Topic Brief: Cost and Effectiveness of Surgical Robots

Date: 01/09/2020
Nomination Number: 0860

Purpose: This document summarizes the information addressing a nomination submitted on 6/5/2019 through the Effective Health Care Website. This information was used to inform the Evidence-based Practice Center (EPC) Program decisions about whether to produce an evidence report on the topic, and if so, what type of evidence report would be most suitable.

Issue: Since the introduction of the Da Vinci robotic surgical system in 2002, indications for use have expanded across several surgical specialties and procedures. For a few procedures, there is a systematic review which reports that the robotic approach offers equivalent or improved short-term clinical outcomes. However, for most procedures and for all long-term outcomes, the evidence is still limited. Additionally, costs have not decreased in the last two decades and cost-benefit analyses are lacking. Health care systems need this information to decide if they should invest over $2 million up-front to attain possible downstream savings and benefits.

Program Decision:

The EPC Program will not develop a new systematic review at this time. While we found enough studies for a new systematic reviews, we found in-process systematic reviews addressed some of the concerns of this nomination. After discussion with the nominator, we decided to wait until the VA ESP reviews were complete to see if they would provide more definitive findings.

Key findings

- Parts of the nomination are duplicative: We found seven recent completed and in-process systematic reviews that cover key parts of the scope of this nomination. No reviews addressed on effectiveness or costs across procedures.
- Most systematic reviews reported low quality evidence for little to no difference in outcomes between procedures; and conclusions across reviews are not consistent. Two systematic reviews are in-process which may provide more definitive findings.
- A new review is feasible. We found 100+ primary studies across the spectrum of procedures of interest to the nominator.
- The value of a new review is uncertain: while the questions and PICOTS were relevant to the nominator, he believed that a guideline based on an AHRQ systematic review would be more useful and accepted by his health system.

Background

- Surgical robotics are designed to allow minimally invasive surgical techniques in more complex cases. For example, traditional hysterectomy surgeries are "open," where the surgeon makes a large (10 cm or more) incision in the abdominal wall to directly see the operating field. In "minimally invasive" laparoscopic surgery, the surgeon makes 2-3 small (1-2 cm) incisions, and has a better view of the field, less blood loss, and the patient has a quicker recovery. The surgeon stands at the bedside and looks at a screen, traditional laparoscopic tools are straight-handled and not flexible, so eye-hand coordination is important. The robotic system builds on the laparoscopic advantage: 3-4 small incisions are used, and surgeon sits at a console (like a video arcade); the instruments move like a human hand, but with increased dexterity and reduced tremor. These allow better dexterity for more complex cases, such as a large uterus, scar tissue, or tumor dissection. However, the system requires expensive equipment, training, and generally longer operating room time.
- There is only one robotic surgical system that is FDA cleared for use in the USA to perform multiple procedures in urologic, gynecologic, general, cardiothoracic, and head and neck surgery: the Da Vinci system (Intuitive Surgical, Sunnyvale, CA). It was first approved in 2000 for adult use in general laparoscopic procedures such as cholecystectomy and Nissan fundoplication. Over time, use has expanded to include adult and pediatric use in urologic, gynecologic laparoscopic, and general non-cardiovascular thoracoscopic surgical procedures. The FDA also cleared the da Vinci System for thoracoscopically assisted cardiotomy procedures, adjunctive mediastinotomy to perform coronary anastomosis during cardiac revascularization. The system has also been used for hiatal hernia repair, mitral valve repair, transoral resection of tongue, thyroidectomy, lung resection and thymectomy.
- There are several emerging robotic surgical systems that have been recently FDA cleared but have little US market share (e.g., Senhance (2017), TransEnterix, Morrisville, NC; Flex Robotic (2018), Medrobotics, Raynham, MA). There are also other robotic systems designed for minimally invasive surgery in areas such as neurosurgery (ROSA brain (2009), Zimmer Bionet, France) and orthopedic surgery (Mako (2015), Styker, Kalamazoo, MI).
- The most commonly performed robotic procedures are hysterectomy (for benign and cancer indications), prostatectomy (for cancer) and several gastrointestinal surgeries. Thus, the surgical specialties most interested in robotics are urology (GU), gynecology (GYN) and general/colorectal specialists. In 2017, the Intuitive Surgical company reported 644,000 procedures, 252,000 in GYN, 246,000 in general surgery, and 118,000 in GU. The annual growth rate is 15% per year. [1]The company reports faster recent growth in general surgery (38% increase), driven by hernia repair, colorectal procedures, and thoracic procedures.
- There are over 2500 DaVinci units in use in the USA as of 2017. For comparison, there are about 6000 short-term acute care hospitals in the US, and about 1100 of these are teaching hospitals. The unit is expensive with a $2-2.5 million purchase price, plus >$100,000 in annual maintenance costs. Costs are not expected to decrease, as the company has a 2-decade monopoly on the technology and several associated patents. Additionally, the system requires extensive training for operators and staff, and (as with many surgeries) patient outcomes seem to be volume dependent. The company reported $1.8 billion in profit in 2017, an 18% increase from 2016. [1]
- Data from the National Inpatient Sample showed that the proportion of robotic cases in GU (radical cystectomy) increased from 0.8% in 2008 to 20.4% in 2013. [2] In GYN, among radical hysterectomy, robotic cases increased from 31% in 2012 to 41% in 2015 [3]
- The effectiveness of robotic surgery over laparoscopic or open surgery is still debated, and depends on the procedure studied. Most reports cite longer operative times. Some cite improved short-term outcomes such as lower blood loss, less pain and shorter hospital stay. Others report that robotic is "as good as" laparoscopic or open surgery.

There is a paucity of quality data: a recent SR found only 27 RCT for any robotic procedure in the last 30 years; most were high or unclear risk of bias. [4]

- Hospitals and health systems need a comprehensive review of both effectiveness and costs to guide efficient use of resources. Due to large volume of single studies, we decided to focus on top three surgical areas by volume, and to exclude non-Da Vinci procedures (i.e., neurologic, orthopedic, etc).

Nomination Summary

- The nominator requests both cost and effectiveness evidence from a systems level, in order to make purchasing decisions at a single hospital.

Scope

1. What are the **comparative effectiveness and harms** of robotic surgery compared to non-robotic surgery for the same gynecology, urology, and gastrointestinal procedure?

    a. For any surgery
    b. By surgical specialty
    c. By specific surgical procedure

2. What are the **costs (and comparative costs)** of robotic surgery compared to non-robotic surgery?
    a. For any surgery
    b. By surgical specialty
    c. By specific surgical procedure

To define the inclusion criteria for the key questions, we specify the population, interventions, comparators, outcomes, timing, setting (PICOTS) of interest (Table 1).

Table 1. Key Questions and PICOTS

Key Questions	1. Comparative effectiveness	2. Comparative costs
Population	Any person undergoing robotic surgery	Any person undergoing robotic surgery
Interventions	Any robotic device-assisted surgery for three high volume areas: gynecology, urology, gastrointestinal	Any robotic device-assisted surgery for three high volume areas: gynecology, urology, gastrointestinal
Comparators	Non-robotic surgery for the same procedure	Non-robotic surgery for the same procedure

Key Questions	1. Comparative effectiveness	2. Comparative costs
Outcomes	Benefits: • Patient o Intraoperative blood loss o conversion rate o LOS o return to normal activities o satisfaction o quality of life • Surgeon / Hospital o operative time o LOS Harms: • Injury • complications • Increased time	Patient level • Operative charges • Non-operative charges • Total costs Hospital/Surgeon level Above plus: • Additional personnel • Training • Equipment (initial) • Annual equipment maintenance Societal • QALY
Timing	Any	Any
Setting	Inpatient or ambulatory surgery center	Inpatient or ambulatory surgery center

Abbreviations: LOS=length of stay; QALY=quality-adjusted life years

Assessment Methods

See Appendix A

Summary of Literature Findings

Twenty-six completed and in-process systematic reviews cover portions of the nomination scope. Of these, three systematic reviews (one completed and two in-process) address effectiveness and cost of GYN, GI and GU procedures (See Appendix C). However findings were not consistent across reviews, or were inconclusive. In many cases the evidence base was limited; only 8 of the 25 reviews included 2 or more studies. Two reviews are in-process which may provide more definitive results. No recent reviews addressed outcomes across the range of procedures within a single review.

We found over 100 RCT and propensity weighted observational studies addressing effectiveness and cost. These covered a dozen specific procedures, the most frequent were hysterectomy, prostatectomy, and colectomy. The cost perspective (patient, payer, system) was varied, and difficult to compare.

For details and references about individual systematic reviews and primary studies see Appendix B and C.

Table 2. Literature identified for each Question

Question	Systematic reviews (01/2017-08/01/2019)	Primary studies (1/2015-9/2019)
Q1: What are the **comparative effectiveness / harms** of robotic surgery	Total: 26 • Cochrane-3 • AHRQ-0 • Other-23 • Published protocols: 7	Total: 103 • RCT:28 • Propensity weighted observational:75 Clinicaltrials.gov • Recruiting: 25
Q 2: What are the **costs** of robotic surgery	Total: 2 • Cochrane- 0 • AHRQ- 0 • Other-2 • Published protocols: 2	Total: 21 • RCT-1 • Propensity weighted observational: 20 Clinicaltrials.gov • Recruiting: 0

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; Q=question; RCT=randomized controlled trial

Summary of Selection Criteria Assessment

While we found duplicative overlapping systematic reviews, findings were either conflicting or inconclusive. We found over 100 primary studies across the range of specialty areas and procedures of interest to the nominator. Although we found enough studies for a systematic review, we note that two in-process systematic reviews by the VA-ESP cover portions of nomination. In addition, the nominator felt that evidence presented within the context of a guideline would be more usable and accepted by his health system.

After discussion with the nominator, we do not recommend a systematic review at this time, pending completion of the ongoing VA ESP systematic reviews to see if they would provide more definitive findings; and exploration of a professional society who might provide guidance based on an AHRQ systematic review.

Please see Appendix B and C for detailed assessments of individual EPC Program selection criteria.

Related Resources

We identified additional information in the course of our assessment that might be useful.

A 2012 systematic review by the Oregon Health and Sciences University informed a coverage decision for the Washington State Health Authority. It is a good quality SR, but is too old. It included many surgeries but did not synthesize across surgeries. It includes cost as a KQ. Based on this assessment, Washington State decided not to provide additional payments for robotic surgery.[6]

Author

Jill Huppert, MD MPH
Christine Chang, MD MPH

Conflict of Interest: None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

Acknowledgements

This report was developed by staff at the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD. The findings and conclusions in this document are those of the author(s) who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. No statement in this article should be construed as an official position of the Agency for Healthcare Research and Quality or of the U.S. Department of Health and Human Services.

Persons using assistive technology may not be able to fully access information in this report. For assistance contact EPC@ahrq.hhs.gov.

References

1. Guthart. Intuitive Surgical, Annual report to NASDEC. Sunnyvale, CA: 2018. http://www.annualreports.com/HostedData/AnnualReportArchive/i/NASDAQ_ISRG_2017.pdf
2. Nazzani S, Mazzone E, Preisser F, et al. Comparison of Perioperative Outcomes Between Open and Robotic Radical Cystectomy: A Population-Based Analysis. Journal of endourology. 2018 Aug;32(8):701-9. doi: 10.1089/end.2018.0313. PMID: 29845866
3. Uppal S, Rebecca Liu J, Kevin Reynolds R, et al. Trends and comparative effectiveness of inpatient radical hysterectomy for cervical cancer in the United States (2012-2015). Gynecologic oncology. 2019 Jan;152(1):133-8. doi: 10.1016/j.ygyno.2018.09.027. PMID: 30424895. https://www.gynecologiconcology-online.net/article/S0090-8258(18)31246-0/pdf
4. Roh HF, Nam SH, Kim JM. Robot-assisted laparoscopic surgery versus conventional laparoscopic surgery in randomized controlled trials: A systematic review and meta-analysis. PloS one. 2018;13(1):e0191628. doi: 10.1371/journal.pone.0191628. PMID: 29360840. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5779699/pdf/pone.0191628.pdf
5. Schroeck FR, Jacobs BL, Bhayani SB, et al. Cost of New Technologies in Prostate Cancer Treatment: Systematic Review of Costs and Cost Effectiveness of Robotic-assisted Laparoscopic Prostatectomy, Intensity-modulated Radiotherapy, and Proton Beam Therapy. European urology. 2017 Nov;72(5):712-35. doi: 10.1016/j.eururo.2017.03.028. PMID: 28366513. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5623181/pdf/nihms862368.pdf
6. Gleitsmann K, Bunker K, Kriz H, et al. Robotic Assisted Surgery. In: Center for Evidence-based Policy OHaSUCfE-bP, Oregon Health & Science University, eds. Health Technology Assessment Program (HTA). Portland, OR 2012.
7. Ilic D, Evans SM, Allan CA, et al. Laparoscopic and robotic-assisted versus open radical prostatectomy for the treatment of localised prostate cancer. Cochrane Database of Systematic Reviews. 2017(9). doi: 10.1002/14651858.CD009625.pub2. PMID: CD009625. https://doi.org//10.1002/14651858.CD009625.pub2
8. Rai BP, Bondad J, Vasdev N, et al. Robotic versus open radical cystectomy for bladder cancer in adults. Cochrane Database of Systematic Reviews. 2019(4). doi: 10.1002/14651858.CD011903.pub2. PMID: CD011903. http://dx.doi.org/10.1002/14651858.CD011903.pub2
9. Lawrie TA, Liu H, Lu D, et al. Robot-assisted surgery in gynaecology. Cochrane Database of Systematic Reviews. 2019(4). doi: 10.1002/14651858.CD011422.pub2. PMID: CD011422. http://dx.doi.org/10.1002/14651858.CD011422.pub2
10. Steffens D, Thanigasalam R, Leslie S, et al. Robotic Surgery in Uro-oncology: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Urology. 2017 Aug;106:9-17. doi: 10.1016/j.urology.2017.03.015. PMID: 28336286. https://www.goldjournal.net/article/S0090-4295(17)30266-2/fulltext

11. Phan K, Kahlaee HR, Kim SH, et al. Laparoscopic vs. robotic rectal cancer surgery and the effect on conversion rates: a meta-analysis of randomized controlled trials and propensity-score-matched studies. Techniques in coloproctology. 2019 Mar;23(3):221-30. doi: 10.1007/s10151-018-1920-0. PMID: 30623315. https://link.springer.com/article/10.1007%2Fs10151-018-1920-0
12. Zhang SS, Ding T, Cui ZH, et al. Efficacy of robotic radical hysterectomy for cervical cancer compared with that of open and laparoscopic surgery: A separate meta-analysis of high-quality studies. Medicine. 2019 Jan;98(4):e14171. doi: 10.1097/md.0000000000014171. PMID: 30681582. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6358398/pdf/medi-98-e14171.pdf
13. Andolfi C, Umanskiy K. Appraisal and Current Considerations of Robotics in Colon and Rectal Surgery. Journal of laparoendoscopic & advanced surgical techniques Part A. 2019 Feb;29(2):152-8. doi: 10.1089/lap.2018.0571. PMID: 30325690
14. Caba Molina D, Lambreton F, Arrangoiz Majul R. Trends in Robotic Pancreaticoduodenectomy and Distal Pancreatectomy. Journal of laparoendoscopic & advanced surgical techniques Part A. 2019 Feb;29(2):147-51. doi: 10.1089/lap.2018.0421. PMID: 30222522
15. Faiena I, Dombrovskiy VY, Modi PK, et al. Regional Cost Variations of Robot-Assisted Radical Prostatectomy Compared With Open Radical Prostatectomy. Clin Genitourin Cancer. 2015 Oct;13(5):447-52. doi: 10.1016/j.clgc.2015.05.004. PMID: 26065923. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5176017/pdf/nihms836074.pdf
16. Fantus RJ, Cohen A, Riedinger CB, et al. Facility-level analysis of robot utilization across disciplines in the National Cancer Database. Journal of robotic surgery. 2019 Apr;13(2):293-9. doi: 10.1007/s11701-018-0855-9. PMID: 30062641. https://link.springer.com/article/10.1007%2Fs11701-018-0855-9
17. Jabaji RB, Fischer H, Kern T, et al. Trend of Surgical Treatment of Localized Renal Cell Carcinoma. The Permanente journal. 2019;23:18-108. doi: 10.7812/tpp/18-108. PMID: 30624203. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6326554/pdf/18-108.pdf
18. Jeong IG, Khandwala YS, Kim JH, et al. Association of Robotic-Assisted vs Laparoscopic Radical Nephrectomy With Perioperative Outcomes and Health Care Costs, 2003 to 2015. Jama. 2017 Oct 24;318(16):1561-8. doi: 10.1001/jama.2017.14586. PMID: 29067427. https://jamanetwork.com/journals/jama/articlepdf/2658321/jama_jeong_2017_oi_170114.pdf
19. Kaminski JP, Bueltmann KW, Rudnicki M. Robotic versus laparoscopic cholecystectomy inpatient analysis: does the end justify the means? Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2014 Dec;18(12):2116-22. doi: 10.1007/s11605-014-2673-3. PMID: 25319034. https://link.springer.com/article/10.1007%2Fs11605-014-2673-3
20. Khorgami Z, Aminian A, Shoar S, et al. Cost of bariatric surgery and factors associated with increased cost: an analysis of national inpatient sample. Surg Obes Relat Dis. 2017 Aug;13(8):1284-9. doi: 10.1016/j.soard.2017.04.010. PMID: 28583812. https://www.soard.org/article/S1550-7289(17)30179-X/fulltext
21. Mikhail E, Sarkar P, Moucharite M, et al. The Association Between Hospital Surgical Volume and the Uptake of Minimally Invasive Surgical Approach and Outpatient Setting for Hysterectomy. Surgical technology international. 2018 Nov 11;33:191-6. PMID: 29985515
22. Piedimonte S, Czuzoj-Shulman N, Gotlieb W, et al. Robotic Radical Hysterectomy for Cervical Cancer: A Population-Based Study of Adoption and Immediate Postoperative Outcomes in the United States. Journal of minimally invasive gynecology. 2019 Mar - Apr;26(3):551-7. doi: 10.1016/j.jmig.2018.08.012. PMID: 30195078. https://www.jmig.org/article/S1553-4650(18)30428-X/fulltext
23. Pohle M, Magheli A, Fischer T, et al. The Effect of Evolving Strategies in the Surgical Management of Organ-Confined Prostate Cancer: Comparison of Data from 2005 to 2014 in a Multicenter Setting. Advances in therapy. 2017 Feb;34(2):576-85. doi: 10.1007/s12325-016-

0469-4. PMID: 28054309.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5331078/pdf/12325_2016_Article_469.pdf
24. Schiffmann J, Haese A, Boehm K, et al. Ten-year experience of robot-assisted radical prostatectomy: the road from cherry-picking to standard procedure. Minerva urologica e nefrologica = The Italian journal of urology and nephrology. 2017 Feb;69(1):69-75. doi: 10.23736/s0393-2249.16.02563-7. PMID: 28009147
25. Zakhari A, Czuzoj-Shulman N, Spence AR, et al. Laparoscopic and robot-assisted hysterectomy for uterine cancer: a comparison of costs and complications. American journal of obstetrics and gynecology. 2015 Nov;213(5):665.e1-7. doi: 10.1016/j.ajog.2015.07.004. PMID: 26188114. https://www.ajog.org/article/S0002-9378(15)00720-6/fulltext
26. Wijk L, Nilsson K, Ljungqvist O. Metabolic and inflammatory responses and subsequent recovery in robotic versus abdominal hysterectomy: A randomised controlled study. Clin Nutr. 2018 Feb;37(1):99-106. doi: 10.1016/j.clnu.2016.12.015. PMID: 28043722.
https://www.ncbi.nlm.nih.gov/pubmed/28043722
https://www.clinicalnutritionjournal.com/article/S0261-5614(16)31356-5/fulltext
27. Silva ESA, de Carvalho JPM, Anton C, et al. Introduction of robotic surgery for endometrial cancer into a Brazilian cancer service: a randomized trial evaluating perioperative clinical outcomes and costs. Clinics (Sao Paulo). 2018 Sep 21;73(suppl 1):e522s. doi: 10.6061/clinics/2017/e522s. PMID: 30281698. https://www.ncbi.nlm.nih.gov/pubmed/30281698
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6131215/pdf/cln-73-522s.pdf
28. Lonnerfors C, Reynisson P, Persson J. A randomized trial comparing vaginal and laparoscopic hysterectomy vs robot-assisted hysterectomy. Journal of minimally invasive gynecology. 2015 Jan;22(1):78-86. doi: 10.1016/j.jmig.2014.07.010. PMID: 25045857.
https://www.ncbi.nlm.nih.gov/pubmed/25045857
https://www.jmig.org/article/S1553-4650(14)00400-2/fulltext
29. Maenpaa MM, Nieminen K, Tomas EI, et al. Robotic-assisted vs traditional laparoscopic surgery for endometrial cancer: a randomized controlled trial. American journal of obstetrics and gynecology. 2016 Nov;215(5):588 e1- e7. doi: 10.1016/j.ajog.2016.06.005. PMID: 27288987.
https://www.ncbi.nlm.nih.gov/pubmed/27288987
https://www.ajog.org/article/S0002-9378(16)30314-3/pdf
30. Salehi S, Avall-Lundqvist E, Legerstam B, et al. Robot-assisted laparoscopy versus laparotomy for infrarenal paraaortic lymphadenectomy in women with high-risk endometrial cancer: A randomised controlled trial. Eur J Cancer. 2017 Jul;79:81-9. doi: 10.1016/j.ejca.2017.03.038. PMID: 28463759. https://www.ncbi.nlm.nih.gov/pubmed/28463759
https://www.ejcancer.com/article/S0959-8049(17)30877-8/fulltext
31. Salehi S, Brandberg Y, Avall-Lundqvist E, et al. Long-term quality of life after comprehensive surgical staging of high-risk endometrial cancer - results from the RASHEC trial. Acta Oncol. 2018 Dec;57(12):1671-6. doi: 10.1080/0284186X.2018.1521987. PMID: 30289327.
https://www.ncbi.nlm.nih.gov/pubmed/30289327
https://www.tandfonline.com/doi/pdf/10.1080/0284186X.2018.1521987?needAccess=true
32. Luo C, Liu M, Li X. Efficacy and safety outcomes of robotic radical hysterectomy in Chinese older women with cervical cancer compared with laparoscopic radical hysterectomy. BMC Womens Health. 2018 May 1;18(1):61. doi: 10.1186/s12905-018-0544-x. PMID: 29716555. https://www.ncbi.nlm.nih.gov/pubmed/29716555
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5930733/pdf/12905_2018_Article_544.pdf
33. Ramirez PT, Frumovitz M, Pareja R, et al. Minimally Invasive versus Abdominal Radical Hysterectomy for Cervical Cancer. N Engl J Med. 2018 Nov 15;379(20):1895-904. doi: 10.1056/NEJMoa1806395. PMID: 30380365. https://www.ncbi.nlm.nih.gov/pubmed/30380365
https://www.nejm.org/doi/full/10.1056/NEJMoa1806395?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed

34. Anand M, Weaver AL, Fruth KM, et al. Perioperative Complications and Cost of Vaginal, Open Abdominal, and Robotic Surgery for Apical Vaginal Vault Prolapse. Female Pelvic Med Reconstr Surg. 2017 Jan/Feb;23(1):27-35. doi: 10.1097/SPV.0000000000000345. PMID: 27682746. https://www.ncbi.nlm.nih.gov/pubmed/27682746
35. Friedman B, Barbash GI, Glied SA, et al. Hospital Revisits Within 30 Days After Conventional and Robotically Assisted Hysterectomy. Med Care. 2016 Mar;54(3):311-8. doi: 10.1097/MLR.0000000000000482. PMID: 26759976.
https://www.ncbi.nlm.nih.gov/pubmed/26759976
36. Nieto VL, Huang Y, Hou JY, et al. Use and outcomes of minimally invasive hysterectomy for women with nonendometrioid endometrial cancers. American journal of obstetrics and gynecology. 2018 Nov;219(5):463 e1- e12. doi: 10.1016/j.ajog.2018.07.028. PMID: 30086293.
https://www.ncbi.nlm.nih.gov/pubmed/30086293
37. Nitschmann CC, Multinu F, Bakkum-Gamez JN, et al. Vaginal vs. robotic hysterectomy for patients with endometrial cancer: A comparison of outcomes and cost of care. Gynecologic oncology. 2017 Jun;145(3):555-61. doi: 10.1016/j.ygyno.2017.03.002. PMID: 28392125.
https://www.ncbi.nlm.nih.gov/pubmed/28392125
38. Paek J, Lee JD, Kong TW, et al. Robotic single-site versus laparoendoscopic single-site hysterectomy: a propensity score matching study. Surgical endoscopy. 2016 Mar;30(3):1043-50. doi: 10.1007/s00464-015-4292-9. PMID: 26092018.
https://www.ncbi.nlm.nih.gov/pubmed/26092018
39. Raspagliesi F, Bogani G, Spinillo A, et al. Introducing nerve-sparing approach during minimally invasive radical hysterectomy for locally-advanced cervical cancer: A multi-institutional experience. European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology. 2017 Nov;43(11):2150-6. doi: 10.1016/j.ejso.2017.08.015. PMID: 28927778.
https://www.ncbi.nlm.nih.gov/pubmed/28927778
40. Schmitt JJ, Occhino JA, Weaver AL, et al. Vaginal versus Robotic Hysterectomy for Commonly Cited Relative Contraindications to Vaginal Hysterectomy. Journal of minimally invasive gynecology. 2017 Nov - Dec;24(7):1158-69. doi: 10.1016/j.jmig.2017.06.026. PMID: 28689682. https://www.ncbi.nlm.nih.gov/pubmed/28689682
41. Wright JD, Burke WM, Tergas AI, et al. Comparative Effectiveness of Minimally Invasive Hysterectomy for Endometrial Cancer. J Clin Oncol. 2016 Apr 1;34(10):1087-96. doi: 10.1200/JCO.2015.65.3212. PMID: 26834057. https://www.ncbi.nlm.nih.gov/pubmed/26834057
42. Kenton K, Mueller ER, Tarney C, et al. One-Year Outcomes After Minimally Invasive Sacrocolpopexy. Female Pelvic Med Reconstr Surg. 2016 Sep-Oct;22(5):382-4. doi: 10.1097/SPV.0000000000000300. PMID: 27403758.
https://www.ncbi.nlm.nih.gov/pubmed/27403758
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5070533/pdf/nihms-821952.pdf
43. Mueller ER, Kenton K, Anger JT, et al. Cosmetic Appearance of Port-site Scars 1 Year After Laparoscopic Versus Robotic Sacrocolpopexy: A Supplementary Study of the ACCESS Clinical Trial. Journal of minimally invasive gynecology. 2016 Sep-Oct;23(6):917-21. doi: 10.1016/j.jmig.2016.05.001. PMID: 27180224. https://www.ncbi.nlm.nih.gov/pubmed/27180224
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5007204/pdf/nihms786413.pdf
44. Soto E, Luu TH, Liu X, et al. Laparoscopy vs. Robotic Surgery for Endometriosis (LAROSE): a multicenter, randomized, controlled trial. Fertil Steril. 2017 Apr;107(4):996-1002 e3. doi: 10.1016/j.fertnstert.2016.12.033. PMID: 28238489.
https://www.ncbi.nlm.nih.gov/pubmed/28238489
https://www.fertstert.org/article/S0015-0282(17)30042-0/pdf
45. Mosbrucker C, Somani A, Dulemba J. Visualization of endometriosis: comparative study of 3-dimensional robotic and 2-dimensional laparoscopic endoscopes. Journal of robotic surgery.

2018 Mar;12(1):59-66. doi: 10.1007/s11701-017-0686-0. PMID: 28255736. https://www.ncbi.nlm.nih.gov/pubmed/28255736 https://link.springer.com/article/10.1007%2Fs11701-017-0686-0
46. Coughlin GD, Yaxley JW, Chambers SK, et al. Robot-assisted laparoscopic prostatectomy versus open radical retropubic prostatectomy: 24-month outcomes from a randomised controlled study. Lancet Oncol. 2018 Aug;19(8):1051-60. doi: 10.1016/S1470-2045(18)30357-7. PMID: 30017351. https://www.ncbi.nlm.nih.gov/pubmed/30017351 https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(18)30357-7/fulltext
47. Porpiglia F, Fiori C, Bertolo R, et al. Five-year Outcomes for a Prospective Randomised Controlled Trial Comparing Laparoscopic and Robot-assisted Radical Prostatectomy. European urology focus. 2018 Jan;4(1):80-6. doi: 10.1016/j.euf.2016.11.007. PMID: 28753822. https://www.ncbi.nlm.nih.gov/pubmed/28753822 https://www.eu-focus.europeanurology.com/article/S2405-4569(16)30165-1/fulltext
48. Yaxley JW, Coughlin GD, Chambers SK, et al. Robot-assisted laparoscopic prostatectomy versus open radical retropubic prostatectomy: early outcomes from a randomised controlled phase 3 study. Lancet. 2016 Sep 10;388(10049):1057-66. doi: 10.1016/S0140-6736(16)30592-X. PMID: 27474375. https://www.ncbi.nlm.nih.gov/pubmed/27474375 https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30592-X/fulltext
49. Capogrosso P, Ventimiglia E, Cazzaniga W, et al. Long-term penile morphometric alterations in patients treated with robot-assisted versus open radical prostatectomy. Andrology. 2018 Jan;6(1):136-41. doi: 10.1111/andr.12446. PMID: 29195014. https://www.ncbi.nlm.nih.gov/pubmed/29195014
50. Garcia-Barreras S, Sanchez-Salas R, Sivaraman A, et al. Comparative Analysis of Partial Gland Ablation and Radical Prostatectomy to Treat Low and Intermediate Risk Prostate Cancer: Oncologic and Functional Outcomes. J Urol. 2018 Jan;199(1):140-6. doi: 10.1016/j.juro.2017.08.076. PMID: 28823768. https://www.ncbi.nlm.nih.gov/pubmed/28823768
51. Hu JC, O'Malley P, Chughtai B, et al. Comparative Effectiveness of Cancer Control and Survival after Robot-Assisted versus Open Radical Prostatectomy. J Urol. 2017 Jan;197(1):115-21. doi: 10.1016/j.juro.2016.09.115. PMID: 27720782. https://www.ncbi.nlm.nih.gov/pubmed/27720782
52. Kim HJ, Choi GS, Park JS, et al. The impact of robotic surgery on quality of life, urinary and sexual function following total mesorectal excision for rectal cancer: a propensity score-matched analysis with laparoscopic surgery. Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland. 2018 May;20(5):O103-O13. doi: 10.1111/codi.14051. PMID: 29460997. https://www.ncbi.nlm.nih.gov/pubmed/29460997
53. Ku JY, Lee CH, Lee JZ, et al. Comparison of functional outcomes between laparoscopic radical prostatectomy and robot-assisted laparoscopic radical prostatectomy: a propensity score-matched comparison study. Asia Pac J Clin Oncol. 2017 Jun;13(3):212-8. doi: 10.1111/ajco.12595. PMID: 27667779. https://www.ncbi.nlm.nih.gov/pubmed/27667779
54. Leow JJ, Chang SL, Meyer CP, et al. Robot-assisted Versus Open Radical Prostatectomy: A Contemporary Analysis of an All-payer Discharge Database. European urology. 2016 Nov;70(5):837-45. doi: 10.1016/j.eururo.2016.01.044. PMID: 26874806. https://www.ncbi.nlm.nih.gov/pubmed/26874806
55. Pearce SM, Pariser JJ, Karrison T, et al. Comparison of Perioperative and Early Oncologic Outcomes between Open and Robotic Assisted Laparoscopic Prostatectomy in a Contemporary Population Based Cohort. J Urol. 2016 Jul;196(1):76-81. doi: 10.1016/j.juro.2016.01.105. PMID: 26860793. https://www.ncbi.nlm.nih.gov/pubmed/26860793
56. Sorokin I, Sundaram V, Singla N, et al. Robot-Assisted Versus Open Simple Prostatectomy for Benign Prostatic Hyperplasia in Large Glands: A Propensity Score-Matched Comparison of Perioperative and Short-Term Outcomes. Journal of endourology. 2017 Nov;31(11):1164-9. doi: 10.1089/end.2017.0489. PMID: 28854815. https://www.ncbi.nlm.nih.gov/pubmed/28854815

57. Yu YD, Lee M, Hong SK, et al. Impact of Variations in Prostatic Apex Shape on Apical Margin Positive Rate After Radical Prostatectomy: Robot-Assisted Laparoscopic Radical Prostatectomy vs Open Radical Prostatectomy. Journal of endourology. 2018 Jan;32(1):46-53. doi: 10.1089/end.2017.0693. PMID: 29212368.
https://www.ncbi.nlm.nih.gov/pubmed/29212368
58. Bochner BH, Dalbagni G, Marzouk KH, et al. Randomized Trial Comparing Open Radical Cystectomy and Robot-assisted Laparoscopic Radical Cystectomy: Oncologic Outcomes. European urology. 2018 Oct;74(4):465-71. doi: 10.1016/j.eururo.2018.04.030. PMID: 29784190.
https://www.ncbi.nlm.nih.gov/pubmed/29784190
https://www.europeanurology.com/article/S0302-2838(18)30336-1/pdf
59. Bochner BH, Dalbagni G, Sjoberg DD, et al. Comparing Open Radical Cystectomy and Robot-assisted Laparoscopic Radical Cystectomy: A Randomized Clinical Trial. European urology. 2015 Jun;67(6):1042-50. doi: 10.1016/j.eururo.2014.11.043. PMID: 25496767.
https://www.ncbi.nlm.nih.gov/pubmed/25496767
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4424172/pdf/nihms656563.pdf
60. Khan MS, Gan C, Ahmed K, et al. A Single-centre Early Phase Randomised Controlled Three-arm Trial of Open, Robotic, and Laparoscopic Radical Cystectomy (CORAL). European urology. 2016 Apr;69(4):613-21. doi: 10.1016/j.eururo.2015.07.038. PMID: 26272237.
https://www.ncbi.nlm.nih.gov/pubmed/26272237
https://www.europeanurology.com/article/S0302-2838(15)00697-1/fulltext
61. Parekh DJ, Reis IM, Castle EP, et al. Robot-assisted radical cystectomy versus open radical cystectomy in patients with bladder cancer (RAZOR): an open-label, randomised, phase 3, non-inferiority trial. Lancet. 2018 Jun 23;391(10139):2525-36. doi: 10.1016/S0140-6736(18)30996-6. PMID: 29976469. https://www.ncbi.nlm.nih.gov/pubmed/29976469
https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)30996-6/fulltext
62. Brassetti A, Moller A, Laurin O, et al. Evolution of cystectomy care over an 11-year period in a high-volume tertiary referral centre. BJU Int. 2018 May;121(5):752-7. doi: 10.1111/bju.14112. PMID: 29281852. https://www.ncbi.nlm.nih.gov/pubmed/29281852
63. Clements MB, Krupski TL, Culp SH. Robotic-Assisted Surgery for Upper Tract Urothelial Carcinoma: A Comparative Survival Analysis. Ann Surg Oncol. 2018 Sep;25(9):2550-62. doi: 10.1245/s10434-018-6557-8. PMID: 29948423.
https://www.ncbi.nlm.nih.gov/pubmed/29948423
64. Hanna N, Leow JJ, Sun M, et al. Comparative effectiveness of robot-assisted vs. open radical cystectomy. Urologic oncology. 2018 Mar;36(3):88 e1- e9. doi: 10.1016/j.urolonc.2017.09.018. PMID: 29277584.
https://www.ncbi.nlm.nih.gov/pubmed/29277584
65. Simone G, Tuderti G, Misuraca L, et al. Perioperative and mid-term oncologic outcomes of robotic assisted radical cystectomy with totally intracorporeal neobladder: Results of a propensity score matched comparison with open cohort from a single-centre series. European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology. 2018 Sep;44(9):1432-8. doi: 10.1016/j.ejso.2018.04.006. PMID: 29699838. https://www.ncbi.nlm.nih.gov/pubmed/29699838
66. Tan WS, Tan MY, Lamb BW, et al. Intracorporeal robot-assisted radical cystectomy, together with an enhanced recovery programme, improves postoperative outcomes by aggregating marginal gains. BJU Int. 2018 Apr;121(4):632-9. doi: 10.1111/bju.14073. PMID: 29124853. https://www.ncbi.nlm.nih.gov/pubmed/29124853
67. Borghesi M, Schiavina R, Chessa F, et al. Retroperitoneal Robot-Assisted Versus Open Partial Nephrectomy for cT1 Renal Tumors: A Matched-Pair Comparison of Perioperative and Early Oncological Outcomes. Clin Genitourin Cancer. 2018 Apr;16(2):e391-e6. doi: 10.1016/j.clgc.2017.09.010. PMID: 29074284. https://www.ncbi.nlm.nih.gov/pubmed/29074284

68. Golombos DM, Chughtai B, Trinh QD, et al. Adoption of Technology and Its Impact on Nephrectomy Outcomes, a U.S. Population-Based Analysis (2008-2012). Journal of endourology. 2017 Jan;31(1):91-9. doi: 10.1089/end.2016.0643. PMID: 27809567. https://www.ncbi.nlm.nih.gov/pubmed/27809567
69. Golombos DM, Chughtai B, Trinh QD, et al. Minimally invasive vs open nephrectomy in the modern era: does approach matter? World J Urol. 2017 Oct;35(10):1557-68. doi: 10.1007/s00345-017-2040-6. PMID: 28477204. https://www.ncbi.nlm.nih.gov/pubmed/28477204
70. Jin SJ, Park JY, Kim DH, et al. Comparison of postoperative pain between laparoscopic and robot-assisted partial nephrectomies for renal tumors: A propensity score matching analysis. Medicine. 2017 Jul;96(29):e7581. doi: 10.1097/MD.0000000000007581. PMID: 28723795. https://www.ncbi.nlm.nih.gov/pubmed/28723795
71. Kim JH, Park YH, Kim YJ, et al. Perioperative and long-term renal functional outcomes of robotic versus laparoscopic partial nephrectomy: a multicenter matched-pair comparison. World J Urol. 2015 Oct;33(10):1579-84. doi: 10.1007/s00345-015-1488-5. PMID: 25585500. https://www.ncbi.nlm.nih.gov/pubmed/25585500
72. Lee C, Kwon T, Yoo S, et al. Comparison of Renal Function between Robot-Assisted and Open Partial Nephrectomy as Determined by Tc 99m-DTPA Renal Scintigraphy. J Korean Med Sci. 2016 May;31(5):743-9. doi: 10.3346/jkms.2016.31.5.743. PMID: 27134496. https://www.ncbi.nlm.nih.gov/pubmed/27134496
73. Tachibana H, Takagi T, Kondo T, et al. Robot-assisted laparoscopic partial nephrectomy versus laparoscopic partial nephrectomy: A propensity score-matched comparative analysis of surgical outcomes and preserved renal parenchymal volume. Int J Urol. 2018 Apr;25(4):359-64. doi: 10.1111/iju.13529. PMID: 29397572. https://www.ncbi.nlm.nih.gov/pubmed/29397572
74. Wu Z, Li M, Song S, et al. Propensity-score matched analysis comparing robot-assisted with laparoscopic partial nephrectomy. BJU Int. 2015 Mar;115(3):437-45. doi: 10.1111/bju.12774. PMID: 24731125. https://www.ncbi.nlm.nih.gov/pubmed/24731125
75. Zhao X, Lu Q, Campi R, et al. Endoscopic Robot-assisted Simple Enucleation Versus Laparoscopic Simple Enucleation With Single-layer Renorrhaphy in Localized Renal Tumors: A Propensity Score-matched Analysis From a High-volume Centre. Urology. 2018 Nov;121:97-103. doi: 10.1016/j.urology.2018.08.015. PMID: 30170093. https://www.ncbi.nlm.nih.gov/pubmed/30170093
76. Bagante F, Spolverato G, Strasberg SM, et al. Minimally Invasive vs. Open Hepatectomy: a Comparative Analysis of the National Surgical Quality Improvement Program Database. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2016 Sep;20(9):1608-17. doi: 10.1007/s11605-016-3202-3. PMID: 27412321. https://www.ncbi.nlm.nih.gov/pubmed/27412321
77. Jayne D, Pigazzi A, Marshall H, et al. Effect of Robotic-Assisted vs Conventional Laparoscopic Surgery on Risk of Conversion to Open Laparotomy Among Patients Undergoing Resection for Rectal Cancer: The ROLARR Randomized Clinical Trial. JAMA. 2017 Oct 24;318(16):1569-80. doi: 10.1001/jama.2017.7219. PMID: 29067426. https://www.ncbi.nlm.nih.gov/pubmed/29067426 https://jamanetwork.com/journals/jama/articlepdf/2658320/jama_jayne_2017_oi_170064.pdf
78. Kim MJ, Park SC, Park JW, et al. Robot-assisted Versus Laparoscopic Surgery for Rectal Cancer: A Phase II Open Label Prospective Randomized Controlled Trial. Ann Surg. 2018 Feb;267(2):243-51. doi: 10.1097/SLA.0000000000002321. PMID: 28549014. https://www.ncbi.nlm.nih.gov/pubmed/28549014
79. Tolstrup R, Funder JA, Lundbech L, et al. Perioperative pain after robot-assisted versus laparoscopic rectal resection. International journal of colorectal disease. 2018 Mar;33(3):285-9. doi: 10.1007/s00384-017-2943-0. PMID: 29242972. https://www.ncbi.nlm.nih.gov/pubmed/29242972

https://link.springer.com/article/10.1007%2Fs00384-017-2943-0
80. Corrigan N, Marshall H, Croft J, et al. Exploring and adjusting for potential learning effects in ROLARR: a randomised controlled trial comparing robotic-assisted vs. standard laparoscopic surgery for rectal cancer resection. Trials. 2018 Jun 27;19(1):339. doi: 10.1186/s13063-018-2726-0. PMID: 29945673. https://www.ncbi.nlm.nih.gov/pubmed/29945673
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6020359/pdf/13063_2018_Article_2726.pdf
81. Ackerman SJ, Daniel S, Baik R, et al. Comparison of complication and conversion rates between robotic-assisted and laparoscopic rectal resection for rectal cancer: which patients and providers could benefit most from robotic-assisted surgery? J Med Econ. 2018 Mar;21(3):254-61. doi: 10.1080/13696998.2017.1396994. PMID: 29065737.
https://www.ncbi.nlm.nih.gov/pubmed/29065737
82. Al-Mazrou AM, Baser O, Kiran RP. Propensity Score-Matched Analysis of Clinical and Financial Outcomes After Robotic and Laparoscopic Colorectal Resection. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2018 Jun;22(6):1043-51. doi: 10.1007/s11605-018-3699-8. PMID: 29404985.
https://www.ncbi.nlm.nih.gov/pubmed/29404985
83. Al-Mazrou AM, Chiuzan C, Kiran RP. The robotic approach significantly reduces length of stay after colectomy: a propensity score-matched analysis. International journal of colorectal disease. 2017 Oct;32(10):1415-21. doi: 10.1007/s00384-017-2845-1. PMID: 28685223.
https://www.ncbi.nlm.nih.gov/pubmed/28685223
84. Altieri MS, Yang J, Telem DA, et al. Robotic approaches may offer benefit in colorectal procedures, more controversial in other areas: a review of 168,248 cases. Surgical endoscopy. 2016 Mar;30(3):925-33. doi: 10.1007/s00464-015-4327-2. PMID: 26139489.
https://www.ncbi.nlm.nih.gov/pubmed/26139489
85. Bhama AR, Obias V, Welch KB, et al. A comparison of laparoscopic and robotic colorectal surgery outcomes using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. Surgical endoscopy. 2016 Apr;30(4):1576-84. doi: 10.1007/s00464-015-4381-9. PMID: 26169638.
https://www.ncbi.nlm.nih.gov/pubmed/26169638
86. Chen ST, Wu MC, Hsu TC, et al. Comparison of outcome and cost among open, laparoscopic, and robotic surgical treatments for rectal cancer: A propensity score matched analysis of nationwide inpatient sample data. J Surg Oncol. 2018 Mar;117(3):497-505. doi: 10.1002/jso.24867. PMID: 29284067. https://www.ncbi.nlm.nih.gov/pubmed/29284067
87. Cho MS, Baek SJ, Hur H, et al. Short and long-term outcomes of robotic versus laparoscopic total mesorectal excision for rectal cancer: a case-matched retrospective study. Medicine. 2015 Mar;94(11):e522. doi: 10.1097/MD.0000000000000522. PMID: 25789947.
https://www.ncbi.nlm.nih.gov/pubmed/25789947
88. de'Angelis N, Abdalla S, Bianchi G, et al. Robotic Versus Laparoscopic Colorectal Cancer Surgery in Elderly Patients: A Propensity Score Match Analysis. Journal of laparoendoscopic & advanced surgical techniques Part A. 2018 Nov;28(11):1334-45. doi: 10.1089/lap.2018.0115. PMID: 29851362. https://www.ncbi.nlm.nih.gov/pubmed/29851362
89. Ezekian B, Sun Z, Adam MA, et al. Robotic-Assisted Versus Laparoscopic Colectomy Results in Increased Operative Time Without Improved Perioperative Outcomes. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2016 Aug;20(8):1503-10. doi: 10.1007/s11605-016-3124-0. PMID: 26966028.
https://www.ncbi.nlm.nih.gov/pubmed/26966028
90. Harr JN, Haskins IN, Amdur RL, et al. The effect of obesity on laparoscopic and robotic-assisted colorectal surgery outcomes: an ACS-NSQIP database analysis. Journal of robotic surgery. 2018 Jun;12(2):317-23. doi: 10.1007/s11701-017-0736-7. PMID: 28900886.
https://www.ncbi.nlm.nih.gov/pubmed/28900886

91. Ishihara S, Kiyomatsu T, Kawai K, et al. The short-term outcomes of robotic sphincter-preserving surgery for rectal cancer: comparison with open and laparoscopic surgery using a propensity score analysis. International journal of colorectal disease. 2018 Aug;33(8):1047-55. doi: 10.1007/s00384-018-3056-0. PMID: 29687373. https://www.ncbi.nlm.nih.gov/pubmed/29687373
92. Kim CW, Baik SH, Roh YH, et al. Cost-effectiveness of robotic surgery for rectal cancer focusing on short-term outcomes: a propensity score-matching analysis. Medicine. 2015 Jun;94(22):e823. doi: 10.1097/MD.0000000000000823. PMID: 26039115. https://www.ncbi.nlm.nih.gov/pubmed/26039115
93. Kim J, Baek SJ, Kang DW, et al. Robotic Resection is a Good Prognostic Factor in Rectal Cancer Compared with Laparoscopic Resection: Long-term Survival Analysis Using Propensity Score Matching. Dis Colon Rectum. 2017 Mar;60(3):266-73. doi: 10.1097/DCR.0000000000000770. PMID: 28177988. https://www.ncbi.nlm.nih.gov/pubmed/28177988
94. Kulaylat AS, Mirkin KA, Puleo FJ, et al. Robotic versus standard laparoscopic elective colectomy: where are the benefits? J Surg Res. 2018 Apr;224:72-8. doi: 10.1016/j.jss.2017.11.059. PMID: 29506855. https://www.ncbi.nlm.nih.gov/pubmed/29506855
95. Lee YF, Albright J, Akram WM, et al. Unplanned Robotic-Assisted Conversion-to-Open Colorectal Surgery is Associated with Adverse Outcomes. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2018 Jun;22(6):1059-67. doi: 10.1007/s11605-018-3706-0. PMID: 29450825. https://www.ncbi.nlm.nih.gov/pubmed/29450825
96. Midura EF, Hanseman DJ, Hoehn RS, et al. The effect of surgical approach on short-term oncologic outcomes in rectal cancer surgery. Surgery. 2015 Aug;158(2):453-9. doi: 10.1016/j.surg.2015.02.020. PMID: 25999253. https://www.ncbi.nlm.nih.gov/pubmed/25999253
97. Panteleimonitis S, Pickering O, Abbas H, et al. Robotic rectal cancer surgery in obese patients may lead to better short-term outcomes when compared to laparoscopy: a comparative propensity scored match study. International journal of colorectal disease. 2018 Aug;33(8):1079-86. doi: 10.1007/s00384-018-3030-x. PMID: 29577170. https://www.ncbi.nlm.nih.gov/pubmed/29577170
98. Park JS, Kim NK, Kim SH, et al. Multicentre study of robotic intersphincteric resection for low rectal cancer. Br J Surg. 2015 Nov;102(12):1567-73. doi: 10.1002/bjs.9914. PMID: 26312601. https://www.ncbi.nlm.nih.gov/pubmed/26312601
99. Raskin ER, Keller DS, Gorrepati ML, et al. Propensity-Matched Analysis of Sigmoidectomies for Diverticular Disease. JSLS. 2019 Jan-Mar;23(1). doi: 10.4293/JSLS.2018.00073. PMID: 30675092. https://www.ncbi.nlm.nih.gov/pubmed/30675092
100. Sawada H, Egi H, Hattori M, et al. Initial experiences of robotic versus conventional laparoscopic surgery for colorectal cancer, focusing on short-term outcomes: a matched case-control study. World journal of surgical oncology. 2015 Mar 12;13:103. doi: 10.1186/s12957-015-0517-6. PMID: 25885046. https://www.ncbi.nlm.nih.gov/pubmed/25885046
101. Speicher PJ, Englum BR, Ganapathi AM, et al. Robotic Low Anterior Resection for Rectal Cancer: A National Perspective on Short-term Oncologic Outcomes. Ann Surg. 2015 Dec;262(6):1040-5. doi: 10.1097/SLA.0000000000001017. PMID: 25405559. https://www.ncbi.nlm.nih.gov/pubmed/25405559
102. Tam MS, Kaoutzanis C, Mullard AJ, et al. A population-based study comparing laparoscopic and robotic outcomes in colorectal surgery. Surgical endoscopy. 2016 Feb;30(2):455-63. doi: 10.1007/s00464-015-4218-6. PMID: 25894448. https://www.ncbi.nlm.nih.gov/pubmed/25894448
103. Yeo HL, Abelson JS, Mao J, et al. Minimally invasive surgery and sphincter preservation in rectal cancer. J Surg Res. 2016 May 15;202(2):299-307. doi: 10.1016/j.jss.2016.01.010. PMID: 27229104. https://www.ncbi.nlm.nih.gov/pubmed/27229104

104. Kudsi OY, Castellanos A, Kaza S, et al. Cosmesis, patient satisfaction, and quality of life after da Vinci Single-Site cholecystectomy and multiport laparoscopic cholecystectomy: short-term results from a prospective, multicenter, randomized, controlled trial. Surgical endoscopy. 2017 Aug;31(8):3242-50. doi: 10.1007/s00464-016-5353-4. PMID: 27864724. https://www.ncbi.nlm.nih.gov/pubmed/27864724 https://link.springer.com/article/10.1007%2Fs00464-016-5353-4
105. Pietrabissa A, Pugliese L, Vinci A, et al. Short-term outcomes of single-site robotic cholecystectomy versus four-port laparoscopic cholecystectomy: a prospective, randomized, double-blind trial. Surgical endoscopy. 2016 Jul;30(7):3089-97. doi: 10.1007/s00464-015-4601-3. PMID: 26497946. https://www.ncbi.nlm.nih.gov/pubmed/26497946 https://link.springer.com/article/10.1007%2Fs00464-015-4601-3
106. Makela-Kaikkonen JK, Rautio TT, Koivurova S, et al. Anatomical and functional changes to the pelvic floor after robotic versus laparoscopic ventral rectopexy: a randomised study. International urogynecology journal. 2016 Dec;27(12):1837-45. doi: 10.1007/s00192-016-3048-y. PMID: 27250828. https://www.ncbi.nlm.nih.gov/pubmed/27250828 https://link.springer.com/article/10.1007%2Fs00192-016-3048-y
107. Makela-Kaikkonen J, Rautio T, Paakko E, et al. Robot-assisted vs laparoscopic ventral rectopexy for external or internal rectal prolapse and enterocele: a randomized controlled trial. Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland. 2016 Oct;18(10):1010-5. doi: 10.1111/codi.13309. PMID: 26919191. https://www.ncbi.nlm.nih.gov/pubmed/26919191 https://onlinelibrary.wiley.com/doi/abs/10.1111/codi.13309
108. Wang G, Jiang Z, Zhao J, et al. Assessing the safety and efficacy of full robotic gastrectomy with intracorporeal robot-sewn anastomosis for gastric cancer: A randomized clinical trial. J Surg Oncol. 2016 Mar;113(4):397-404. doi: 10.1002/jso.24146. PMID: 27100025. https://www.ncbi.nlm.nih.gov/pubmed/27100025 https://onlinelibrary.wiley.com/doi/abs/10.1002/jso.24146
109. Adair MJ, Alharthi S, Ortiz J, et al. Robotic Surgery Is More Expensive with Similar Outcomes in Sleeve Gastrectomy: Analysis of the NIS Database. Am Surg. 2019 Jan 1;85(1):39-45. PMID: 30760343. https://www.ncbi.nlm.nih.gov/pubmed/30760343
110. Celio AC, Kasten KR, Schwoerer A, et al. Perioperative safety of laparoscopic versus robotic gastric bypass: a propensity matched analysis of early experience. Surg Obes Relat Dis. 2017 Nov;13(11):1847-52. doi: 10.1016/j.soard.2017.07.016. PMID: 28844577. https://www.ncbi.nlm.nih.gov/pubmed/28844577
111. Li J, Xi H, Cui J, et al. Minimally invasive surgery as a treatment option for gastric cancer with liver metastasis: a comparison with open surgery. Surgical endoscopy. 2018 Mar;32(3):1422-33. doi: 10.1007/s00464-017-5826-0. PMID: 29075971. https://www.ncbi.nlm.nih.gov/pubmed/29075971
112. Obama K, Kim YM, Kang DR, et al. Long-term oncologic outcomes of robotic gastrectomy for gastric cancer compared with laparoscopic gastrectomy. Gastric Cancer. 2018 Mar;21(2):285-95. doi: 10.1007/s10120-017-0740-7. PMID: 28639136. https://www.ncbi.nlm.nih.gov/pubmed/28639136
113. Parisi A, Reim D, Borghi F, et al. Minimally invasive surgery for gastric cancer: A comparison between robotic, laparoscopic and open surgery. World journal of gastroenterology. 2017 Apr 7;23(13):2376-84. doi: 10.3748/wjg.v23.i13.2376. PMID: 28428717. https://www.ncbi.nlm.nih.gov/pubmed/28428717
114. Sharma G, Strong AT, Tu C, et al. Robotic platform for gastric bypass is associated with more resource utilization: an analysis of MBSAQIP dataset. Surg Obes Relat Dis. 2018 Mar;14(3):304-10. doi: 10.1016/j.soard.2017.11.018. PMID: 29276076. https://www.ncbi.nlm.nih.gov/pubmed/29276076

115. Carbonell AM, Warren JA, Prabhu AS, et al. Reducing Length of Stay Using a Robotic-assisted Approach for Retromuscular Ventral Hernia Repair: A Comparative Analysis From the Americas Hernia Society Quality Collaborative. Ann Surg. 2018 Feb;267(2):210-7. doi: 10.1097/SLA.0000000000002244. PMID: 28350568.
https://www.ncbi.nlm.nih.gov/pubmed/28350568
116. Gamagami R, Dickens E, Gonzalez A, et al. Open versus robotic-assisted transabdominal preperitoneal (R-TAPP) inguinal hernia repair: a multicenter matched analysis of clinical outcomes. Hernia. 2018 Oct;22(5):827-36. doi: 10.1007/s10029-018-1769-1. PMID: 29700716.
https://www.ncbi.nlm.nih.gov/pubmed/29700716
117. Kolachalam R, Dickens E, D'Amico L, et al. Early outcomes of robotic-assisted inguinal hernia repair in obese patients: a multi-institutional, retrospective study. Surgical endoscopy. 2018 Jan;32(1):229-35. doi: 10.1007/s00464-017-5665-z. PMID: 28646321.
https://www.ncbi.nlm.nih.gov/pubmed/28646321
118. Ielpo B, Caruso R, Duran H, et al. Robotic versus standard open pancreatectomy: a propensity score-matched analysis comparison. Updates Surg. 2019 Mar;71(1):137-44. doi: 10.1007/s13304-018-0529-1. PMID: 29582359.
https://www.ncbi.nlm.nih.gov/pubmed/29582359
119. Kim HS, Han Y, Kang JS, et al. Comparison of surgical outcomes between open and robot-assisted minimally invasive pancreaticoduodenectomy. J Hepatobiliary Pancreat Sci. 2018 Feb;25(2):142-9. doi: 10.1002/jhbp.522. PMID: 29117639.
https://www.ncbi.nlm.nih.gov/pubmed/29117639
120. Liu R, Liu Q, Zhao ZM, et al. Robotic versus laparoscopic distal pancreatectomy: A propensity score-matched study. J Surg Oncol. 2017 Sep;116(4):461-9. doi: 10.1002/jso.24676. PMID: 28628713. https://www.ncbi.nlm.nih.gov/pubmed/28628713
121. McMillan MT, Zureikat AH, Hogg ME, et al. A Propensity Score-Matched Analysis of Robotic vs Open Pancreatoduodenectomy on Incidence of Pancreatic Fistula. JAMA Surg. 2017 Apr 1;152(4):327-35. doi: 10.1001/jamasurg.2016.4755. PMID: 28030724.
https://www.ncbi.nlm.nih.gov/pubmed/28030724
122. Qu L, Zhiming Z, Xianglong T, et al. Short- and mid-term outcomes of robotic versus laparoscopic distal pancreatosplenectomy for pancreatic ductal adenocarcinoma: A retrospective propensity score-matched study. International journal of surgery (London, England). 2018 Jul;55:81-6. doi: 10.1016/j.ijsu.2018.05.024. PMID: 29802919.
https://www.ncbi.nlm.nih.gov/pubmed/29802919
123. Tian F, Hong XF, Wu WM, et al. Propensity score-matched analysis of robotic versus open surgical enucleation for small pancreatic neuroendocrine tumours. Br J Surg. 2016 Sep;103(10):1358-64. doi: 10.1002/bjs.10220. PMID: 27480993.
https://www.ncbi.nlm.nih.gov/pubmed/27480993

Appendix A: Methods

We assessed nomination for priority for a systematic review or other AHRQ Effective Health Care report with a hierarchical process using established selection criteria. Assessment of each criteria determined the need to evaluate the next one. See Appendix B for detailed description of the criteria.

Appropriateness and Importance

We assessed the nomination for appropriateness and importance.

Desirability of New Review/Absence of Duplication

We searched for high-quality, completed or in-process evidence reviews published in between **01/01/2017 and 8/6/2019** on the questions of the nomination from these sources:

- AHRQ: Evidence reports and technology assessments
  - EHC Program https://effectivehealthcare.ahrq.gov/
  - AHRQ Technology Assessment Program https://www.ahrq.gov/research/findings/ta/index.html
- US Department of Veterans Affairs Products publications
  - Evidence Synthesis Program https://www.hsrd.research.va.gov/publications/esp/
  - VA/Department of Defense Evidence-Based Clinical Practice Guideline Program https://www.healthquality.va.gov/
- Cochrane Systematic Reviews https://www.cochranelibrary.com/
- PROSPERO Database (international prospective register of systematic reviews and protocols) http://www.crd.york.ac.uk/prospero/
- PubMed https://www.ncbi.nlm.nih.gov/pubmed/

Impact of a New Evidence Review

The impact of a new evidence review was qualitatively assessed by analyzing the current standard of care, the existence of potential knowledge gaps, and practice variation. We considered whether it was possible for this review to influence the current state of practice through various dissemination pathways (practice recommendation, clinical guidelines, etc.).

Feasibility of New Evidence Review

We conducted a limited literature search in PubMed from the last five years **(8/12/2014 to 8/12/2019)** on parts of the nomination scope with the greatest potential for yield. This included three targeted areas: GYN, GU and GI procedures). We reviewed all identified titles and abstracts for inclusion and removed articles pertaining to other procedures (thoracotomy, thymectomy, etc), comparisons within robotic procedures, or to training the surgeon. We classified identified studies by question and study design to estimate the size and scope of a potential evidence review.

Search strategy

Search (((((((((robot*[Title/Abstract]) AND surgery[Title/Abstract] AND Clinical Trial[ptyp] AND "last 5 years"[PDat] AND Humans[Mesh] AND English[lang])) NOT limb) AND Clinical Trial[ptyp] AND "last 5 years"[PDat] AND Humans[Mesh] AND English[lang])) NOT arthro*) AND Clinical Trial[ptyp] AND "last 5 years"[PDat] AND Humans[Mesh] AND English[lang])) AND random*[Title/Abstract] Filters: Clinical Trial; published in the last 5 years; Humans; English 127

Search (((robot*[Title/Abstract]) AND surgery[Title/Abstract])) AND propensity Filters: published in the last 5 years; Humans; English

Clinical Trials: 1/1/2015 to 9/1/2019; robotic + davinci
https://clinicaltrials.gov/ct2/results?cond=&term=davinci&intr=robotic&strd_s=01%2F10%2F2015&strd_e=09%2F01%2F2019&cntry=&state=&city=&dist=&Search=Search&flds=aby

Value

We assessed the nomination for value. We considered whether or not the clinical, consumer, or policymaking context had the potential to respond with evidence-based change; and if a partner organization would use this evidence review to influence practice.

Appendix B. Selection Criteria Assessment

Selection Criteria	Assessment
Appropriateness	
1a. Does the nomination represent a health care drug, intervention, device, technology, or health care system/setting available (or soon to be available) in the U.S.?	Yes. The Da Vinci system is used in ~ 2500 hospitals in the USA. Use is growing despite unclear benefits.
1b. Is the nomination a request for an evidence report?	Yes.
1c. Is the focus on effectiveness or comparative effectiveness?	Yes. The nominator also wants to see comparative costs.
1d. Is the nomination focus supported by a logic model or biologic plausibility? Is it consistent or coherent with what is known about the topic?	NA
Importance	
2a. Represents a significant disease burden; large proportion of the population	The volume of robotic procedures is increasing each year. The company markets to physicians and direct to consumer, which may be driving uptake. • The most commonly performed robotic procedures are hysterectomy (for benign and cancer indications), prostatectomy (for cancer) and several gastrointestinal surgeries. Thus, the surgical specialties most interested in robotics are urology (GU), gynecology (GYN) and general/colorectal specialists. In 2017, the Intuitive Surgical company reported 644,000 procedures, 252,000 in GYN, 246,000 in general surgery, and 118,000 in GU. The annual growth rate is 15% per year. [1]The company reports faster recent growth in general surgery (38% increase), driven by hernia repair, colorectal procedures, and thoracic procedures. • Data from the National Inpatient Sample showed that the proportion of robotic cases in GU (radical cystectomy) increased from 0.8% in 2008 to 20.4% in 2013. [2] In GYN, among radical hysterectomy, robotic cases increased from 31% in 2012 to 41% in 2015 [3]
2b. Is of high public interest; affects health care decision making, outcomes, or costs for a large proportion of the US population or for a vulnerable population	Yes. Health systems and patients need information on which to base decision-making.
2c. Incorporates issues around both clinical benefits and potential clinical harms	Yes. Short term data on clinical outcomes suggests that robotic surgery may offer some advantages but long term (especially cancer survival) data is lacking, and RCTs are few. • The effectiveness of robotic surgery over laparoscopic or open surgery is still debated, and depends on the procedure studied. Most reports cite longer operative times. Some cite improved short-term outcomes such as lower blood loss, less pain and shorter hospital stay. Others report that robotic is “as good as” laparoscopic or open surgery. There is a paucity of quality data: a recent SR found only 27 RCT for any robotic procedure in the last 30 years; most were high or unclear risk of bias. [4]

Selection Criteria	Assessment
2d. Represents high costs due to common use, high unit costs, or high associated costs to consumers, to patients, to health care systems, or to payers	Yes. The Da Vinci device costs $2 million, plus substantial annual maintenance costs, training and additional personnel. • There are over 2500 DaVinci units in use in the USA as of 2017. For comparison, there are about 6000 short-term acute care hospitals in the US, and about 1100 of these are teaching hospitals. The unit is expensive with a $2-2.5 million purchase price, plus >$100,000 in annual maintenance costs. Costs are not expected to decrease, as the company has a 2-decade monopoly on the technology and several associated patents. Additionally, the system requires extensive training for operators and staff, and (as with many surgeries) patient outcomes seem to be volume dependent. The company reported $1.8 billion in profit in 2017, an 18% increase from 2016. [1]
Desirability of a New Evidence Review/Absence of Duplication	

3. A recent high-quality systematic review or other evidence review is not available on this topic	A new review that specifically addresses both costs and effectiveness across procedures (from a health systems perspective) would duplicate several existing reviews. We highlight here selected systematic reviews. However findings are not consistent across reviews or were inconclusive; the information is scattered across many reviews; and no recent reviews addressed outcomes across the range of procedures within a single review. One high-quality review covers the entire scope of the nomination, but the search date is too old. • *Roh 2018* [4] (27 RCTs) This review may be too outdated for decisionmaking**.** *Results: Conventional laparoscopic surgery (LS) shows significant advantages in total operative time, net operative time, total complication rate, and* ***operative cost*** *(p< 0.05 in all cases), whereas the estimated blood loss was less in Robotic LS (p< 0.05). As subgroup analyses, conversion rate on colectomy and length of hospital stay on hysterectomy statistically favors Robotic LS (p< 0.05). Conventional laparoscopic surgery (LS) shows significant advantages in operative cost (p < 0.05 in all cases) over Robotic LS.* One recent good quality review and two planned VA reviews cover costs and effectiveness by surgical specialty (KQ 1b and 2b) for the high volume da Vinci procedures. Two VA protocols plan to assess effectiveness of GU and GI procedures. [Personal communication from VA EPC, 8/12/2019] • A Cochrane review assesses effectiveness of GYN procedures [Lawrie 2019]. [9] (12 RCTs). *Results: Evidence on the effectiveness and safety of Robotic LS compared with conventional LS for non-malignant disease (hysterectomy and sacrocolpopexy) is of low certainty but suggests that surgical complication rates might be comparable. Evidence on the effectiveness and safety of Robotic LS compared with conventional LS or open surgery for malignant disease is more uncertain because survival data are lacking. Robotic LS is an operator-dependent expensive technology; therefore evaluating the safety of this technology independently will present challenges. This SR was unable to synthesize cost results since only 2 studies included costs as an outcome*. Three Cochrane reviews cover KQ 1c on effectiveness and harms for specific procedures: • Radical Prostatectomy (RP) [Ilic][7]: (2 RCTs). *Ilic 2017 results: There is no high-quality evidence to inform the comparative effectiveness of laparoscopic RP or robotic RP compared to open RP for oncological outcomes. Urinary and sexual quality of life-related outcomes appear similar. Overall and serious postoperative complication rates appear similar. The difference in postoperative pain may be minimal. Men undergoing laparoscopic RP or robotic RP may have a shorter hospital stay and receive fewer blood transfusions. All available outcome data were short-term, and this study was unable to account for surgeon volume or experience.* • Cystectomy for bladder cancer [Rai]: [8] (5 RCTs). *Rai 2019 results: Robotic cystectomy and open cystectomy may have similar outcomes with regard to time to recurrence, rates of major complications, quality of life, and positive margin rates (all low-certainty evidence). We are very uncertain whether the robotic approach reduces rates of minor complications (very low-certainty evidence), although it probably reduces the risk of blood transfusions substantially (moderate-certainty evidence) and may reduce hospital stay slightly (low-certainty evidence).* • Hysterectomy and sacrolpopexy [Lawrie 2019] Other reviews for KQ1 (fair to good quality) • GU (prostate and bladder cancer surgeries). [10] [Steffens 2019] Results: *Robotic surgery is comparable with laparoscopic or open surgery for oncological outcomes and overall complications, and has mixed effects on functional outcomes when compared with laparoscopic and open surgery.*

Selection Criteria	Assessment
	• Rectal surgery *[Phan 2019]: [11]This review focused on a single outcome. Robotic surgery for rectal cancer is associated with reduced conversion to open surgery compared to a laparoscopic approach.* • Radical Hysterectomy (RH) [Zhang 2019] [12] *Compared with open RH, patients with robotic RH had less estimated blood loss (EBL), a lower transfusion rate, and shorter length of stay (LOS) (all P < .01). There was no significant difference between robotic RH and laparoscopic RH with respect to the operation time, intraoperative or postoperative complications, retrieved lymph nodes, and tumor recurrence.* Other review for KQ2: costs Radical Prostatectomy (RP) [Schroek 2017] [5] *Results: Robotic RP is costlier than open radical retropubic prostatectomy for hospitals and payers. However, robotic RP has the potential for a moderate cost advantage for payers and society over a longer time horizon **when** optimal cancer and quality-of-life outcomes are achieved. The 37 studies comparing the cost of robotic RP to open RP were all observational with moderate or high risk of bias. The overall quality of the evidence is low.* **See Appendix C** for details
Impact of a New Evidence Review	
4a. Is the standard of care unclear (guidelines not available or guidelines inconsistent, indicating an information gap that may be addressed by a new evidence review)?	To our knowledge, guidelines are not available.
4b. Is there practice variation (guideline inconsistent with current practice, indicating a potential implementation gap and not best addressed by a new evidence review)?	We expect there is practice variation, as access to robotic surgery instruments is not universal.
Primary Research	

5. Effectively utilizes existing research and knowledge by considering:
- Adequacy (type and volume) of research for conducting a systematic review
- Newly available evidence (particularly for updates or new technologies)

A new systematic review is feasible.

We found 28 RCT and 73 cohort studies reporting propensity matching. We performed a separate search for robotic AND cost AND (NIS or HCUP) which yielded 14 studies.[3,13-25] Details are provided in Table 3 below. This suggests that although the literature may have expanded slightly, there are few studies of costs, and the most commonly reported procedures (GYN and GU) are already covered by recent good quality systematic reviews. We found no primary studies that were designed to evaluate a systems perspective, or examine outcomes across surgeries (KQ1a, KQ2a).

Table 3: Feasibility: number of citations found

Area	Procedure	RCT (n=28)	Propensity (n=73)	Number that include costs (RCT or propensity)
GYN	hysterectomy	8[26-33]	8[34-41]	5
	sacrocolpopexy	2[42, 43]	1[34]	1
	endometriosis procedures	2[44, 45]	0	0
GU	Prostatectomy	3[46-48]	9[49-57]	2
	Radical Cystectomy for Bladder CA	4[58-61]	5[62-66]	1
	nephrectomy	0	11[63, 67-76]	2
General/GI	Colectomy for Rectal cancer	4[77-80]	24[52, 81-103]	8
	Cholecystectomy	2[104, 105]	0	0
	Rectal prolapse procedures	2 [106, 107]	0	0
	Gastrectomy/ gastric bypass	1[108]	6[109-114]	1
	Hernia repair	0	3[115-117]	1
	Pancreatectomy	0	6 [118-123]	0

Table 4: Clinical trials related to GYN, GU and general/GI procedures (number reported in last 5 years; all have no results listed)

Topic	Total	USA	Non-USA
GYN	2	0	2 NCT03861195 NCT03633786
GU	2	0	2 NCT03849820 NCT02933398
General/GI: Colectomy	9	1 NCT03700593	8 NCT04013152 NCT03696472 NCT03589131 NCT02673177 NCT03574493 NCT02642978 NCT02817126 NCT03931980
General/GI: Hernia repair	4	4 NCT03283982 NCT03490266 NCT02684448 NCT04074200	0

Selection Criteria	Assessment				
	General/GI: Resection of gastric tumors	7	0	7 NCT03727126 NCT03447106 NCT03804762 NCT03931044 NCT02413476 NCT02751086 NCT03612830	
Value					
6a. The proposed topic exists within a clinical, consumer, or policy-making context that is amenable to evidence-based change	The uptake of robotic surgery seems to be increasing rapidly, despite low quality evidence to direct its use. This increase may be driven by direct marketing, competition, and enthusiasm for novelty. It is unclear if balanced scientific evidence could change this trend.				
6b. Identified partner who will use the systematic review to influence practice (such as a guideline or recommendation)	The nominator is an individual considering purchasing a DaVinci system for his hospital. However he feels that a guideline based on an AHRQ SR would be more acceptable and useful by his health system.				

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; EBL= estimated blood loss; EPC=evidence-based practice center; GI=gastrointestinal; GYN=gynecology; GU= genitourinary; HCUP= Healthcare Cost and Utilization Project; LOS= length of stay; LS-laparoscopic surgery; National Inpatient Sample; obs= observational study; RH=radical hysterectomy; RP=radical prostatectomy; VA= Veterans Affairs; RCT= randomized controlled trial; NIS= National Inpatient Sample

Appendix C: Further details on recent systematic reviews and published protocols

Recent Systematic Reviews:

Source	Procedure	Outcomes	Quality	Search end	# of studies
AHRQ: 0					
Cochrane: 3					
GYN Lawrie 2019 [9]	Hysterectomy, sacrocolpopexy, endometriosis procedures	complications, conversion, EBL, OR time, QoL (unable to assess costs)	Good	Jan 2018	12 RCT
GU Ilic 2017[7]	Prostatectomy	complications, pain, EBL, LOS, sexual/urinary QoL	Good	June 2017	2 RCT
GU Rai 2019[8]	Cystectomy for Bladder cancer	complications, pain, EBL, LOS, +margins, survival	Good	July 2018	5 RCT
Other: 4					
Steffens 2017[10]	Prostatectomy Cystectomy for Bladder cancer	complications, pain, EBL, OR Time, LOS, +margins, survival	Good	Aug 2016	RCT (4 prostate, 4 bladder)
Roh 2018[4]	GI, GU, GYN	Costs	Good	Dec 2016	27 RCT
Zhang 2019[12]	Radical Hyst (cervical cancer)	complications, pain, EBL, LOS, +margins, survival, OR time	Fair	Feb 2018	12 obs studies with low RoB
Phan 2019[11]	GI Colectomy (Rectal cancer)	Conversion to open case	Fair	Missing full text	5 RCT , analyzed separately from 6 propensity matched obs studies

Abbreviations: EBL= estimated blood loss; EPC=evidence-based practice center; GI=gastrointestinal; GYN=gynecology ; GU= genitourinary; LOS= length of stay; obs= observational study; OR=operating room; RCT= randomized controlled trial; QoL=Quality of Life;

Published systematic review protocols **(as of 8/21/2019)**

Year	Topic	Title
2019-DONE 8/2019 embargoed for journal-end 2019 to early 2020	GU	**Robotic-assisted Surgery in Partial Nephrectomy and Cystectomy** VA: PROSPERO CRD 42019127413 • KQ1A: What is the clinical effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for cystectomy? • KQ1B: What is the cost effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for cystectomy? • KQ2A: What is the clinical effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for partial nephrectomy? • KQ2B: What is the cost effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for partial nephrectomy?
2019	GI	**Robot-assisted General Surgery (protocol under development)** VA- expect completion Feb 2020 • KQ1: What is the clinical effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for adults undergoing colectomy, cholecystectomy, or hernia repair? • KQ2: What is the cost-effectiveness of robotic-assisted surgery compared to open surgery or conventional laparoscopic surgery for adults undergoing colectomy, cholecystectomy, or hernia repair?
2019	GYN	A systematic review on the clinical effectiveness, cost effectiveness and safety of surgical interventions for the treatment of pelvic organ prolapse PROSPERO CRD42019138687
2019	GYN	Quality of life in patients who undergo conventional or robotic-assisted total laparoscopic hysterectomy: Protocol for a systematic review of randomized controlled trials. Medicine (Baltimore), 98: e15974. PMID: 31169730.
2018	GI	Robotic gastrectomy versus laparoscopic gastrectomy for gastric cancer: meta-analyses and trial sequential analyses of 8010 patients from observational studies. PROSPERO CRD42018089637
2018	GI	Right hemicolectomy: a network meta-analysis comparing the open, laparoscopic, hand-assisted laparoscopic, and robotic approach PROSPERO CRD42018091308

Abbreviations: GI=gastrointestinal; GYN=gynecology; GU= genitourinary; VA=Veterans Affairs