⁴ Lee J, Jennings K, Borahay MA, Rodriguez AM, Kilic GS, Snyder RR, Patel PR. Trends in the national distribution of laparoscopic hysterectomies from 2003 to 2010. *J Minim Invasive Gynecol*. 2014 Jul-Aug;21(4):656-61 ([PMID: 24462854](#))
- ⁵ ACOG Committee Opinion No. 444: choosing the route of hysterectomy for benign disease. *Obstet Gynecol*. 2009 Nov;114(5):1156-8 ([PMID: 20168127](#))
- ⁶ AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL position statement: route of hysterectomy to treat benign uterine disease. *J Minim Invasive Gynecol*. 2011 Jan-Feb;18(1):1-3 ([PMID: 21059487](#))
- ⁷ Practice Bulletin No. 149: Endometrial cancer. *Obstet Gynecol*. 2015 Apr;125(4):1006-26 ([PMID: 25798986](#))
- ⁸ Colombo N, Preti E, Landoni F, Carinelli S, Colombo A, Marini C, Sessa C; ESMO Guidelines Working Group. Endometrial cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2013 Oct;24 Suppl 6:vi33-8 ([PMID: 24078661](#))
- ⁹ Roy S, Patkar A, Daskiran M, Levine R, Hinoul P, Nigam S. Clinical and economic burden of surgical site infection in hysterectomy. *Surg Infect (Larchmt)*. 2014 Jun;15(3):266-73 ([PMID: 24801549](#))
- ¹⁰ Bakkum-Gamez JN, Dowdy SC, Borah BJ, Haas LR, Mariani A, Martin JR, Weaver AL, McGree ME, Cliby WA, Podratz KC. Predictors and costs of surgical site infections in patients with endometrial cancer. *Gynecol Oncol*. 2013 Jul;130(1):100-6 ([PMID: 23558053](#))
- ¹¹ Shander A, Hofmann A, Ozawa S, Theusinger OM, Gombotz H, Spahn DR. Activity-based costs of blood transfusions in surgical patients at four hospitals. *Transfusion*. 2010 Apr;50(4):753-65 ([PMID: 20003061](#))
- ¹² Hill SR, Carless PA, Henry DA, Carson JL, Hebert PC, McClelland DB, Henderson KM. Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion. *Cochrane Database Syst Rev*. 2002;(2):CD002042. Review. Update in: *Cochrane Database Syst Rev*. 2010;(10):CD002042 ([PMID: 12076437](#))
- ¹³ Jonsdottir GM, Jorgensen S, Cohen SL, Wright KN, Shah NT, Chavan N, Einarsson JI. Increasing minimally invasive hysterectomy: effect on cost and complications. *Obstet Gynecol*. 2011 May;117(5):1142-9 ([PMID: 21508754](#))
- ¹⁴ Mahdi H, Lockhart D, Maurer KA. Impact of age on 30-day mortality and morbidity in patients undergoing surgery for endometrial cancer. *Gynecol Oncol*. 2015 Apr;137(1):106-11 ([PMID: 25640765](#))
- ¹⁵ Mikhail E, Miladinovic B, Velanovich V, Finan MA, Hart S, Imudia AN. Association between obesity and the trends of routes of hysterectomy performed for benign indications. *Obstet Gynecol*. 2015 Apr;125(4):912-8 ([PMID: 25751208](#))

-
- ¹⁶ Vree FE, Cohen SL, Chavan N, Einarsson JI. The impact of surgeon volume on perioperative outcomes in hysterectomy. *JLS*. 2014 Apr-Jun;18(2):174-81 ([PMID: 24960479](#))
- ¹⁷ Wallenstein MR, Ananth CV, Kim JH, Burke WM, Hershman DL, Lewin SN, Neugut AI, Lu YS, Herzog TJ, Wright JD. Effect of surgical volume on outcomes for laparoscopic hysterectomy for benign indications. *Obstet Gynecol*. 2012 Apr;119(4):709-16 ([PMID: 22433333](#))
- ¹⁸ Oksuzoglu A, Seckin B, Turkcapar AF, Ozcan S, Gungor T. Comparison of tissue trauma after abdominal, vaginal and total laparoscopic hysterectomy. *Ginekol Pol*. 2015 Apr;86(4):268-73 ([PMID: 26117985](#))
- ¹⁹ Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, van Voorst S, Mol BW, Kluivers KB. Surgical approach to hysterectomy for benign gynaecological disease. *Cochrane Database Syst Rev*. 2009 Jul 8;(3):CD003677 ([PMID: 19588344](#))
- ²⁰ Wang HL, Ren YF, Yang J, Qin RY, Zhai KH. Total laparoscopic hysterectomy versus total abdominal hysterectomy for endometrial cancer: a meta-analysis. *Asian Pac J Cancer Prev*. 2013;14(4):2515-9 ([PMID: 23725166](#))
- ²¹ Walsh CA, Walsh SR, Tang TY, Slack M. Total abdominal hysterectomy versus total laparoscopic hysterectomy for benign disease: a meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2009 May;144(1):3-7 ([PMID: 19324491](#))
- ²² Garry R, Fountain J, Mason S, Hawe J, Napp V, Abbott J, Clayton R, Phillips G, Whittaker M, Lilford R, Bridgman S, Brown J. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. *BMJ*. 2004 Jan 17;328(7432):129 ([PMID: 14711749](#))
- ²³ Sculpher M, Manca A, Abbott J, Fountain J, Mason S, Garry R. Cost effectiveness analysis of laparoscopic hysterectomy compared with standard hysterectomy: results from a randomised trial. *BMJ*. 2004 Jan 17;328(7432):134 ([PMID: 14711748](#))
- ²⁴ Baker J, Janda M, Belavy D, Obermair A. Differences in Epidural and Analgesic Use in Patients with Apparent Stage I Endometrial Cancer Treated by Open versus Laparoscopic Surgery: Results from the Randomised LACE Trial. *Minim Invasive Surg*. 2013;2013:764329 ([PMID: 23956855](#))
- ²⁵ Warren L, Ladapo JA, Borah BJ, Gunnarsson CL. Open abdominal versus laparoscopic and vaginal hysterectomy: analysis of a large United States payer measuring quality and cost of care. *J Minim Invasive Gynecol*. 2009 Sep-Oct;16(5):581-8 ([PMID: 19835801](#))
- ²⁶ Leiserowitz GS, Xing G, Parikh-Patel A, Cress R, Abidi A, Rodriguez AO, Dalrymple JL. Laparoscopic versus abdominal hysterectomy for endometrial cancer: comparison of patient outcomes. *Int J Gynecol Cancer*. 2009 Nov;19(8):1370-6 ([PMID: 20009892](#))
- ²⁷ Hanwright PJ, Mioton LM, Thomasse MS, Bilimoria KY, Van Arsdale J, Brill E, Kim JY. Risk profiles and outcomes of total laparoscopic hysterectomy compared with laparoscopically assisted vaginal hysterectomy. *Obstet Gynecol*. 2013 Apr;121(4):781-7 ([PMID: 23635678](#))
- ²⁸ Doğanay M, Yildiz Y, Tonguc E, Var T, Karayalcin R, Eryilmaz OG, Aksakal O. Abdominal, vaginal and total laparoscopic hysterectomy: perioperative morbidity. *Arch Gynecol Obstet*. 2011 Aug;284(2):385-9 ([PMID: 20844884](#))
- ²⁹ Wright JD, Herzog TJ, Neugut AI, Burke WM, Lu YS, Lewin SN, Hershman DL. Comparative effectiveness of minimally invasive and abdominal radical hysterectomy for cervical cancer. *Gynecol Oncol*. 2012 Oct;127(1):11-7 ([PMID: 22735788](#))

-
- ³⁰ Scalici J, Laughlin BB, Finan MA, Wang B, Rocconi RP. The trend towards minimally invasive surgery (MIS) for endometrial cancer: an ACS-NSQIP evaluation of surgical outcomes. *Gynecol Oncol*. 2015 Mar;136(3):512-5 ([PMID: 25462206](#))
- ³¹ Chalermchokchareonkit A, Tekasakul P, Chaisilwattana P, Sirimai K, Wahab N. Laparoscopic hysterectomy versus abdominal hysterectomy for severe pelvic endometriosis. *Int J Gynaecol Obstet*. 2012 Feb;116(2):109-11 ([PMID: 22093496](#))
- ³² Kumar A, Pearl M. Mini-laparotomy versus laparoscopy for gynecologic conditions. *J Minim Invasive Gynecol*. 2014 Jan-Feb;21(1):109-14 ([PMID: 23911561](#))
- ³³ Park JY, Kim DY, Kim JH, Kim YM, Kim YT, Nam JH. Laparoscopic versus open radical hysterectomy in patients with stage IB2 and IIA2 cervical cancer. *J Surg Oncol*. 2013 Jul;108(1):63-9 ([PMID: 23737035](#))
- ³⁴ Tinelli R, Litta P, Meir Y, Surico D, Leo L, Fusco A, Angioni S, Cicinelli E. Advantages of laparoscopy versus laparotomy in extremely obese women (BMI>35) with early-stage endometrial cancer: a multicenter study. *Anticancer Res*. 2014 May;34(5):2497-502 ([PMID: 24778066](#))
- ³⁵ Ribeiro SC, Ribeiro RM, Santos NC, Pinotti JA. A randomized study of total abdominal, vaginal and laparoscopic hysterectomy. *Int J Gynaecol Obstet*. 2003 Oct;83(1):37-43 ([PMID: 14511870](#))
- ³⁶ Barnett JC, Judd JP, Wu JM, Scales CD Jr, Myers ER, Havrilesky LJ. Cost comparison among robotic, laparoscopic, and open hysterectomy for endometrial cancer. *Obstet Gynecol*. 2010 Sep;116(3):685-93 ([PMID: 14711748](#))
- ³⁷ Lenihan JP Jr, Kovanda C, Cammarano C. Comparison of laparoscopic-assisted vaginal hysterectomy with traditional hysterectomy for cost-effectiveness to employers. *Am J Obstet Gynecol*. 2004 Jun;190(6):1714-20 ([PMID: 15284779](#))
- ³⁸ Graves N, Janda M, Merollini K, Gebiski V, Obermair A; LACE trial committee. The cost-effectiveness of total laparoscopic hysterectomy compared to total abdominal hysterectomy for the treatment of early stage endometrial cancer. *BMJ Open*. 2013 Apr 18;3(4) ([PMID: 23604345](#))
- ³⁹ Rhou YJ, Pather S, Loadsman JA, Campbell N, Philp S, Carter J. Direct hospital costs of total laparoscopic hysterectomy compared with fast-track open hysterectomy at a tertiary hospital: a retrospective case-controlled study. *Aust N Z J Obstet Gynaecol*. 2013 May 2. doi: 10.1111/ajo.12093. [Epub ahead of print] ([PMID: 23634987](#))
- ⁴⁰ Bijen CB, Vermeulen KM, Mourits MJ, Arts HJ, Ter Brugge HG, van der Sijde R, Wijma J, Bongers MY, van der Zee AG, de Bock GH. Cost effectiveness of laparoscopy versus laparotomy in early stage endometrial cancer: a randomized trial. *Gynecol Oncol*. 2011 Apr;121(1):76-82 ([PMID: 21215439](#))
- ⁴¹ Coronado PJ, Herraiz MA, Magrina JF, Fasero M, Vidart JA. Comparison of perioperative outcomes and cost of robotic-assisted laparoscopy, laparoscopy and laparotomy for endometrial cancer. *Eur J Obstet Gynecol Reprod Biol*. 2012 Dec;165(2):289-94 ([PMID: 22819573](#))