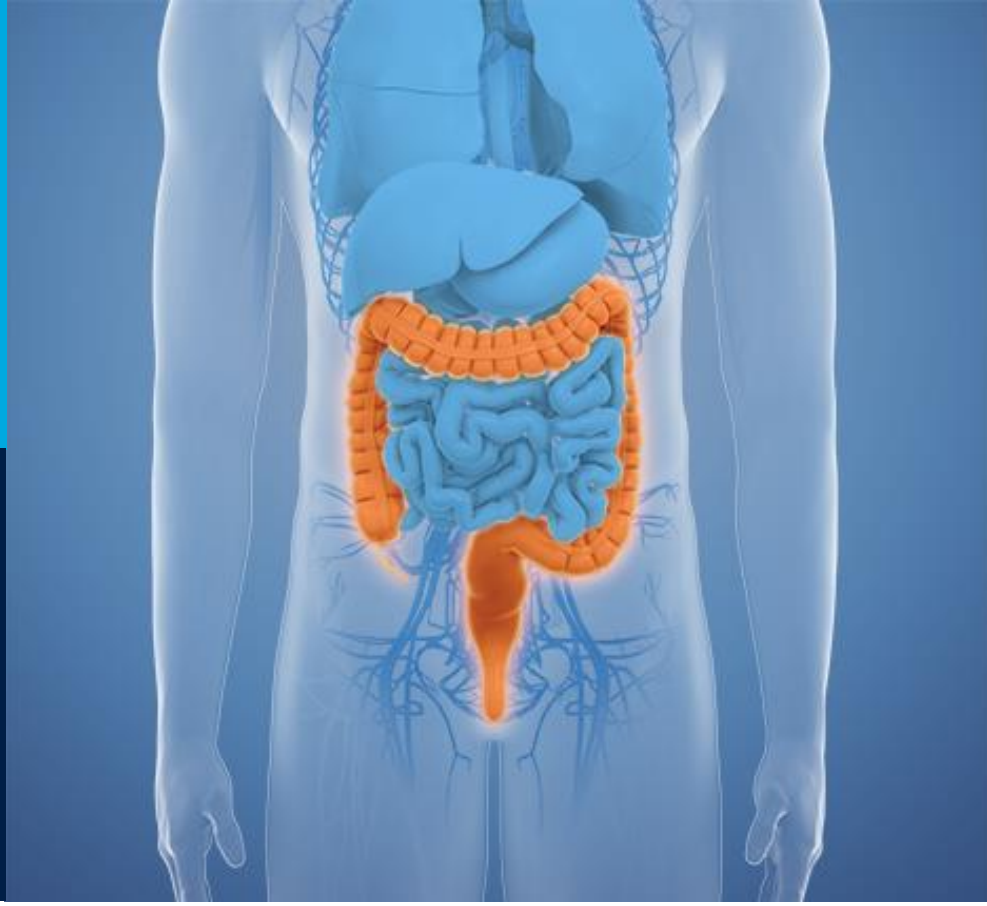

GLOBAL VALUE DOSSIER
FOR MINIMALLY INVASIVE SURGERY (MIS)
COLORECTAL SURGERY

Medtronic
Further, Together

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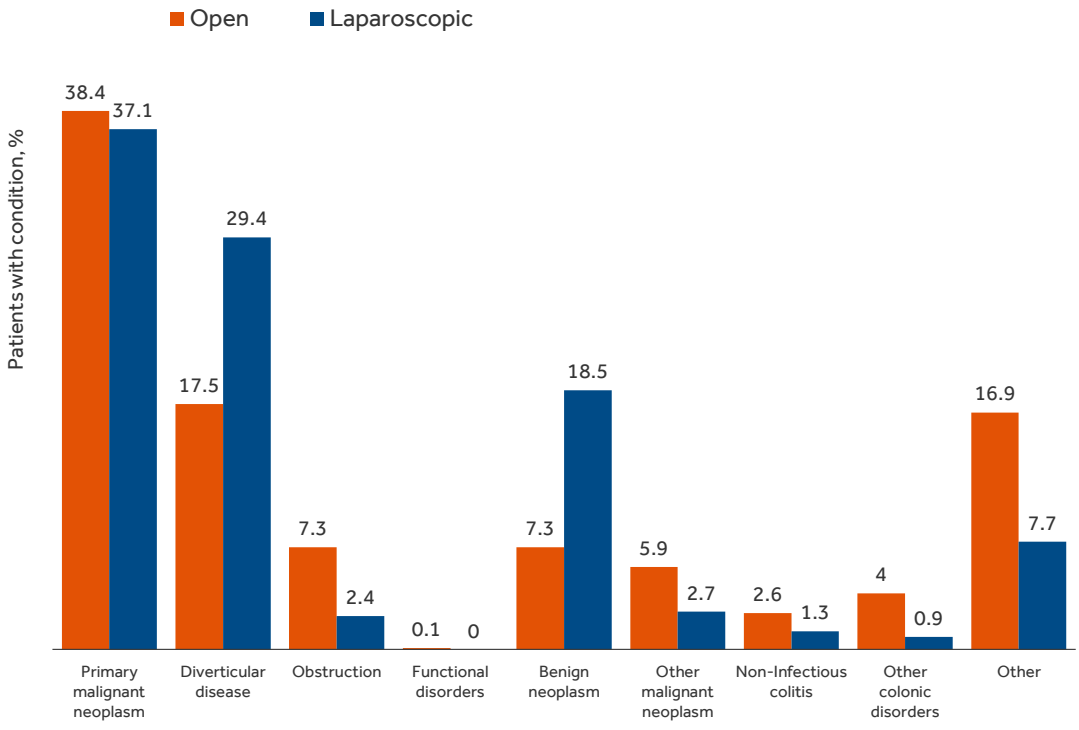
1. Colorectal surgery (right, left and sigmoid colectomy, rectal resection)

1.1. Overview of procedure

Laparoscopic colorectal resection was first performed in 1991.[1,2] Initially, when used for removal of tumors in patients with colorectal cancer there was concern over the high incidence of port-site metastases. This has now largely been negated due to improved technique isolation of diseased tissue prior to extraction and rates of port site metastases with laparoscopic colectomy are now similar to rates of metastases around the edge of the wound site reported with open colectomy.[3,4,5] Laparoscopic colectomy has several benefits compared with open colectomy (see Section 1.2) and is becoming increasingly widely used across both developed and emerging markets. However, as operating time is typically longer with laparoscopic colectomy versus open there is demand in some settings to demonstrate tangible clinical benefit and cost-effectiveness of the use of laparoscopic techniques.

US data show that 37% of laparoscopic colectomies are performed in patients with primary malignant neoplasm, 29% for diverticular disease and 19% for benign neoplasms[6] and in 2015 there will be an estimated 132,700 cases of colorectal cancer in the United States, which represents 8% of total cancer cases in the US making it the fourth most common cancer.[7] Surgery (laparoscopic or open) is the only curative treatment for colorectal cancer and encompasses complete resection of the primary tumor with negative margins in addition to a complete oncologic lymphadenectomy.

Figure 1-1 Indications for colectomy in US patients 2005–2010

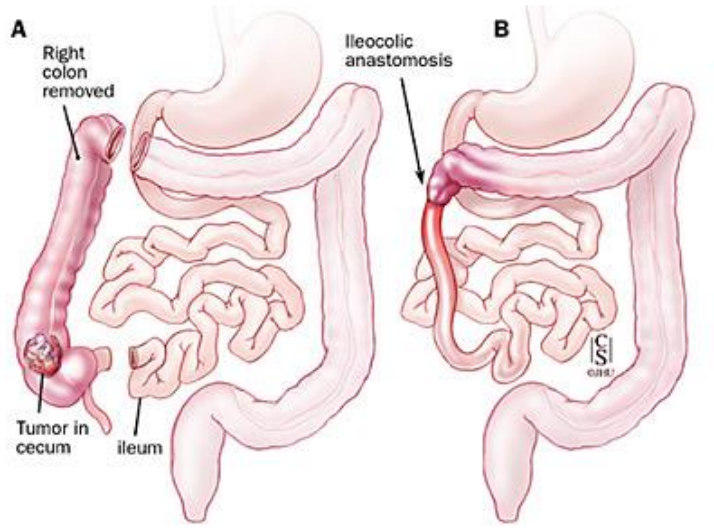


Source: Wilson *et al.* 2014[6] (n=37,249 patients from the National Surgical Quality Improvement Program database)

Common colorectal surgical procedures

Right hemicolectomy: the removal of the cecum, ascending colon, hepatic flexure, initial third of the transverse colon and part of the terminal ileum (in addition to removal of fat and lymph nodes). Laparoscopic right colectomy involves a total of four surgical incisions and insufflation of the abdomen with carbon dioxide. Prior to any mobilization the surrounded area is examined for the presence of metastases, after which the colon is divided from its posterior and lateral attachments and ileocolic vessels ligated (Figure 1-2). The ascending colon is then transected from the ileum and transverse colon and removed after deflating the abdomen. Finally, an anastomosis is created between the ileum and transverse colon.

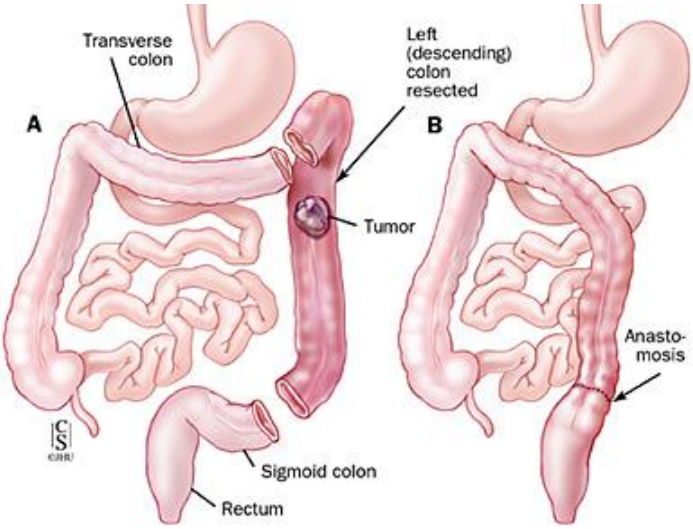
Figure 1-2 Right hemicolectomy with ileocolic anastomosis



Source: Johns Hopkins Department of gastroenterology and Hepatology, available at: https://gi.jhsps.org/GDL_Disease.aspx?CurrentUDV=31&GDL_Cat_ID=AF793A59-B736-42CB-9E1F-E79D2B9FC358&GDL_Disease_ID=FB4F2BE3-FC13-44E4-BB69-2CCE936A6CD5

Left hemicolectomy: the removal of the left (descending) colon. The laparoscopic procedures requires approximately five small incisions. The renocolic, splenocolic and pancreaticolic ligaments are first cut to remove the descending colon from its attachments. The mesentery and the major vessels it contains must be ligated and divided. The omentum is divided from the transverse colon, splenic flexure mobilized and the necessary length of diseased bowel removed (Figure 1-3). An anastomosis is then created between the transverse and sigmoid colon.

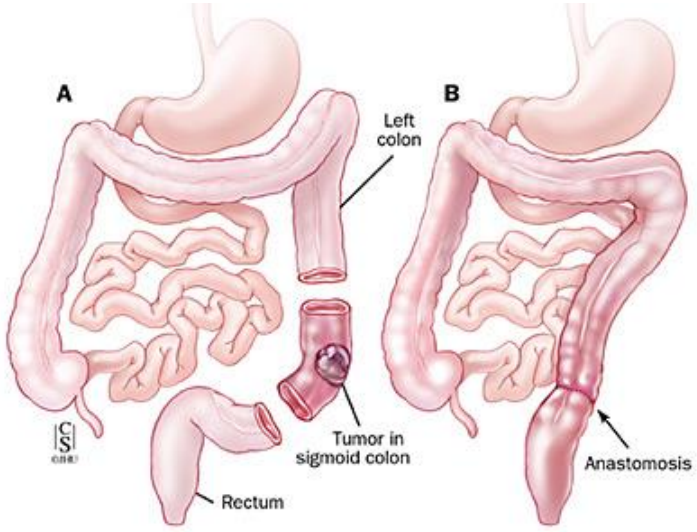
Figure 1-3 Left hemicolectomy with transverse and sigmoid colon anastomosis



Source: Johns Hopkins Department of gastroenterology and Hepatology, available at: https://gi.jhsps.org/GDL_Disease.aspx?CurrentUDV=31&GDL_Cat_ID=AF793A59-B736-42CB-9E1F-E79D2B9FC358&GDL_Disease_ID=FB4F2BE3-FC13-44E4-BB69-2CCE936A6CD5

Proctosigmoidectomy, sigmoidectomy and protectomy: the removal of the rectum and sigmoid colon, removal of the sigmoid colon (from the splenic fixture to the rectosigmoid junction) and removal of the rectum, respectively. The laparoscopic procedure involves three to five incisions and the colon transected 5–10 cm on either side of the tumor (or at the rectosigmoid junction); in proctosigmoidectomy the upper section of the rectum is also removed (Figure 1-4). After which, in cases of colorectal carcinoma, the excised tissue can be placed in a specimen bag and removed through the excisions or removed through a wound protector at the wound site to prevent contact of malignant cells with healthy tissue. An anastomosis is then created.

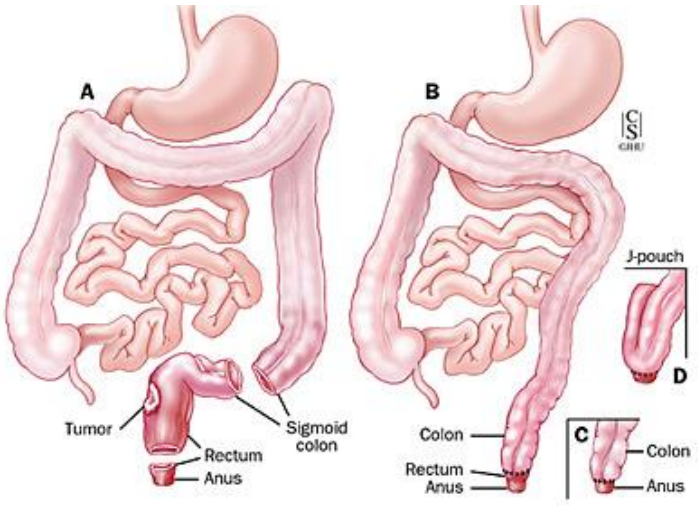
Figure 1-4 Sigmoid colectomy with anastomosis of descending colon and upper rectum



Source: Johns Hopkins Department of gastroenterology and Hepatology, available at: https://gi.jhsps.org/GDL_Disease.aspx?CurrentUDV=31&GDL_Cat_ID=AF793A59-B736-42CB-9E1F-E79D2B9FC358&GDL_Disease_ID=FB4F2BE3-FC13-44E4-BB69-2CCE936A6CD5

Low anterior resection: the removal of a segment of the rectum (subtype of protectomy), as well as associated lymph nodes in the case of surgery for colorectal cancer (Figure 1-5). The procedure is less extensive than abdominal perineal resection and a colostomy is not required; an anastomosis is created between the remaining part of the colon and rectum.

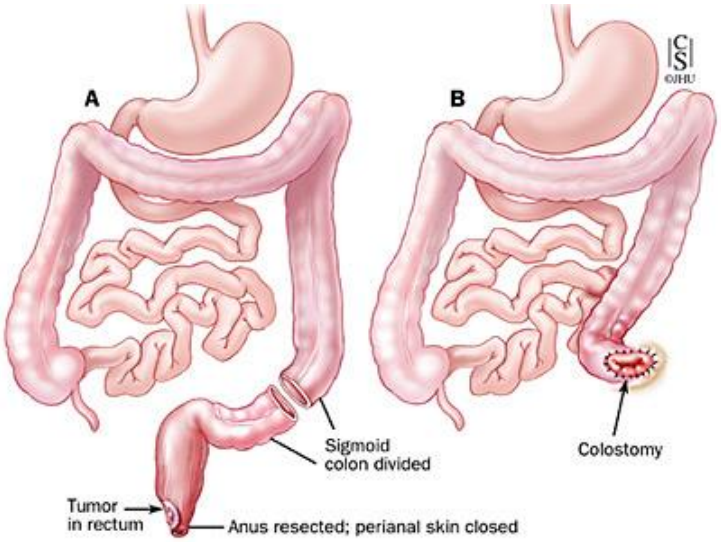
Figure 1-5 Low anterior resection



A, low anterior resection, B, C coloanal anastomosis, D, j pouch construction creating a reservoir
Source: Johns Hopkins Department of gastroenterology and Hepatology, available at: https://gi.jhsps.org/GDL_Disease.aspx?CurrentUDV=31&GDL_Cat_ID=AF793A59-B736-42CB-9E1F-E79D2B9FC358&GDL_Disease_ID=FB4F2BE3-FC13-44E4-BB69-2CCE936A6CD5

Abdominal perineal resection: (also known as the Miles operation) the removal of the anus, rectum and part of the sigmoid colon (in addition to lymph nodes), used in cases of rectal carcinoma in the distal third of the rectum (Figure 1-6). A colostomy is created by pulling the end of the sigmoid colon through the abdominal wall. The creation of a colostomy involves creating an opening (stoma) for the large intestine in the abdomen wall through which stool can exit into an external bag (colostomy bag). Colostomies are associated with impairment in some aspects of HRQoL; in a study of Japanese patients with colostomies >7 years post-surgery, significantly lower scores relative to the general population were reported in role physical and social functioning domains but there was no significant impairment in any other domain.[8]

Figure 1-6 Abdominoperineal resection with colostomy



Source: Johns Hopkins Department of gastroenterology and Hepatology, available at: https://gi.jhsps.org/GDL_Disease.aspx?CurrentUDV=31&GDL_Cat_ID=AF793A59-B736-42CB-9E1F-E79D2B9FC358&GDL_Disease_ID=FB4F2BE3-FC13-44E4-BB69-2CCE936A6CD5

Guidelines on the use of laparoscopic colorectal resection

United Kingdom National Institute for Health and Care Excellence (NICE) technology appraisal guidance (TA105) on the use of laparoscopic surgery for colorectal cancer[9]

- Laparoscopic (including laparoscopically assisted) resection is recommended as an alternative to open resection for individuals with colorectal cancer in whom both laparoscopic and open surgery are considered suitable
- Laparoscopic colorectal surgery should be performed only by surgeons who have completed appropriate training in the technique and who perform this procedure often enough to maintain competence.
- The decision about which of the procedures (open or laparoscopic) is undertaken should be made after informed discussion between the patient and the surgeon. In particular, they should consider:
    - The suitability of the lesion for laparoscopic resection
    - The risks and benefits of the two procedures
    - The experience of the surgeon in both procedures

Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Guidelines for laparoscopic resection of curable colon and rectal cancer

- We recommend that laparoscopic resection follow standard oncologic principles: proximal ligation of the primary arterial supply to the segment harboring the cancer, appropriate proximal and distal margins, and adequate lymphadenectomy. (++++, strong)
- We recommend that laparoscopic resection for rectal cancer follow standard oncologic principles: Adequate distal margin, ligation at the origin of the arterial supply for the involved rectal segment, and mesorectal excision. (+++O, strong)
- For locally advanced adherent colon and rectal tumors, an en bloc resection is recommended. We suggest an open approach if a laparoscopic en bloc resection cannot be performed adequately. (++OO, weak)
- We recommend that patients with an obstructing right or transverse colon cancer undergo a right or extended right colectomy. The open approach is required if the laparoscopic approach will not result in an oncologically sound resection. (++OO, strong)
- We suggest that for patients with an obstructing left-sided colon cancer, the procedure be individualized according to clinical factors. Colonic stenting may increase the likelihood of completing a one-stage procedure and may decrease the likelihood of an end colostomy. (+++O, weak)
- The use of a wound protector at the extraction site and the irrigation of port sites and extraction site incisions may reduce abdominal wall cancer recurrences. (++OO, strong)
- Before surgeons apply the laparoscopic approach for the resection of curable colon and rectal cancer, they must have adequate knowledge, training, and experience in laparoscopic techniques and oncologic principles. (+++O, strong)

1.2. Clinical and economic outcomes with laparoscopic versus open colorectal surgery

Key findings

Clinical outcomes

- **Oncologic equivalence:** Laparoscopic surgery for colorectal cancer is now associated with similar outcomes to open surgery in terms of overall survival, disease-free survival and port-site metastases[22,24,28,38,44,47]
- **Survival:** There is no significant difference between laparoscopic and open colorectal surgery for colorectal cancer in terms of overall survival rates[20,22,23,24,27,28,44,47]
- **Surgical Site Infection:** Rates of surgical site infection are consistently lower (often significantly) with laparoscopic colorectal surgery than open colorectal surgery[6,32,33](Figure 1-7)
- **Length of Stay:** Length of hospital stay is significantly shorter following laparoscopic colorectal surgery than with open colorectal surgery[6,29,31,34,36,38,41,42,43,47,48,49] (Figure 1-8)
- **Blood loss:** Blood loss during surgery is significantly lower with laparoscopic versus open colorectal surgery[36,37,42,45,50] (Figure 1-9)
- **Blood transfusion:** The proportion of patients requiring blood transfusion is lower with laparoscopic colorectal resection than with open colorectal resection[37,41,46]
- **Incision size:** Laparoscopic colorectal surgery requires a significantly shorter incision, leading to less scarring, than open colorectal surgery[45,50]
- **Bowel function:** Return of bowel function occurs significantly sooner in patients who have undergone laparoscopic colorectal surgery than in those who have undergone open colorectal surgery[36,42,45]
- **Operating time:** Studies show that the operating time associated with laparoscopic colorectal surgery is consistently and significantly longer than with open surgery[22,32,37,41,42,43,45,50] (Figure 1-10)

Economic outcomes

- **Operating time:** Longer operating time is not associated with significantly higher costs[10]
- **Total costs:** Findings from cost studies are inconsistent, in instances where total costs were lower with laparoscopic versus open colorectal surgery the cost savings were primarily driven by lower complication rates
    - **United States:** In US-based studies, total hospital costs for laparoscopic colorectal resection were generally lower than for open colorectal resection (Figure 1-11)
    - **Europe:** In the UK, there was no significant difference in total hospital costs for open versus laparoscopic colorectal resection[55] (Figure 1-12)

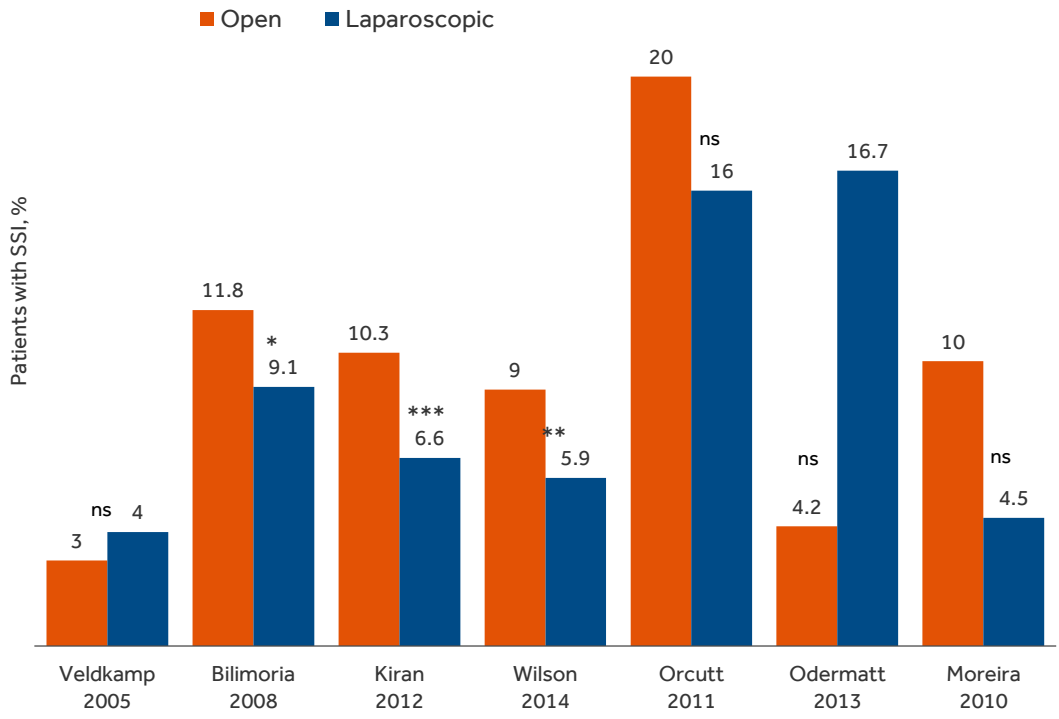
- **Canada:** In Canada, total costs were lower for laparoscopic colectomy than for open colectomy[41,51], in one study this achieved statistical significance[41]
- **China:** In one study conducted in China total hospital costs were significantly higher with laparoscopic colectomy than open colectomy[45]
- **Australia:** Findings from Australia were inconsistent; in one study total costs were significantly lower with laparoscopic colectomy than open colectomy[34] and is another study they were non-significantly higher[52]

- **Savings due to clinical benefits:** Clinical benefits of laparoscopic colectomy, including shorter LoS and lower rates of post-operative complications translate into economic benefits, which are important from the payer perspective.

Other findings

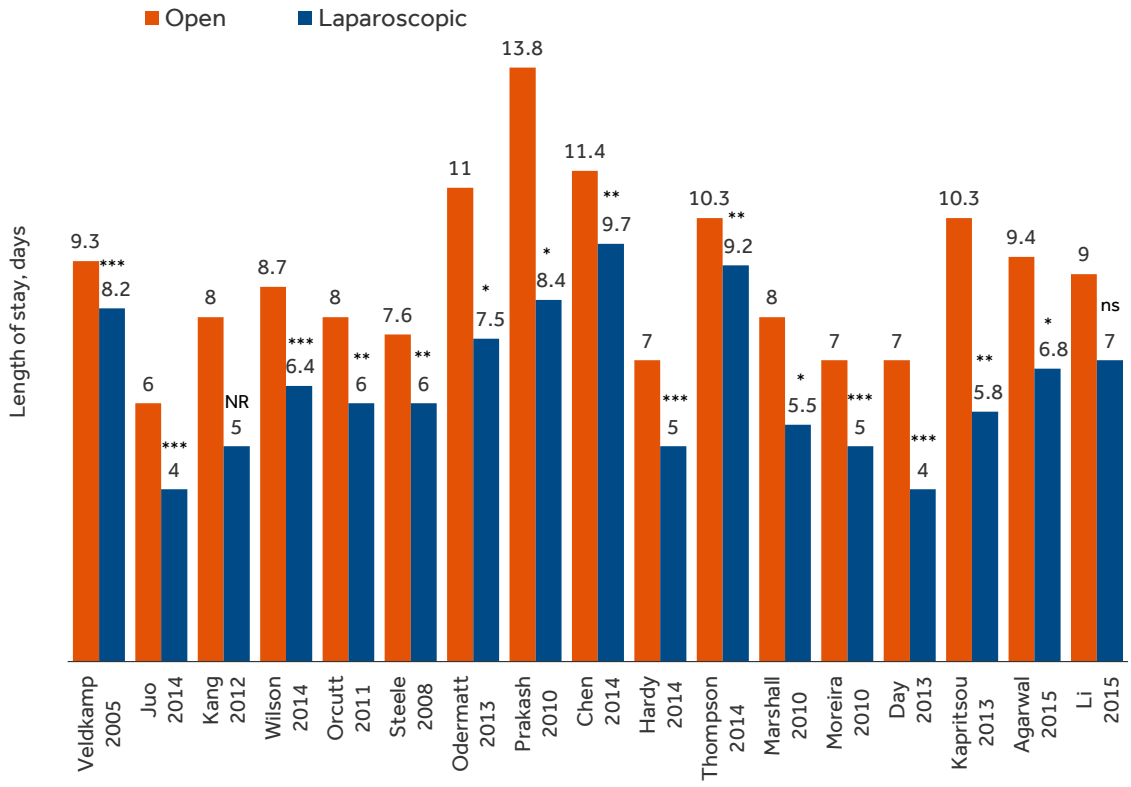
- **Surgeon volume:** Higher surgeon volume is associated with better outcomes and lower costs compared with low volume surgeons.[11]
- **Readmission rates:** Readmission rates are typically lower, but not significantly so, in patients undergoing laparoscopic colorectal resection than in those undergoing open colorectal resection[6,41]
  - Rates of readmission are influenced by several factors including BMI, surgeon volume, operating time and presence of SSI[12,13]; increased BMI is also associated with an increased surgical difficulty[14] and significantly increased risk for SSI[14,15]
- **Pulmonary complications:** Laparoscopic surgery is associated with lower absolute risk of pulmonary complications versus open surgery[16]
- **Quality of life:** Evidence from quality of life studies is inconsistent; with a recent systematic review reporting that some studies suggest no significant difference, whilst others suggest a significant QoL benefit with the laparoscopic approach.[17]
- **Emerging markets:** Clinical outcomes reported in studies of laparoscopic versus open colectomy in emerging markets such as India and Brazil are similar to outcomes reported in Europe and North America.[18 46]
- **Trends in cost studies:** In published cost studies the percentage difference between laparoscopic and open colectomy varies widely, but for studies conducted in Western settings there is a trend towards a decline in the cost of laparoscopic colectomy over time.[19]

Figure 1-7 Reported rates of SSI with laparoscopic versus open colorectal surgery



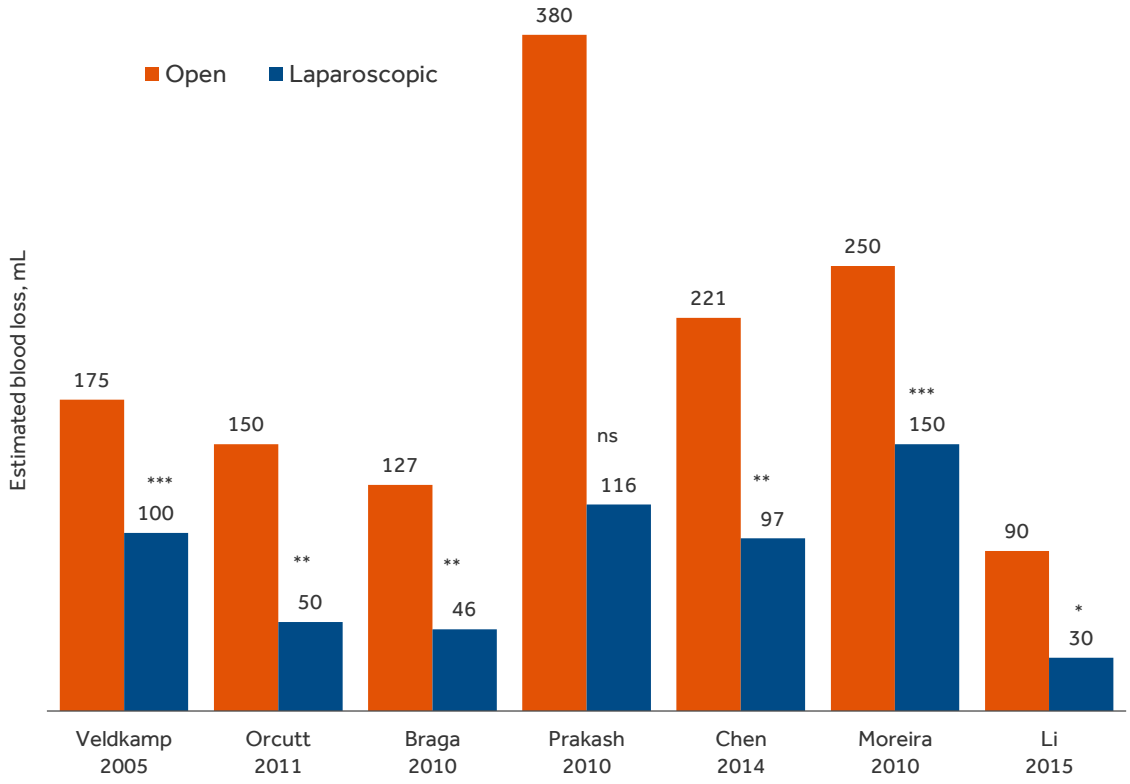
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant; SSI surgical site infection

Figure 1-8 Length of stay with laparoscopic versus open colorectal surgery



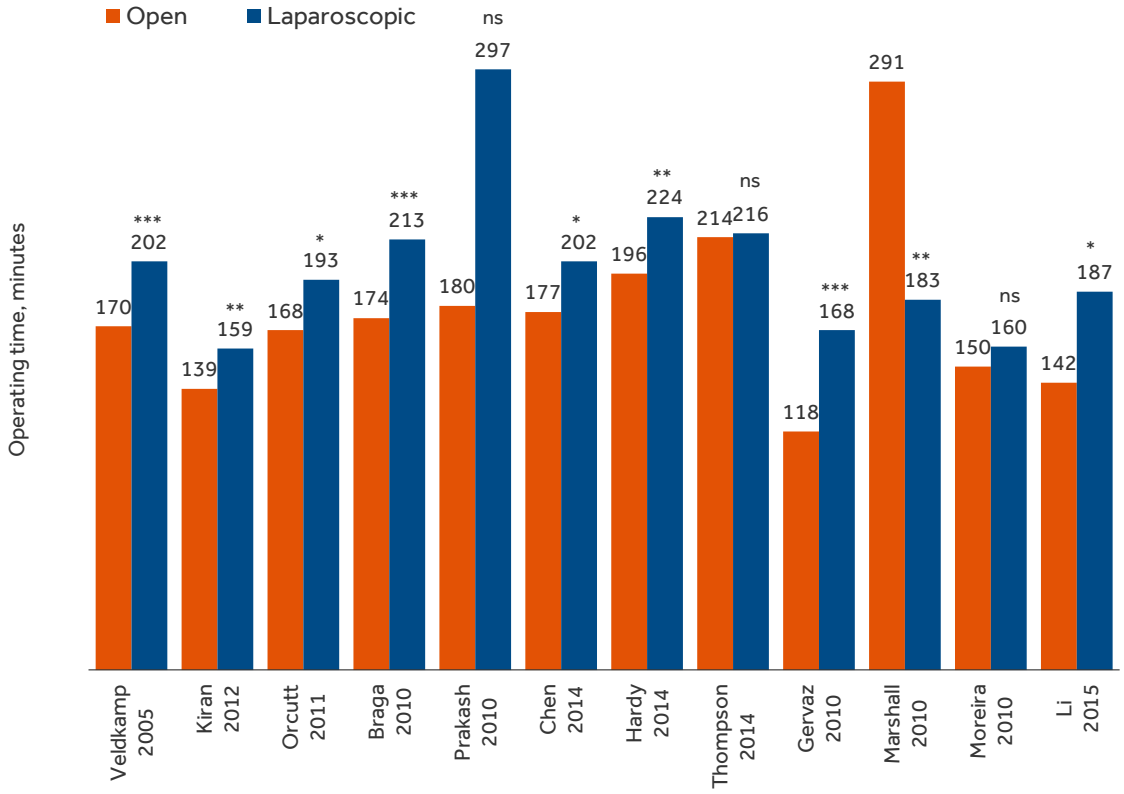
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-9 Blood loss with laparoscopic versus open colorectal surgery



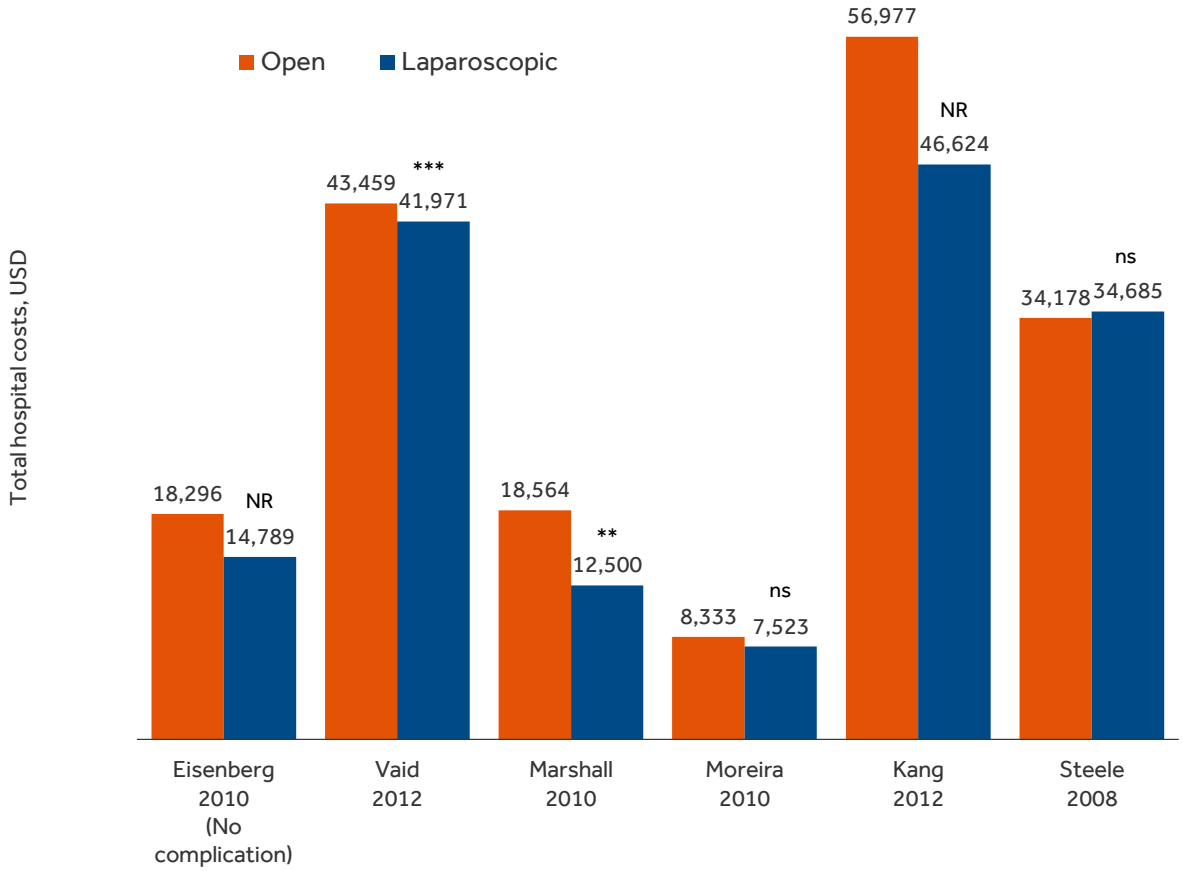
*p<0.05; **p<0.01; p<0.001; NR, not reported; ns, not significant

Figure 1-10 Operating time with laparoscopic versus open colorectal surgery



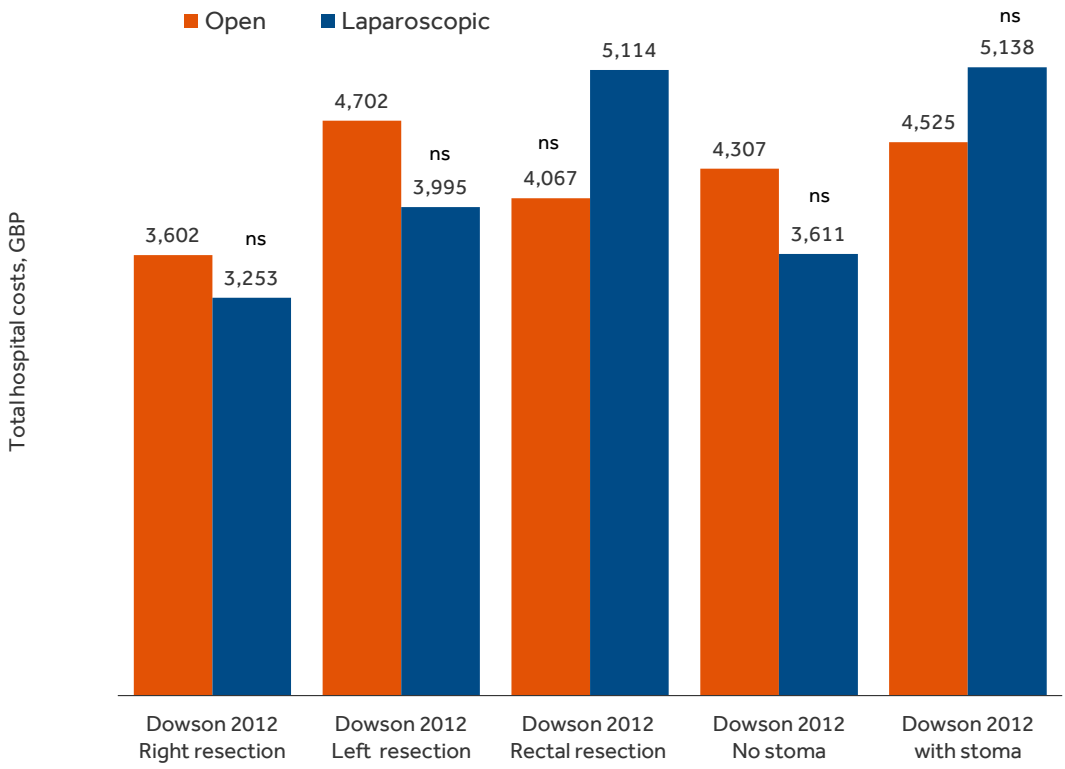
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-11 Total hospital costs for laparoscopic versus open colorectal surgery in US-based studies



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

Figure 1-12 Total hospital costs for laparoscopic versus open colorectal surgery in the UK



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

1.1.1. Clinical and economic evidence tables

A summary of clinical evidence on laparoscopic versus open colorectal surgery from published meta-analyses and published studies is shown in Table 1-1 and Table 1-2, respectively. A summary of economic evidence from published cost studies is shown in Table 1-3.

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

Table 1-1 Summary of meta-analyses comparing laparoscopic versus open colorectal surgery					
Authors	**Details**	**Procedures**	**Outcome**	**OR (95% CI)**	**P value**
Wang *et al*. 2014[20]	15 RCTs, n=6,557 patients	Open versus laparoscopic surgery for colorectal cancer	**Peri-operative**		
			Blood loss, mL	−91.06 (−179.66, −2.46)[a]	0.000
			Operating time, minutes	49.34 (29.57, 69.12)[a]	0.000
			Length of incision, cm	−9.23 (−13.77, −4.68)[a]	0.000
			Post-operative		
			Time to first bowel movement, days	−0.95 (−1.18, −0.73)[a]	0.767
			Fluid intake	−0.70 (−1.11, −0.29)[a]	0.042
			Complication rate	0.86 (0.77, 0.97)	0.067
			Blood transfusion	0.46 (0.32, 0.65)	0.026
			30-day mortality	0.58 (0.38, 0.88)	0.996
			Anastomotic leak	0.99 (0.72, 1.34)	0.543
			3-year survival	1.03 (0.97, 1.10)	0.856
			3-year disease-free survival	1.03 (0.95, 1.10)	0.014
			5-year overall survival	1.00 (0.95, 1.05)	0.595
Ma et al. 2011[21]	15 RCTs, n=4,207 patients	Open versus laparoscopic resection for colorectal cancer	**Post-discharge**		
			Overall recurrence	0.92 (0.77, 1.10)	0.34
			Local recurrence	0.81 (0.59, 1.12)	0.20
			Distant metastases	1.01 (0.78, 1.30)	0.95
			Wound-site recurrence	1.97 (0.77, 5.02)	0.15
			Cancer-related mortality at max follow up	0.82 (0.66, 1.02)	0.07
			Overall mortality at max follow up	0.87 (0.73, 1.03)	0.003
			Overall complications	0.71 (0.58, 0.87)	0.001
Ohtani et al. 2011[22]	12 RCTs, 4,458	Open versus laparoscopic surgery for colorectal cancer	**Peri-operative**		
			Operating time, minutes	39.31 (30.72, 47.91)[a]	<0.001
			Estimated blood loss, mL	−133.05 (−201.30, −64.81)[a]	<0.001
			Post-operative		
			Number of transfused patients		0.06
			LoS, days	0.45 (0.19, 1.05)	0.006
			Incision length, cm	−2.80 (−4.78, −0.80)[a]	<0.001
			Time to oral intake, days	−10.97 (−14.37, −7.57)[a]	<0.001
			Overall complication	−1.08 (−1.36, −0.80)[a]	0.12
			Anastomotic leakage	0.83 (0.66, 1.05)	0.73
			Peri-operative mortality	1.07 (0.74, 1.54)	0.25
			Post-discharge	0.69 (0.36, 1.31)	

			Overall recurrence		0.81
			Local recurrence	0.98 (0.84, 1.14)	0.36
			Distant metastasis	0.86 (0.62, 1.19)	0.81
			Wound site recurrence	1.02 (0.84, 1.25)	0.04
			Cancer-related mortality	2.87 (1.08, 7.68)	0.14
			Overall mortality	0.83 (0.65, 1.07)	0.33
				0.93 (0.79, 1.08)	
Kuhry et al. 2008[23]	12 RCTs, 3,346	Open versus laparoscopic surgery for non-metasized colorectal cancer	**Post-operative**		
			Recurrence in operation area, colorectal	0.81 (0.54, 1.22)	0.31
			Port site recurrence, colorectal	1.97 (0.77, 5.02)	0.16
			Distant metastases, colorectal	1.01 (0.76, 1.34)	0.93
			Cancer-related mortality at maximum follow up, colorectal	0.84 (0.67, 1.06)	0.15
			Overall mortality at maximum follow up, colorectal	0.84 (0.70, 1.00)	0.050
Di et al. 2013[24]	5 RCTs, n=2,695 patients	Open versus laparoscopic surgery for colon cancer	Total recurrence	0.94 [0.81, 1.10][b]	0.43
			Total mortality	0.94 [0.82, 1.09][b]	0.87
			5 year tumor-free survival	1.00 [0.94, 1.06][b]	0.54
Ding et al. 2013[25]	12 studies (RCTs and non-randomized), n=1,362 patients	Open versus hand-assisted laparoscopic surgery for colorectal disease	Operating time, minutes	3.51 (−16.47, 23.50)[a]	0.73
			Blood loss, mL	−108.20 (−141.52,	<0.00001
			Incision length, cm	−74.87)[a]	<0.001
			Time to first flatus, days	−8.79 (−13.14, −4.44)[a]	<0.00001
			LoS, days	−0.94 (−1.22, −0.65)[a]	<0.00001
			Urinary tract infection	−3.22 (−3.88, −2.57)[a]	0.43
			Pneumonia	0.58 (0.15, 2.20)	0.16
			Anastomotic leak	0.46 (0.16, 1.35)	0.91
			Wound infection	0.95 (0.40, 2.27)	0.02
			Ileus	0.45 (0.23, 0.87)	0.006
			Mortality	0.35 (0.16, 0.74)	0.54
				0.68 (0.19, 2.36)	

[a]Weighted mean difference (95% CI); negative values favor laparoscopic surgery, positive values favor open surgery
[b]RR (95% CI); for both ORs and RRs, values below 1.00 favor laparoscopic surgery, values above 1.00 favor open surgery

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
Veldkamp *et al.* 2005[26]	Multinational	COLOR RCT n=621 open, n=627 laparoscopic	Elective open versus laparoscopic colectomy for colon cancer[g] (1997–2003)	**Peri-operative**			
				Median time in theatre, minutes	170	202	<0.0001
				Median blood loss, mL	175	100	<0.0001
				Post-operative			
				Mean fluid intake <1L, days	3.8	1.9	<0.0001
				Mean time to first bowel movement, days	4.6	1.7	<0.0001
				Mean LoS, days	9.3	8.2	<0.0001
				All complications	20%	21%	0.88
				Wound infection	3%	4%	0.57
				Anastomotic failure	2%	3%	0.39
				Bowel obstruction >3 days	3%	2%	0.45
				Re-intervention	5%	7%	0.13
				Death	2%	1%	0.45
Jayne *et al.* 2010[27]	United Kingdom	MRC CLASSICC RCT 5-year follow up n=268 open; n=526 laparoscopic	Open versus laparoscopic colectomy for colorectal cancer (1996–2002)	**Post-discharge**			
				5 year OS	58.1%	57.9%	0.848
				DFS	58.6%	55.3%	0.483
				Local recurrence	8.7%	10.8%	0.594
				Distant recurrence	20.6%	21.0%	0.820
				Wound/port site recurrence	65.0%	67.7%	0.547
Fleshman *et al.* 2007[28]	United States and Canada	5 year follow up of the COST RCT, n=428 open; n=435 laparoscopic	Open versus laparoscopic colectomy for colon cancer[d] (1994–2001)	**Post-discharge (5 years)**			
				5 year OS	74.6%	76.4%	0.93
				DFS	68.4%	69.2%	0.94
				Local recurrence rate	2.6%	2.3%	0.79
				Overall recurrence rate	21.8%	19.4%	0.25
Juo *et al.* 2014[29]	United States	US Nationwide Inpatient sample n=126,284 open; n=116,261 laparoscopic; propensity matched	Elective open versus laparoscopic colectomy[a] (2008–2010)	**Post-operative**			
				In hospital mortality	2.0%	0.4%	<0.001
				Complication rate	33.2%	19.8%	<0.001
				Ostomy rate	13.0%	3.5%	<0.001
				Median LoS, days	6	4	<0.001
				Discharge disposition:			
				Routine	68.4%	86.1%	NR
				Transfer to other healthcare facility	21.1%	4.6%	NR
Kang *et al.* 2012[30]	United States	Retrospective analysis using the	Elective open versus	**Post-operative**			
				In-hospital mortality	1.17%	0.49%	NR

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
		National Inpatient Sample, n=71,200 open, n=43,165 laparoscopic and n=7,545 converted	laparoscopic colorectal resection for colon cancer, rectal cancer or diverticulitis	Mean LoS (days)	8	5	NR
				Wound complication	5.8%	2.6%	NR
				Anastomotic leak	13.5%	9.4%	NR
				Pneumonia	2.7%	1.3%	NR
				Ileus or bowel obstruction	4.6%	2.4%	NR
				Urinary retention	2.7%	1.9%	NR
				Respiratory failure	2.5%	1.0%	NR
				Acute renal failure	7.1%	3.9%	NR
				Cardiac complications	2.3%	1.6%	NR
Wilson *et al.* 2014[6]	United States	Retrospective study using National Surgical Quality Improvement Program data, n=21,606 open; n=15,643 laparoscopic	Open versus laparoscopic partial colectomy[h] (2005–2010)	**Post-operative**			
				LoS (days)	8.7	6.4	<0.0001
				Overall complications	29.1%	21.2%	<0.0001
				Superficial SSI	9.0%	5.9%	0.003
				Deep SSI	5.8%	5.4%	0.959
				Deep Vein Thrombosis	1.2%	0.3%	0.001
				Urinary tract infection	3.9%	3.7%	0.122
Steele *et al.* 2008[31]	United States	Retrospective analysis of the Nationwide Inpatient Sample, n=95,627 open, n=3,296 laparoscopic	Elective open versus laparoscopic resection for colon cancer (2003–2004)	**Post-operative**			
				In-hospital complication	22%	18%	<0.001
				In-hospital mortality	1.4%	0.6%	<0.001
				Mean (SD) LoS, days	7.6 (5.1)	6 (6.1)	0.006
Kiran *et al.* 2012[32]	United States	Retrospective analysis of the National Surgical Quality Improvement Program database; n=7,565 open; n=3,414 laparoscopic	Open versus laparoscopic colorectal surgery[e] (2006–2007)	**Peri-operative**			
				Mean operating time, minutes	139	159	0.001
				Operating time <180 minutes	30.8%	39.1%	0.001
				Post-operative			
				Superficial infection	10.3%	6.6%	0.001
				Deep infection	2.4%	1.0%	0.001
				Organ space infection	4.3%	2.4%	0.001
				Wound dehiscence	2.7%	0.85%	0.001

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery

Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
Bilimoria *et al.* 2008[33]	United States	Retrospective analysis of the American College of Surgeons-data 121 hospitals n=2,222 open, n=837 laparoscopic	Elective open versus laparoscopic colectomy for cancer (2005–2006)	**Post-operative**			
				SSI	11.8%	9.1%	0.033
				Pneumonia	3.4%	1.8%	0.022
				Pulmonary embolism	0.8%	0.5%	0.47
				Unplanned intubation	2.5%	1.6%	0.13
				Bleeding requiring transfusion	0.5%	0.7%	0.60
				Sepsis	6.5%	4.7%	0.060
				Return to OR	5.8%	5.5%	0.79
				Post-operative LoS >6 days	49.7%	26.3%	<0.0001
				Mortality	1.8%	1.4%	0.53
Thompson *et al.* 2014[34]	Australia	Retrospective analysis, n=647 open, n=744 laparoscopic	Elective open versus laparoscopic resection for colorectal cancer[k] (2009–2011)	**Peri-operative**			
				Mean (95% CI) operating time, minutes	214 (204–224)	216 (209–224)	0.687
				Post-operative			
				Mean (95% CI) anesthesia duration, minutes	261 (251–272)	260 (252–269)	0.937
				Mean (95% CI) LoS, days	10.3 (9.7–11.0)	9.2 (8.7–9.7)	0.008
				Mean (95% CI) ICU admission, hours	14.7 (10.8–18.7)	7.4 (4.8–10.0)	0.002
Causey *et al.* 2012[35]	United States	Retrospective database analysis of the American College of Surgeons data, n=735 open; n=342 laparoscopic	Open versus laparoscopic colectomy for ulcerative colitis (2005–2008)	**Post-operative**			
				Superficial incisional SSI			
				Partial colectomy	10.6%	8.25%	0.599
				Total abdominal colectomy	6.25%	11.6%	0.151
				End ileostomy	5.71%	14.1%	0.186
				Pouch	7.43%	12.4%	0.11
				Deep incisional SSI			
				Partial colectomy	4.25%	1.83%	0.312
				Organ/space SSI			
				Partial colectomy	6.38%	9.17%	0.538
				Total abdominal colectomy	2.67%	8.33%	0.061
				End ileostomy	14.2%	2.02%	0.005
				Wound disruption			
				Partial colectomy	4.25%	1.37%	0.188
				Total abdominal colectomy	0.89%	2.5%	0.347
				End ileostomy	0	6.06%	0.136

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
				Mortality			
				Partial colectomy			
				Total abdominal colectomy	0	1.37%	0.419
				End ileostomy	0.89%	6.66%	0.023
					0	2.02%	0.397
Moreira *et al.* 2010[36]	United States	Retrospective analysis of a prospectively maintained database, n=231 open and n=231 matched laparoscopic patients with ASA level 3 or 4	Open versus laparoscopic colectomy[l] in patients with ASA classification 3 or 4 (2002–2007)	**Peri-operative**			
				Median (range) estimated blood loss, mL	250 (20–2000)	150 (20–1500)	<0.001
				Median (range) operating time, minutes	150 (60–400)	160 (40–500)	0.09
				Post-operative			
				Median (range) time to first flatus, days	4 (1–35)	3 (1–13)	<0.001
				Median (range) time to first bowel movement, days	5 (1–35)	3 (1–13)	<0.001
				Median (range) LoS, days	7 (3–97)	5 (2–67)	<0.001
				30-day mortality	2.5%	1%	0.3
				Post-operative complication	28%	19%	0.02
				Anastomotic leak	4%	5%	0.6
				Wound infection	10%	4.5%	0.8
Braga *et al.* 2010[37]	Italy	RCT n=134 open, n=134 laparoscopic	Open versus laparoscopic left colonic resection (2000–2004)	**Peri-operative**			
				Mean (SD) operating time, minutes	174 (77)	213 (57)	<0.001
				Mean (SD) operative blood loss, mL	127 (265)	46 (130)	0.002
				Transfused patients	14.9%	8.2%	0.136
				Conversion to open	—	5.2%	
				Post-operative			
				30-day morbidity	20.1%	11.9%	0.094
				Reoperation	6.7%	5.2%	0.881
Day *et al.* 2013[38]	United Kingdom	Retrospective single center data, n=208 open; n=457 laparoscopic	Elective resection for colorectal cancer[m] (2003–2010)	**Post-operative**			
				Median (range) LoS, days	7 (2–43)	4 (1–59)	<0.0005
				Post-discharge			
				5 year OS	72.5%	75.8%	0.12
Vallribera *et al.* 2014[39]	Spain	Retrospective single center chart review, n=268	Open versus laparoscopic colectomy for colonic	**Post-operative**			
				All complications	37.3%	21.6%	0.001
				Medical complications	16.4%	10.5%	0.033
				Wound complications	4.8%	4.7%	0.924

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
		open, n=277 laparoscopic	adenocarcinoma (2005–2009)	Surgical complications	23.5%	15.5%	0.034
				Mortality	6.7%	3.2%	0.034
White *et al.* 2014[40]	United Kingdom	Retrospective analysis of n=207 consecutive patients, n=131 open, n=76 laparoscopic	Open versus laparoscopic restorative portectomy and protocolectomy (2006–2011)	**Post-operative**			
				30-day readmission	12.2%	17%	NR
				30-day re-operation	7.6%	13%	NR
				Ileostomy closure at 6 months	63%	66%	0.772
				Ileostomy closure at 1 year	86.6%	93%	0.173
				Pouch problems	13.2%	11%	0.198
				Pouch failure	11.3%	3%	0.172
				Anastomotic leakage	9.2%	11%	NR
Hardy *et al.* 2014[41]	Canada	Retrospective cohort analysis, n=168 open, n=223 laparoscopic	Elective open versus laparoscopic colon surgery for all indications[j] (2004–2009)	**Peri-operative**			
				Median (IQR) operating time, minutes	196 (152–251)	224 (185–259)	0.001
				Median (IQR) incision to closure time, minutes	133 (95–187)	170 (133–200)	0.001
				Post-operative			
				Median (IQR) LoS, days	7.0 (6.0–11.0)	5.0 (4.0–7.0)	0.000
				In-hospital complication	22.5%	21.6%	0.900
				Admission to ICU	6.0%	5.8%	0.966
				Received blood transfusion	9.7%	5.4%	0.116
				Re-operation	6.5%	5.8%	0.833
				30-day re-admission	12.5%	7.6%	0.122
Orcutt *et al.* 2011[42]	United States	Retrospective database analysis of prospectively collected data, n=243 open, n=75 hand-assisted laparoscopic and 35 laparoscopic assisted	Open versus MIS (laparoscopic-assisted [LA] and hand-assisted laparoscopic [HAL]) for colon cancer (2002–2010)	**Peri-operative**			
				Blood loss, mL	150	50	<0.01
				Surgical time, minutes	168	193 (LA=229; HAL =179)	0.02
				Post-operative			
				Complication rate	49%	36%	0.03
				Wound infection rate	20%	16%	0.38
				Anastomotic leak	5%	2%	0.24
				Days to return of flatus	4	3	<0.01
				Days to return of BM	5	4	<0.01
				LoS, days	8	6	<0.01

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
				Length of ICU stay, days	1	0	<0.01
				90-day readmission rate	22%	13%	0.08
Gervaz *et al.* 2010[43]	Switzerland	RCT, n=54 open, n=113 laparoscopic	Elective open versus laparoscopic sigmoidectomy for diverticulitis	**Peri-operative**			
				Mean (SD) duration of surgery, minutes	118 (28)	168 (37)	<0.001
				Post-operative			
				Mean (SD) maximal pain, VAS	4.5 (1.9)	3.9 (1.8)	0.055
				Mean (SD) duration of ileus (flatus) hours,	53.6 (18)	35.9 (14.2)	<0.001
				Mean (SD) duration of ileus (bowel movement) hours	106.6 (24)	81.4 (31)	<0.001
				Mean (SD) LoS, days	7.9 (2.6)	7.7 (9.7)	<0.001
Agarwal *et al.* 2015[44]	United States	Retrospective, single center case-matched review, n=123 open; n=41 laparoscopic	Open versus laparoscopic colectomy (extended right, extended left and total abdominal) for stage I–III adenocarcinoma of the transverse colon (1996–2009)	**Post-operative**			
				Mean (SD) LoS, days	9.4 (6.3)	6.8 (2.9)	0.02
				Complication rate	29%	24%	0.68
				Mild	50%	44%	
				Moderate	16%	22%	
				Severe	34%	34%	
				Post-discharge			
				5 year survival	59%	61%	0.39
				Stage I	75%	55%	0.80
				Stage II	61%	83%	0.19
				Stage III	35%	58%	0.82
				5 year DFS	82%	88%	0.23
Chen *et al.* 2014[45]	China	Retrospective non-randomized analysis, n=80 open, n=80 laparoscopic-assisted	Open versus laparoscopic surgery for colorectal cancer[i] (2009–2013)	**Peri-operative**			
				Conversion to open	—	1%	—
				Mean (SD) surgical time, minutes	177 (7)	202 (7)	0.015
				Mean (SD) blood loss, mL	221 (37)	97 (10)	0.002
				Mean (SD) incision length, cm	19.9 (0.62)	5.0 (0.18)	<0.001
				Post-operative			
				Mean (SD) time to first flatus, days	3.80 (0.17)	2.34 (0.12)	<0.001
				Mean (SD) time to first BM, days	4.87 (0.18)	3.43 (0.28)	0.009
				Mean (SD) time to resume liquid food, days	4.34 (0.19)	3.66 (0.15)	0.015
				Mean (SD) time to walk independently,	2.22 (0.17)	1.63 (0.11)	0.006
					11.36 (0.67)	9.7 (0.59)	0.007

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
				days			
				Mean (SD) LoS, days			
Prakash *et al.* 2010[46]	India	Retrospective analysis n=62 open and n=62 matched laparoscopic patients	Open versus laparoscopic colorectal resection for cancer in the rectosigmoid region (2006–2008 for laparoscopic; 2003–2005 for open)	**Peri-operative**			
				Conversion to open surgery	—	6.4%	—
				Mean (SD) operation time, minutes	180 (58.3)	296.7 (57.5)	ns
				Mean (SD) blood loss, mL	380 (108)	116 (108)	0.23
				Blood transfusion	38.7%	6.4%	<0.001
				Post-operative			
				Mean (SD) length of ICU stay, hours	79 (37.1)	24.2 (11.8)	<0.05
				Mean (SD) LoS, days	13.8 (5.3)	8.4 (1.04)	<0.05
Odermatt *et al.* 2013[47]	United Kingdom	Retrospective analysis of a prospective database, patients propensity matched, n=72 open, n=36 laparoscopic	Open versus laparoscopic emergency resection[f] for colon cancer (2006–2011)	**Post-operative**			
				30-day mortality	12.5%	8.3%	0.747
				Wound infection	4.2%	16.7%	0.057
				Complication needing re-intervention	8.3%	13.9%	0.668
				Median LoS, days	11.0	7.5	0.019
				Readmission	6.9%	8.3%	1.00
				Post-discharge (3 years)			
				3 year OS	43.2%	51.1%	0.239
				3 year recurrence-free survival	36.6%	34.9%	0.528
Kapritsou *et al.* 2013[48]	Greece	Retrospective study, n= 40 open, n=48 laparoscopic	Open versus laparoscopic colectomy for colorectal cancer (2009–2011)	**Post-operative**			
				Mean (SD) LoS, days	10.28 (8.59)	5.79 (1.61)	0.001
				Complications	42.9%	2.4%	0.000
Marshall *et al.* 2010[49]	United States	Single-center retrospective database analysis, n=17 open, n=33 laparoscopic	Open versus laparoscopic surgery for colon cancer (2009)	**Peri-operative**			
				Median operation time, minutes	291	183	0.008
				Median LoS, days	8	5.5	<0.05
				Median ICU stay, days	1.5	<1	<0.02
Li *et al.* 2015[50]	China	Retrospective single center study of n=25 open and	Open versus hand assisted laparoscopic right	**Peri-operative**			
				Mean (SD) length of incision, cm	16 (2.3)	5.8 (0.7)	<0.05
				Mean (SD) operating time, minutes	142 (20.8)	186.5 (18.4)	<0.05

Table 1-2 Summary of key clinical studies comparing laparoscopic versus open colorectal surgery							
Study	**Setting**	**Study details**	**Procedure (year performed)**	**Summary of clinical findings Endpoint**	**Open**	**Laparoscopic**	**P value**
		n=10 laparoscopic matched patients	hemicolectomy for obstructive right-sided colon cancer (2013)	Mean (SD) blood loss, mL	90 (29.4)	30 (15.2)	<0.05
				Post-operative			
				Mean (SD) time to flatus (days)	5 (1.8)	5 (1.2)	ns
				Mean (SD) LoS, days	9 (3.6)	7 (2.5)	ns

[a]Excluded rectal resection and patients with distant metastases; study also included comparison versus robot-assisted colectomy; only the findings of open versus laparoscopic colectomy are presented here

[b]Excluding previous colonic resection, multiple previous surgeries, severe co-morbid conditions, coagulopathy and metastatic disease

[c]Including anterior resection, high anterior resection, right hemicolectomy, left colonic resection, APER, subtotal colectomy, Hartmann's, right hemicolectomy and anterior resection, and panproctocolectomy

[d]Excluded patients with advanced or systemic cancer

[e]Includes partial colectomy, ileocolic resection, low pelvic anastomosis, Hartmann's procedure, total abdominal colectomy, colectomy/coloprotostomy, TPC/EI

[f]Includes right colectomy, left colectomy, subtotal colectomy and sigmoid colectomy

[g]Includes right hemicolectomy, left hemicolectomy, sigmoid resection and other

[h]Excluded patients undergoing total abdominal colectomy or a procedure involving the rectum

[i]Includes right hemicolectomy, left hemicolectomy, sigmoid colectomy, low anterior resection, abdominoperineal resection and total colectomy

[j]Includes right hemicolectomy, extended right hemicolectomy, ileocecal resection, transverse colectomy, left colectomy, sigmoid colectomy, subtotal colectomy, Hartmann's

[k]Includes right hemicolectomy, transcolectomy, extended right hemicolectomy/total colectomy, left hemicolectomy, sigmoidectomy, high anterior resection, abdominoperineal resection, anterior resection of the rectum, ultralow anterior resection

[l]including right colectomy/ileocecectomy, left colectomy/sigmoidectomy, anterior resection, total abdominal colectomy, abdominoperineal resection, and ileo-pouch anal anastomosis

[m]Including anterior resection (TME), high anterior resection, right hemicolectomy, left colonic resection, APER, subtotal colectomy, Hartmann's, right hemicolectomy and anterior resection, panprotocolectomy

ASA, American Society of Anaesthesiology; BM, bowel movement; DFS, disease-free survival; HAL; hand-assisted laparoscopic; LA, laparoscopic assisted; LoS, length of stay; NR, not reported; ns, not significant; OS, overall survival; RCT, randomized controlled trial; SSI, surgical site infection

Table 1-3 Summary of key studies comparing economic outcomes of laparoscopic versus open colorectal surgery

Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
Hardy *et al.* 2014[41]	Canada	Retrospective cohort analysis, n=168 open, n=223 laparoscopic	Elective open versus laparoscopic colon surgery for all indications (2004–2009)	CAD (2010)	Median (IQR) OR cost	3,456 (2,456–5,089)	4,171 (3,332–5,491)	0.009
					Median (IQR) PACU cost	505 (0–767)	438 (269–602)	0.022
					Median (IQR) ward cost	5,592 (3,972–8,478)	3,224 (2,141–5,391)	0.001
					Median (IQR) total hospital cost	12,721 (9,621–18,790)	9,600 (7,666–13,518)	0.001
Thompson *et al.* 2014[34]	Australia	Retrospective analysis, n=647 open, n=744 laparoscopic	Elective open versus laparoscopic resection for colorectal cancer[a](2009–2011)	EUR (2012)	Mean (95% CI) total cost	22,442 (21,125, 23,719)	20,396 (19,451, 21,286)	0.010
					Mean (95% CI) anesthesia cost	2,155 (2,028, 2,273)	2,424 (2,323, 2,525)	0.001
					Mean (95% CI) imaging cost	134 (108, 161)	168 (130, 208)	0.174
					Mean (95% CI) pathology cost	818 (768, 867)	789 (748, 830)	0.389
					Mean (95% CI) pharmacy cost	229 (164, 295)	154 (122, 187)	0.058
					Mean (95% CI) theatre cost	5,584 (5,386, 5,783)	5,628 (5,445, 5,810)	0.757
Alkhamesi *et al.* 2011[51]	Canada	Retrospective analysis	Elective open versus laparoscopic segmental colectomies (right and left-sided colectomies) (2005–2010)	CAD (year not stated)	**Right colectomy**			
					Bed cost	6,632.8	4,556.1	NR
					OR cost	3,811.9	5,541.9	NR
					Total cost	10,444.7	10,097.9	NR
					Left colectomy			
					Bed cost	5,949.1	3,297.2	NR
					OR cost	5,197.5	7,770.5	NR
					Total cost	11,146.6	11,076.7	NR
Norwood *et al.* 2011[52]	Australia	Analysis of RCT data, n=44 open, n=53 laparoscopic	Open versus laparoscopic surgery for colon cancer (1999–2005)	AUD (year not stated)	Median (range) total cost	9,948 (5,395–90,398)	10,111 (6,505–44,405)	0.65

Table 1-3 Summary of key studies comparing economic outcomes of laparoscopic versus open colorectal surgery								
Study	**Setting**	**Study details**	**Procedures**	**Currency (Cost year)**	**Cost Outcome**	**Open**	**Laparoscopic**	**P value**
Eisenberg *et al.* 2010[53]	United States	Retrospective analysis, n=162 open, n=76 laparoscopic	Elective open versus laparoscopic colon resection (2004–2006)	USD (year not stated)	Total cost with complication	18,296	14,789	NR
					Total cost with no complication	17,686	14,518	NR
Vaid *et al.* 2012[54]	United States	Retrospective cost study using the National Inpatient Sample	Elective open versus laparoscopic colectomy for cancer (right, left or sigmoid)	USD (2008)	Median total cost	43,459	41,971	<0.001
					Median total cost, complicated	62,221	58,388	0.407
					Median total cost, not complicated	39,152	39,017	0.532
Marshall *et al.* 2010[49]	United States	Single-center retrospective database analysis, n=17 open, n=33 laparoscopic	Open versus laparoscopic surgery for colon cancer (2009)	USD (year not stated)	Median overall inpatient cost	18,564	12,500	<0.01
					Median surgical cost	8,709	5,842	<0.05
					Median nursing cost	10,095	5,328	<0.05
					Median laboratory cost	1,703	805	ns
					Median radiology cost	504	0	<0.05
					Median pharmacy cost	2	863	ns
					Median cost, other	2,509	1,459	<0.05
Dowson *et al.* 2012[55]	United Kingdom	Prospective cost study in consecutive patients, n=70 open, n=131 laparoscopic	(2006–2007)	GBP (2006/7)	Mean (SD) hospital costs (all)	2,981 (2,895)	1,712 (1,779)	<0.001
					Mean (SD) total costs (all)	4,382 (2,952)	3,847 (2,002)	0.286
					Mean (SD) total cost right resection	3,602 (1,070)	3,253 (2,299)	0.454
					Mean (SD) total cost left resection	4,702 (4,091)	3,995 (2,212)	0.428
					Mean (SD) total cost rectal resection	4,067 (1,708)	5,114 (2,432)	0.358
					Mean (SD) total cost no stoma	4,307 (3,303)	3,611 (1,876)	0.218
					Mean (SD) total cost with stoma	4,525 (2,321)	5,138 (2,299)	0.413

Table 1-3 Summary of key studies comparing economic outcomes of laparoscopic versus open colorectal surgery								
Study	**Setting**	**Study details**	**Procedures**	**Currency (Cost year)**	**Cost Outcome**	**Open**	**Laparoscopic**	**P value**
Moreira *et al.* 2010[36]	United States	Retrospective analysis of a prospectively maintained database, n=231 open and n=231 matched laparoscopic patients with ASA level 3 or 4	Open versus laparoscopic colectomy in patients with ASA classification 3 or 4 (2002–2007)	USD (year not stated)	Mean anesthesia cost	1,328	1,229	0.3
					Mean pharmacy cost	886	725	<0.001
					Mean medicine therapy cost	643	423	<0.001
					Mean nursing floors cost	2,445	1,687	<0.001
					Mean ICU cost	360	286	0.2
					Mean radiology cost	222	180	0.08
					Mean OR cost	1,725	2,672	<0.001
					Mean other cost	1,870	1,338	<0.01
					Mean total direct cost	8,333	7,523	0.05
Crawshaw *et al.* 2015[56]	United States	Retrospective analysis of a national claims database, n=2,265 open; n=1,895 laparoscopic	Elective open versus laparoscopic colectomy (2010)	USD (2010)	Mean (SD) net payment to hospital	25,470 (19,957)	19,140 (13,523)	<0.001
					Mean (SD) net payment to physician	2,141 (2,160)	2,182 (1,630)	0.49
					Mean (SD) payment to hospital	26,919 (21,928)	19,970 (13,515)	<0.001
					Mean(SD) payment to physician	2,340 (2,243)	2,355 (1,715)	0.80
					Mean (SD) total net payment	29,753 (21,421)	23,064 (14,558)	<0.001
					Mean (SD) total payment	31,601 (23,586)	24,196 (14,507)	<0.001
Kapritsou *et al.* 2013[48]	Greece	Retrospective study, n= 40 open, n=48 laparoscopic	Open versus laparoscopic colectomy for colorectal cancer (2009–2011)	USD	Mean surgical cost	3,617	5,750	0.000
Jensen *et al.* 2012[57]	United States	Cost-effectiveness analysis using decision analytic model	Open versus laparoscopic surgery for colon and rectal cancer	USD (2010)	Total cost	Not stated	4,283 cheaper with laparoscopic	NR

Table 1-3 Summary of key studies comparing economic outcomes of laparoscopic versus open colorectal surgery								
Study	**Setting**	**Study details**	**Procedures**	**Currency (Cost year)**	**Cost Outcome**	**Open**	**Laparoscopic**	**P value**
Kang *et al.* 2012[30]	United States	Retrospective analysis using the National Inpatient Sample, n=71,200 open, n=43,165 laparoscopic and n=7,545 converted	Elective open versus laparoscopic colorectal resection for colon cancer, rectal cancer or diverticulitis	USD (year not stated)	Mean hospital cost	56,977	46,624	NR
Chen *et al.* 2014[45]	China	Retrospective non-randomized analysis, n=80 open, n=80 laparoscopic-assisted	Open versus laparoscopic surgery for colorectal cancer (2009–2013)	RMB (year not stated)	Mean (SD) surgery expenditure, thousands	3.9 (1.1)	8.1 (3.1)	0.003
					Mean (SD) post-surgery costs, thousands	10.8 (6.5)	9.6 (3.7)	0.372
					Mean (SD) total hospitalization costs, thousands	26.9 (7.5)	48.3 (10.7)	<0.001
Steele *et al.* 2008[31]	United States	Retrospective database analysis using the Nationwide Inpatient Sample, n=95,627 open, n=3,296 laparoscopic	Elective open versus laparoscopic resection for colon cancer (2003–2004)	USD (2003/4)	Total hospital charges	34,178	34,685	0.187

[a]Includes right hemicolectomy, transcolectomy, extended right hemicolectomy/total colectomy, left hemicolectomy, sigmoidectomy, high anterior resection, abdominoperineal resection, anterior resection of the rectum, ultralow anterior resection

ICU; intensive care unit; IQR, inter-quartile range; OR, operating room; PACU, post-anesthesia care unit; SD, standard deviation

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