Supplemental Table S1. PICOS criteria for inclusion of systematic review.

Population	Patients with malignant disease
Intervention	Laparoscopic surgery
Comparison	High volume center *versus* low volume center
Outcome	Surgical morbidity, mortality, cost, length of hospital stay, rate of laparotomy conversion, and rate of positive surgical margins
Study design	Retrospective or prospective cohort studies, case-control study, and randomized controlled trials

Abbreviations: PICOS, Patient/Population, Intervention, Comparator, Outcome, Study.

Supplemental Table S2. Summary of included studies evaluating the effect of surgical volume in minimally invasive surgery.

Author	Year	Study period	Area	No.	Robotic	Cancer type	Surgery type
Gynecology (4 studies)							
Matsuo K [1]	2020	2001-2011	USA	4,822	-	Ovarian Ca	Oophorectomy
Matsuo K [2]	2020	2007-2011	USA	2,202	Yes*	Cervical Ca	Radical hysterectomy
Wright JD [3]	2014	2006-2012	USA	10,906	Yes*	EM Ca	Hysterectomy
Wright JD [4]	2012	2000-2010	USA	4,137	-	EM Ca	Hysterectomy
GI tract (9 studies)							
Concors SJ [5]	2019	2010-2015	USA	8,107	Yes	Colorectal Ca	Colectomy
Salfity H [6]	2019	2010-2013	USA	2,371	No	Esophag Ca	Esophagectomy
Gietelink L [7]	2016	2011-2012	NLD	5,161	-	Colorectal Ca	Colectomy
Murata A [8]	2015	2009-2011	JPN	5,941	-	Gastric Ca	Gastrectomy
Zheng Z [9]	2014	2003-2007	USA	4,617	-	Colorectal Ca	Colectomy
Keller DS [10]	2013	2010-2012	USA	1,428	Yes	na	Colectomy
Kuwabara K [11]	2009	2007	JPN	3,765	-	Colorectal Ca	Colectomy
Yasunaga H [12]	2009	2006-2007	JPN	1,212	-	Colorectal Ca	Colectomy
Kuhry E [13]	2005	1997-2003	NLD	627	-	Colorectal Ca	Colectomy
HPB (2 studies)							
Nassour I [14]	2018	2010-2013	USA	1,623	Yes*	Pancreas Ca	PD
Adam MA [15]	2017	2000-2012	USA	865	Yes*	Pancreas Ca	PD
GU (7 studies)							
Xia L [16]	2020	2010-2014	USA	114,957	Yes	Prostate Ca	Radical prostatectomy
Peyronnet B [17]	2018	2009-2015	FRA	1,222	Yes	Renal tumor	Partial nephrectomy
Weiner AB [18]	2015	2010-2011	USA	87,415	Yes*	Prostate Ca	Radical prostatectomy
Monn MF [19]	2014	2009-2011	USA	17,583	Yes	Renal tumor	Partial nephrectomy
Hyams ES [20]	2013	2008-2011	USA	1,489	Yes	na	Radical prostatectomy
Yu HY [21]	2012	2008	USA	2,348	Yes	Prostate Ca	Radical prostatectomy
Budäus L [22]	2011	2005-2008	DEU	2,108	-	Prostate Ca	Radical prostatectomy
Other (1 study)							
Tchouta LN [23]	2017	2008-2013	USA	8,253	Yes	Lung tumor	Lobectomy

* mixed with conventional laparoscopic surgery. Abbreviations: na, not applicable; -, not specified; No., number; GYN, gynecology; HPB, Hepato-Pancreato-Biliary; GI, Gastrointestinal, GU, genitourinary; Ca, cancer; PD, Pancreaticoduodenectomy; DEU, Germany; NLD, Netherlands; FRA, France; JPN, Japan; USA, United States of America; EM, endometrial; and Esophag, Esophageal

Supplemental Table S3. Risk of bias assessment for the comparator study.

Authors	Confounding	Selection	Classification of intervention	Deviations from interventions	Missing data	Measurement of outcomes	Reported results	Overall bias
Matsuo K [1]	●	●	●	●	●	●	●	●
Matsuo K [2]	●	●	●	●	●	●	●	●
Wright JD [3]	●	●	●	●	●	●	●	●
Wright JD [4]	●	●	●	●	●	●	●	●
Concors SJ [5]	●	●	●	●	●	●	●	●
Salfity H [6]	●	●	●	●	●	●	●	●
Gietelink L [7]	●	●	●	●	●	●	●	●
Murata A [8]	●	●	●	●	●	●	●	●
Zheng Z [9]	●	●	●	●	●	●	●	●
Keller DS [10]	●	●	●	●	●	●	●	●
Kuwabara K [11]	●	●	●	●	●	●	●	●
Yasunaga H [12]	●	●	●	●	●	●	●	●
Kuhry E [13]	●	●	●	●	●	●	●	●
Nassour I [14]	●	●	●	●	●	●	●	●
Adam MA [15]	●	●	●	●	●	●	●	●
Xia L [16]	●	●	●	●	●	●	●	●
Peyronnet B [17]	●	●	●	●	●	●	●	●
Weiner AB [18]	●	●	●	●	●	●	●	●
Monn MF [19]	●	●	●	●	●	●	●	●
Hyams ES [20]	●	●	●	●	●	●	●	●
Yu HY [21]	●	●	●	●	●	●	●	●
Budäus L [22]	●	●	●	●	●	●	●	●
Tchouta LN [23]	●	●	●	●	●	●	●	●

Risk of bias assessment was performed using the Risk Of Bias In Non-randomized Studies–of Interventions tool (ROBINS-I) [24–26].

● Low risk of bias (the study is comparable to a well-performed randomized trial with regard to this domain)

● Moderate risk of bias (the study is sound for a non-randomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial)

● Serious risk of bias (the study has some important problems in this domain)

● Critical risk of bias (the study is too problematic in this domain to provide any useful evidence on the effects of intervention.

● No information on how to base a judgment on the risk of bias for this domain.

Supplemental Table S4. Sub-analysis of volume-outcome relationship in minimally invasive surgeries for malignant diseases.

Surgery type	Author	Year	Infection	Re-operation	Hospital stay	Cost for stay	Specific age
Oophorectomy	Matsuo [1]	2020	--	--	--	--	--
PD	Nassour [14]	2018	--	--	--	--	--
	Adam [15]	2017	No	No	Yes	--	--
Radical prostatectomy	Xia [16]	2020	--	--	--	--	--
	Weiner [18]	2015	--	--	--	--	--
	Hyams [20]	2013	--	--	Yes	--	--
	Yu [21]	2012	No‡	--	Yes	--	--
	Budäus [22]	2011	--	--	Yes	--	--
Nephrectomy	Peyronnet [17]	2018	--	--	Yes	--	--
	Monn [19]	2014	--	--	Yes	--	--
Lobectomy	Tchouta [23]	2017	No	--	--	--	--
RH	Matsuo [2]	2020	--	--	--	--	--
Hysterectomy	Wright [3]	2014	--	--	--	--	--
	Wright [4]	2012	No†	--	--	--	--
Colectomy	Concors [5]	2019	--	--	--	--	--
	Gietelink [7]	2016	--	--	--	--	--
	Zheng [9]	2014	--	--	Yes	--	--
	Keller [10]	2013	No‡	--	--	--	--
	Kuwabara [11]	2009	No†	--	Yes	Yes	--
	Yasunaga [12]	2009	--	--	Yes	--	--
	Kuhry [13]	2005	No	--	Yes	--	--
Gastrectomy	Murata [8]	2015	--	--	--	--	--
Esophagectomy	Salfity [6]	2019	--	--	--	--	--

† Abdominal abscess. ‡ Wound infection.

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