Evidence Table
Guideline for Minimally Invasive Surgery
December 15, 2016

REFERENCE #	CITATION	CONCLUSION(S)	CONSENSUS SCORE	EVIDENCE TYPE	POPULATION	INTERVENTIONS	COMPARISON	SAMPLE SIZE	OUTCOME MEASURE
1	Guideline for processing flexible endoscopes. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:675-758.	This guideline provides best practice for processing flexible endoscopes.	IVA	Guideline	N/A	N/A	N/A	N/A	N/A
2	Guideline for cleaning and care of surgical instruments. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:773-808.	This guideline provides best practice for cleaning and care of surgical instruments	IVB	Guideline	N/A	N/A	N/A	N/A	N/A
3	Guideline for a safe environment of care, part 2. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:263-288.	This guideline provides guidance for the design of the building structure; movement of patients, personnel, supplies and equipment through the suite; safety during construction; environmental controls; maintenance of structural surfaces; power failure response planning; security and control of noise and distractions.	IVB	Guideline	N/A	N/A	N/A	N/A	N/A
4	Guideline for surgical smoke safety. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:e77-e106.	This guideline provides guidance for the safe evacuation of surgical smoke.	IVA	Guideline	N/A	N/A	N/A	N/A	N/A
5	Guideline for prevention of unplanned patient hypothermia. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:531-554.	This guideline provides evidence for prevention of unplanned hypothermia in regards to fluid warming.	IVA	Guideline	N/A	N/A	N/A	N/A	N/A
6	Guideline for a safe environment of care, part 1. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:237-262.	This guideline provides information about fire safety, electrical equipment, medical gas cylinders, blanket and solution warming cabinets.	IVB	Guideline	N/A	N/A	N/A	N/A	N/A
7	Guideline for positioning the patient. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:649-668.	This guideline provides best practice for positioning the patient in perioperative practice	IVB	Guideline	N/A	N/A	N/A	N/A	N/A
8	Guideline for safe use of energy-generating devices. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:e49-e76.	This guideline provides best practice for use of energy-generating devices in surgery.	IVA	Guideline	N/A	N/A	N/A	N/A	N/A
9	Samii A, Gerganov VM. The dedicated endoscopic operating room. World Neurosurg. 2013;79(2 Suppl):S15. e19-e22.	A dedicated endoscopic OR should provide workflow optimization, ergonomic solutions, and highest safety standards for the patient. The flexible setup should allow use of the dedicated endoscopic OR for various pathologies by different surgeons to optimize the cost-effectiveness. Modular organization with flexible platforms for integration of novel technologies in the future appears to be the optimal solution.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A

10	Sabnis R, Ganesamoni R, Mishra S, Sinha L, Desai MR. Concept and design engineering: endourology operating room. Curr Opin Urol. 2013;23(2):152-157.	A dedicated endourology operating room is required for any hospital, which has a significant amount of endourology procedures. A custom-made integrated endourology operating room will facilitate endourology procedures, smoothen the workflow in operating room and improve patient outcomes. Meticulous planning and involving experts in the field are critical for the success of the project.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
11	Persoon MC, Broos HJ, Witjes JA, Hendrikx AJ, Scherpbier AJ. The effect of distractions in the operating room during endourological procedures. Surg Endosc. 2011;25(2):437-443.	Distracting events occur frequently in the OR. Equipment problems and communication, the latter both procedure-related and medically irrelevant, have the largest impact on the sterile team and regularly interrupt procedures. Distracting stimuli can influence performance negatively and should therefore be minimized. Further research is required to determine the direct effect of distraction on patient safety. This study was conducted in one facility with observations of 4 urologists and 3 residents from January to July 2009.	VA	Organizational experience	N/A	N/A	N/A	N/A	N/A
12	Koninckx PR, Stepanian A, Adamyan L, Ussia A, Donnez J, Wattiez A. The digital operating room and the surgeon. Gynecol Surg. 2013;10(1):57-62.	Review of literature did not show much evidence on the safety and quality improvement for the use of digital OR technologies. The author reviewed the different aspects of the DOR such as image routing, video distribution of images from one OR to the outside world and discussed the use of intelligence to further enhance the safety and patient outcomes. Table 1 outlines what a digital OR can bring to the surgeon.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
13	Strong VE, Forde KA, MacFadyen BV, et al. Ethical considerations regarding the implementation of new technologies and techniques in surgery. Surg Endosc. 2014;28(8):2272-2276.	The authors described creating a New Technologies committee composed of representation from hospital administration, physician and nursing leadership to review ethical considerations for implementation of new technologies and new techniques in surgery. This committee would review new devices and procedures, approve the introduction of new devices into the health care system, provide uniform credentialing standards, review early outcomes all in an effort to improve quality.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A

14	Choi SD. A review of the ergonomic issues in the laparoscopic operating room. J Healthc Eng. 2012;3(4):587-603.	Ergonomic factors for laparoscopic surgery. OR staff encounter physical stress and mental strain beyond those in open surgery. MIS procedures with it's increasing dependency on technology creates physical, sensorial and cognitive ergonomic problems for OR personnel. Items listed that create ergonomic challenges are OR table, position of monitor, hand held instruments, hand force, foot pedals, cognitive challenges (lack of direct viewing of surgical field and interpretation of camera angle to images on video monitor), equipment carts.	IIB	Literature review	N/A	N/A	N/A	N/A	N/A
15	Stavroulis A, Cutner A, Liao L-M. Staff perceptions of the effects of an integrated laparoscopic theatre environment on teamwork. Gynecol Surg. 2013;10(3):177-180.	The theatre team members had high satisfaction scores in the integrated theatre environment. They felt that it resulted in greater efficiency, better teamwork and reduced stress levels.	IIIB	Non-experimental survey	9 consultants, 9 theatre nurses and 9 trainees.	N/A	Visual analog score were used to compare integrated vs. non-integrated theatre	27 theatre staff	Satisfaction with staff safety, patient safety and efficiency
16	Tjiam IM, Goossens RH, Schout BM, et al. Ergonomics in endourology and laparoscopy: an overview of musculoskeletal problems in urology. J Endourol. 2014;28(5):605-611.	This study aims to provide an overview of type and frequency of musculoskeletal complaints among urologists. In addition, the urologists' knowledge about ergonomic conditions during minimally invasive urology was assessed, and they were asked how they would prefer to gain knowledge about this topic. High prevalence of experienced musculoskeletal complaints was found among urologists predominantly related to endourology and laparoscopy. Urologists indicate that they have a lack of knowledge about ergonomics in the operating room. Hence, we recommend integration of ergonomics in hands-on training programs early in the residency curriculum to gain knowledge and awareness and hopefully to offer possibilities to prevent these complaints in the future.	IIIA	Non-experimental survey	Urologists from different countries, mainly from Europe, performing endourology and laparoscopy.	N/A	N/A	285	Musculoskeletal complaints

17	Murad FM, Banerjee S, Barth BA, et al. Image management systems. Gastrointest Endosc. 2014;79(1):15-22.	The review featured information about image quality, storage and retrieval systems, ease of use, and safety considerations. The authors recommended that hospitals assess for the compatibility , the type of image capture (e.g., SD vs HD), and integration with electronic medical record systems and centralized storage and archiving systems when purchasing an image management system.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A
18	Rockstroh M, Franke S, Neumuth T. Requirements for the structured recording of surgical device data in the digital operating room. Int J Comput Assist Radiol Surg. 2014;9(1):49-57.	The authors developed a prototype that was able to store the generated data correctly, completely and quickly enough even when more data than expected was entered to the system. Medical devices usually have proprietary interfaces and can be a challenge to manage and store the data when multiple vendors are present within a system. The surgical data recorder prototype allows the data to be stored in one location for easier retrieval for intraoperative analysis and postoperative analysis.	IIIC	Non-experimental	Workflow recordings of 40 real brain tumor removals	N/A	N/A	40	N/A
19	45 CFR 162 Subpart F—Standard Unique Employer Identifier. 2016. US Government Publishing Office. http://www.ecfr.gov/cgi-bin/text-idx?SID=cae9c2c6e308e3d431bcaaf2c5a1207a&mc=true&node=sp45.1.162.f&rgn=div6. Accessed October 26, 2016.	Health Insurance Portability and Accountability Act (HIPAA), sets the legal requirements for protecting sensitive patient data. Any company that deals with protected health information (PHI) must ensure that all the required physical, network, and process security measures are in place and followed.	R	Regulatory	N/A	N/A	N/A	N/A	N/A
20	45 CFR 160 Subpart C—Compliance and Investigations. 2016. US Government Publishing Office. http://www.ecfr.gov/cgi-bin/text-idx?SID=60c2bd4a007fc0d54110ea2f89d6dab9&mc=true&node=pt45.1.160&rgn=div5#sp45.1.160.c. Accessed October 26, 2016.	HIPAA	R	Regulatory	N/A	N/A	N/A	N/A	N/A
21	45 CFR 162 Subpart D—Standard Unique Health Identifier for Health Care Providers. 2016. US Government Publishing Office. http://www.ecfr.gov/cgi-bin/text-idx?SID=60c2bd4a007fc0d54110ea2f89d6dab9&mc=true&node=pt45.1.162&rgn=div5#sp45.1.162.d. Accessed October 26, 2016.	HIPAA	R	Regulatory	N/A	N/A	N/A	N/A	N/A

22	Anderson SM, Kapp BB, Angell JM, et al. Remote monitoring and supervision of urology residents utilizing integrated endourology suites—a prospective study of patients' opinions. J Endourol. 2013;27(1):96-100.	A report on integrated endourology suites (IES), remote monitoring and supervision (RMS) of urology residents and to evaluate patients' opinions, acceptance, and satisfaction level with IES and RMS. RMS in IES is highly acceptable to patients undergoing endoscopic procedures. RMS has the potential to positively impact residency training, efficiency, regulatory compliance, safety, and productivity. They concluded that this could be a positive impact of residency training, efficiency, regulatory compliance and safety.	IIIC	Qualitative	Patients undergoing flexible cystoscopy in the IES with RMS.	N/A	N/A	100	N/A
23	Santomauro M, Reina GA, Stroup SP, L'Esperance JO. Telementoring in robotic surgery. Curr Opin Urol. 2013;23(2):141-145.	MIS represents one of the most important breakthroughs in medicine over the past few decades. Newcomers to MIS need the guidance of more experienced, 'high volume' mentors to achieve the superior outcomes promised by MIS over conventional techniques. Telementoring, a subset of telemedicine, allows a surgeon at a remote site to offer intraoperative guidance via telecommunication networks. MIS lends itself well to telementoring techniques for several reasons; the primary surgeon performing MIS is working off of video images of the surgical field or images sent to a console. As such, the mentor is seeing the exact same images as the primary surgeon. In this review, we highlight many of the latest technologies in telemedicine, which are applicable to MIS and provide an overview of the pitfalls, which need to be overcome to make telementoring (and eventually telesurgery) a standard tool in the MIS arsenal.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
24	Haidegger T, Sándor J, Benyó Z. Surgery in space: the future of robotic telesurgery. Surg Endosc. 2011;25(3):681-690.	Surgical robotic technology is an emerging interdisciplinary field, with a great potential impact on many areas of health care, including telemedicine. With the proposed three-layered concept—relying only on currently available technology—effective support of long-distance telesurgery and human space missions are both feasible.	VB	Literature review	N/A	N/A	N/A	N/A	N/A

25	Nalugo M, Craner DR, Schwachter M, Ponsky TA. What is “telemedicine” and what does it mean for a pediatric surgeon? Eur J Pediatr Surg. 2014;24(4):295-302.	Telemedicine is a broad term and has recently become a household term in the medical field.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
26	Buzink SN, van Lier L, de Hingh IHJT, Jakimowicz JJ. Risk-sensitive events during laparoscopic cholecystectomy: the influence of the integrated operating room and a preoperative checklist tool. Surg Endosc. 2010;24(8):1990-1995.	This study was designed to investigate the influence of the integrated OR system and Pro/cheQ, a digital checklist tool, on the number and type of equipment- and instrument- related risk-sensitive events (RSE) during laparoscopic cholecystectomies. Using both an integrated OR and Pro/cheQ has a stronger reducing effect on the number of RSE than using an integrated OR alone. The Pro/cheQ tool supported the optimal workflow in a natural way and raised the general safety awareness amongst all members of the surgical team. For tools such as integrated OR systems and checklists to succeed it is pivotal not to underestimate the value of the implementation process. To further improve safety and quality of surgery, a multifaceted approach should be followed, focusing on the performance and competence of the surgical team as a whole.	IIB	Quasi-experimental	Laparoscopic cholecystectomies	Pro/CheQ checklist		45	Risk-sensitive events
27	Nocco U, del Torchio S. The integrated OR: efficiency and effectiveness evaluation after two years use, a pilot study. Int J Comput Assist Radiol Surg. 2011;6(2):175-186.	Results show that there is a deep appreciation of the system which proved to be efficient (reducing surgery time and enhancing surgical quality) and effective. This is a pilot study based on few collected data, but the questionnaire could be handed to many hospitals where integrated ORs are present, in order to achieve a significant degree of assessment and find common topics to be considered fundamental especially in the evaluating phase.	VA	Organizational experience	N/A	N/A	N/A	N/A	N/A

28	Schmitz PM, Gollnick I, Modemann S, Rothe A, Niegsch R, Strauss G. An improved instrument table for use in functional endoscopic sinus surgery. Med Sci Monit Basic Res. 2015;21:131-134.	The improved instrument table is of value for everyday use in surgery and offers a great benefit for FESS, and may be useful in other kinds of surgery (e.g., duraplasty). With use of the improved IT during functional endoscopic sinus surgery (FESS), preparation-time was extended by 0.1 min and the SLOT-time was reduced by 19.6%. The number of different instruments (35.3%) used was reduced, as well as the number of manual interactions with instruments (7.8%) and the number of manual interactions with the scrub nurse (66.1%). In addition, the ergonomics with use of the IT improved by 40.0%. The only potential disadvantage was a reduction of working space and thereby a constraint of the scope. Compared to the benefits, this problem is minor.	IIC	Quasi-experimental	Functional endoscopic sinus surgeries	An improved instrument table (IT) was designed, built, and tested.		300	Preparation-time, the SLOT-time, the number of different instruments used, and the number of manual interactions with the instruments from their uptake to deposition.
29	Al-Hakim L. The impact of preventable disruption on the operative time for minimally invasive surgery. Surg Endosc. 2011;25(10):3385-3392.	Disruption prolonged operative time by more than 32%. Teamwork forms the main source of disruption followed by operating table and patient positioning and arrangement of instruments. These three sources represented approximately 20% of operative time. Failure to follow principles of work design had a significant negative impact, lengthening operative time by approximately 15%. Although lighting and monitors had a relatively small impact on operative time, these factors could create inconvenience and stress within the surgical teams. In addition, the effect of failure to follow surgical protocols and policies or having incomplete patient records may have a limited effect on operative time but could have serious consequences.	IIIC	Non-experimental	Minimally invasive procedures	N/A	N/A	17	Events inside operating rooms that disturbed operative time.

30	Held RT, Hui TT. A guide to stereoscopic 3D displays in medicine. Acad Radiol. 2011;18(8):1035-1048.	Stereoscopic displays provide more accurate depth information than non stereoscopic displays. This technology could be beneficial in application to the medical field by aiding the detection of diagnostically relevant shapes, orientations and positions of anatomical features, especially when monocular cues are absent or unreliable. In laparoscopic surgery the surgeon may not be able to accurately identify structures due to lack of familiar size and perspective and the surgeon will touch parts of the anatomy with the surgical instruments to gain points of reference. Additional depth information could improve the quality of laparoscopy surgery especially for the novice surgeon.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
31	Kong SH, Oh BM, Yoon H, et al. Comparison of two and three-dimensional camera systems in laparoscopic performance: a novel 3D system with one camera. Surg Endosc. 2010;24(5):1132-1143.	The 3D system provided significantly greater depth perception than the 2D system. The errors during the two tasks were significantly lower with 3D system in novice group, but performance time was not different between the 2D and 3D systems.	IIIA	Non-experimental	Surgeons	N/A	Effects of a 3D imaging system on laparoscopy performance compared with a conventional 2D system.	27	
32	Kranzfelder M, Schneider A, Gillen S, Feussner H. New technologies for information retrieval to achieve situational awareness and higher patient safety in the surgical operating room: the MRI institutional approach and review of the literature. Surg Endosc. 2011;25(3):696-705.	The presented technologies are a first step to achieving an increased situational awareness in the OR. However, workflow definition in surgery is feasible only if the procedure is standardized, the peculiarities of the individual patient are taken into account, the level of the surgeon's expertise is regarded, and a comprehensive data capture can be obtained.	VB	Literature review	N/A	N/A	N/A	N/A	N/A

33	Pluyter JR, Buzink SN, Rutkowski AF, Jakimowicz JJ. Do absorption and realistic distraction influence performance of component task surgical procedure? Surg Endosc. 2010;24(4):902-907.	Under distracting conditions, the interns showed a significant decline in task performance (overall task score, task errors, and operating time) and significantly increased levels of irritation toward both the assistant handling the laparoscope in a nonoptimal way and the sources of social distraction. The results suggest careful evaluation of the social and technological sources of distraction in the operation room to reduce irritation for the surgeon and provision of proper pre-clinical laparoscope navigation training to increase security for the patient.	IIA	Quasi-experimental	Interns	Pre and Post test	Distracting conditions vs. nondistracting conditions	12	
34	Shukla PJ, Maharaj R, Fingerhut A. Ergonomics and technical aspects of minimal access surgery in acute surgery. Eur J Trauma Emerg Surg. 2010;36(1):3-9.	High-tech equipment and associated procedures have modified the needs for a modern operating room setup. Laparoscopic procedures for emergency surgery must make use of well-known ergonomic principles and be adapted to the patient and the pathology.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
35	Klein MI, DeLucia PR, Olmstead R. The impact of visual scanning in the laparoscopic environment after engaging in strain coping. Hum Factors. 2013;55(3):509-519.	After novice observers experience strain coping, visual scanning can impair the detection of critical signals.	IIA	Quasi-experimental	Right-handed university undergraduates	Camera and monitor angles.	Split-screen vs separated display.	48	Strain coping
36	Morton PJ. Implementing AORN recommended practices for MIS: Part II. AORN J. 2012;96(4):378-392.	This article focuses on the equipment and workplace safety aspects of the revised AORN "Recommended practices for minimally invasive surgery."	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A

37	Ulmer BC. Best practices for minimally invasive procedures. AORN J. 2010;91(5):558-572.	Techniques and instrumentation for minimally invasive surgical procedures originated in gynecologic surgery, but the benefits of surgery with small incisions or no incisions at all have prompted the expansion of these techniques into numerous specialties. Technologies such as robotic assistance, single-incision laparoscopic surgery, natural orifice transluminal endoscopic surgery, and video-assisted thoracoscopic surgery have led to the continued expansion of minimally invasive surgery into new specialties. With this expansion, perioperative nurses and other members of the surgical team are required to continue to learn about new technology and instrumentation, as well as the techniques and challenges involved in using new technology, to help ensure the safety of their patients.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
38	Llarena NC, Shah AB, Milad MP. Bowel injury in gynecologic laparoscopy: a systematic review. Obstet Gynecol. 2015;125(6):1407-1417.	The overall incidence of bowel injury in gynecologic laparoscopy is 1 in 769 but increases with surgical complexity. Delayed diagnosis is associated with a mortality rate of 1 in 31.	IIA	Systematic literature review	N/A	N/A	N/A	90 studies published between 1972 and 2014, representing 474,063 gynecologic laparoscopies	
39	Levy BF, De Guara J, Willson PD, Soon Y, Kent A, Rockall TA. Bladder injuries in emergency/expedited laparoscopic surgery in the absence of previous surgery: a case series. Ann R Coll Surg Engl. 2012;94(3):e118-e120.	Although the incidence of bladder injury is low, its importance is highlighted by the large number of laparoscopies being performed. In addition to catheterization of the patient, care must be taken with the insertion of low suprapubic ports and consideration should be made regarding alternative sites. Adequate laparoscopic supervision and training in port site planning is required for surgical trainees.	VC	Case study	N/A	N/A	N/A	N/A	N/A

40	Park EY, Kwon JY, Kim KJ. Carbon dioxide embolism during laparoscopic surgery. Yonsei Med J. 2012;53(3):459-466.	Clinically significant carbon dioxide embolism is a rare but potentially fatal complication of anesthesia administered during laparoscopic surgery. Its most common cause is inadvertent injection of carbon dioxide into a large vein, artery or solid organ. This error usually occurs during or shortly after insufflation of carbon dioxide into the body cavity, but may result from direct intravascular insufflation of carbon dioxide during surgery. Clinical presentation of carbon dioxide embolism ranges from asymptomatic to neurologic injury, cardiovascular collapse or even death, which is dependent on the rate and volume of carbon dioxide entrapment and the patient's condition. We reviewed extensive literature regarding carbon dioxide embolism in detail and set out to describe the complication from background to treatment. We hope that the present work will improve our understanding of carbon dioxide embolism during laparoscopic surgery.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
41	Cheng Y, Lu J, Xiong X, et al. Gases for establishing pneumoperitoneum during laparoscopic abdominal surgery. Cochrane Database Syst Rev. 2013(1):CD009569.	Nitrous oxide pneumoperitoneum during laparoscopic abdominal surgery appears to decrease post-operative pain in patients with low anesthetic risk. Helium pneumoperitoneum decreases cardiopulmonary changes associated with laparoscopic abdominal surgery. However, this did not translate into any clinical benefit over carbon dioxide pneumoperitoneum. The safety of nitrous oxide and helium pneumoperitoneum has yet to be established.	IA	Systematic literature review	N/A	N/A	CO2 vs. nitrous, nitrous oxide and helium insufflation gases for pneumoperitoneum.	340	Cardio pulmonary complications and procedure related complications

42	Binda MM. Humidification during laparoscopic surgery: overview of the clinical benefits of using humidified gas during laparoscopic surgery. Arch Gynecol Obstet. 2015;292(5):955-971.	The use of humidified and warm insufflation gas offers a significant clinical benefit to the patient, creating a more physiologic peritoneal environment and reducing the post-operative pain and hypothermia. In animal models, although humidified and warm gas reduces postoperative adhesions, humidified gas at 32°C reduced them even more. Humidified gas should be used during laparoscopic surgery; however, a question remains unanswered: to achieve even greater clinical benefit to the patient, at what temperature should the humidified gas be when insufflated into the abdomen? More clinical trials should be performed to resolve this query.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
43	Lee KC, Kim JY, Kwak HJ, Lee HD, Kwon IW. The effect of heating insufflation gas on acid-base alterations and core temperature during laparoscopic major abdominal surgery. Korean J Anesthesiol. 2011;61(4):275-280.	The heating of insufflating CO2 did not affect changes in the acid-base status and PaCO2 in patients undergoing laparoscopic abdominal surgery when the ventilator was set to maintain constant end-tidal CO2. However, the heated CO2 reduced the decrease in the core body temperature 30 min after the pneumoperitoneum.	IA	RCT	Adult patients undergoing laparoscopic major abdominal surgery.	Heating of insufflation gas	Randomized to receive either room temperature CO2 (control group, n = 15) or heated CO2 (heated group, n = 15).	30	Acid-base balance
44	Najam O, Krishnamoorthy B, Kadir I, et al. Scrotal distension after endoscopic harvesting of the saphenous vein in patients with inguinal hernia. Ann Thorac Surg. 2011;92(2):733-735.		VC	Case report	N/A	N/A	N/A	N/A	N/A
45	Maeda Y, Hirasawa D, Fujita N, et al. A pilot study to assess mediastinal emphysema after esophageal endoscopic submucosal dissection with carbon dioxide insufflation. Endoscopy. 2012;44(6):565-571.	Insufflation of CO2 rather than air during esophageal ESD significantly reduced post procedural mediastinal emphysema. CO2 can be considered an insufflation gas for esophageal ESD.	IA	RCT	Adult patients	Multi-detector row computed tomography (MDCT)	Patients who had undergone esophageal ESD with insufflation of CO2 and a historical control of patients who had undergone esophageal ESD with air insufflation.	27 with CO2 insufflation gas, 105 with air insufflation gas	Detection rate of mediastinal emphysema by multi-detector row computed tomography and chest radiography

46	Kim JA, Kim JS, Chang MS, Yoo YK, Kim DK. Influence of carbon dioxide insufflation of the neck on intraocular pressure during robot-assisted endoscopic thyroidectomy: a comparison with open thyroidectomy. Surg Endosc. 2013;27(5):1587-1593.	CO2 insufflation of the neck at pressure of 6 mmHg increased the Intraocular pressure (IOP) significantly compared with open thyroidectomy. However, this increase in IOP could be balanced by an anesthetic-induced IOP-lowering effect, thereby having no clinical significance in patients with normal IOP undergoing robot-assisted endoscopic thyroidectomy.	IIIB	Non-Experimental	Patients undergoing open thyroidectomy (OT) or robot-assisted endoscopic thyroidectomy(RET) with CO2 insufflation.	N/A	OT versus RET	37	IOP
47	AAGL Advancing Minimally Invasive Gynecology Worldwide; Munro MG, Storz K, Abbott JA, et al. AAGL Practice Report: Practice Guidelines for the Management of Hysteroscopic Distending Media: (replaces Hysteroscopic Fluid Monitoring Guidelines. J Am Assoc Gynecol Laparosc. 2000;7:167-168.). J Minim Invasive Gynecol. 2013;20(2):137-148.		IVB	Guideline	N/A	N/A	N/A	N/A	N/A
48	Hayden P, Cowman S. Anaesthesia for laparoscopic surgery. Contin Educ Anaesth Crit Care Pain. 2011;11(5):177-180.	Laparoscopic surgery has many benefits for patients, including reduced postoperative pain and fewer wound-related complications. Generation of a pneumoperitoneum induces significant physiological changes which must be appreciated, and compensated for, to avoid adverse outcomes. Specific groups may benefit from laparoscopic techniques such as obese patients or individuals with severe respiratory disease. Complications may have an insidious onset and all organizations undertaking laparoscopic surgery should have locally devised protocols to ensure staff recognize and rapidly act upon deteriorating patients after operation.	VC	Expert opinion	N/A	N/A	N/A	N/A	N/A

49	Rammohan A, Manimaran AB, Manohar RR, Naidu RM. Nitrous oxide for pneumoperitoneum: no laughing matter this! A prospective single blind case controlled study. Int J Surg. 2011;9(2):173-176.	N2O pneumoperitoneum has a definitive advantage over CO2 pneumoperitoneum. Further multicentric randomized trials are necessary before N2O becomes the standard insufflating agent. The search for the perfect insufflating gas has been elusive. Even though CO2 is the most commonly used gas, it has numerous cardiovascular, respiratory and hemodynamic side effects, which have often been taken for granted. In the current scenario of ever expanding and complex indications for laparoscopic surgery these changes have an increasing implication of placing the patient at risk. N2O has now made a comeback and shown by recent studies to be as safe as CO2 for creating pneumoperitoneum.	IA	RCT	Patients undergoing laparoscopic surgery	Abdominal insufflation	N2O insufflation vs. CO2 insufflation	77	Heart rate, mean arterial blood pressure, end-tidal CO2, arterial pH, peak airway pressure, minute ventilation and O2 saturation.
50	Jacobs VR, Morrison JE Jr, Kiechle M. Twenty-five simple ways to increase insufflation performance and patient safety in laparoscopy. J Am Assoc Gynecol Laparosc. 2004;11(3):410-423.		VA	Organizational experience	N/A	N/A	N/A	N/A	N/A
51	Olsen M, Avery N, Khurana S, Laing R. Pneumoperitoneum for neonatal laparoscopy: how safe is it? Paediatr Anaesth. 2013;23(5):457-459.	The features of the neonatal circulation may predispose neonates to embolic phenomena during laparoscopic procedures. There may be a potential benefit of priming the insufflation apparatus with carbon dioxide. The possibility of gas embolism should be considered when contemplating laparoscopic surgery in this patient group.	VC	Case report	N/A	N/A	N/A	N/A	N/A
52	Aran T, Unsal MA, Guven S, Kart C, Cetin EC, Alver A. Carbon dioxide pneumoperitoneum induces systemic oxidative stress: a clinical study. Eur J Obstet Gynecol Reprod Biol. 2012;161(1):80-83.	Laparoscopic surgery causes systemic ischemia and this ischemic effect can be revealed by measuring serum ischemia modified albumin. IMA is more sensitive than MDA, TOS, OSI and TAS in early detection of systemic oxidative stress	IIIB	Non-experimental	Patients undergoing laparoscopic surgery for ovarian cyst removal	N/A	IMA, TAS, OSI, TOS, MDA	33	Systemic oxidative stress
53	Eryilmaz HB, Memis D, Sezer A, Inal MT. The effects of different insufflation pressures on liver functions assessed with LiMON on patients undergoing laparoscopic cholecystectomy. The Scientific World Journal. 2012;2012:172575.	The results show that a 14mmHg decreased the blood flow to the liver and increased postoperative 1st hour serum AST and ALT levels. Recommend 10mmHg for laparoscopic cholecystectomy procedures.	IA	RCT	Patients undergoing laparoscopic cholecystectomy		10mmHg pressure vs. 14mmHg pressure.	43	Liver function
54	Kim HY, Kim TY, Lee KC, et al. Pneumothorax during laparoscopic totally extraperitoneal inguinal hernia repair—a case report. Korean J Anesthesiol. 2010;58(5):490-494.	Anesthesiologists should be aware of the possible occurrence of pneumothorax during laparoscopic TEP hernia repair.	VC	Case report	N/A	N/A	N/A	N/A	N/A

55	Otsuka Y, Katagiri T, Ishii J, et al. Gas embolism in laparoscopic hepatectomy: what is the optimal pneumoperitoneal pressure for laparoscopic major hepatectomy? J Hepatobiliary Pancreat Sci. 2013;20(2):137-140.	There is a higher risk of gas embolism in laparoscopic hepatectomy patients. Lower pressure PP at 12 mmHg indicate lower rate of clinically severe gas embolism.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
56	Liu F, Zhu S, Ji Q, Li W, Liu J. The impact of intraabdominal pressure on the stroke volume variation and plethysmographic variability index in patients undergoing laparoscopic cholecystectomy. Biosci Trends. 2015;9(2):129-133.	Evaluate the effect of increasing intra-abdominal pressure (IAP) on stroke volume variation (SVV) and plethysmographic variability index (PVI) in patients undergoing laparoscopic cholecystectomy.	IIIB	Non-experimental	Patients undergoing elective laproscopic cholecystectomy	N/A	The effect of pneumoperitoneum pressure on SVV and PVI	45	Intra-abdominal pressure (IAP) on stroke volume variation (SVV) and plethysmographic variability index (PVI).
57	Lasersohn L. Anaesthetic considerations for paediatric laparoscopy. S Afr J Surg. 2011;49(1):22-26.	Children, infants and neonates represent an anesthetic challenge because of age-specific anatomical and physiological issues. Apart from pediatric-specific anesthetic considerations, the pediatric anesthetist must understand the implications of laparoscopic surgery, and prevent and react appropriately to changes that will occur during these procedures. Pre-operative assessment is a multi-specialist responsibility. Predicting the effects on each organ system, planning the strategy required and maintaining open communication within the team ensure the success of the operation and limit perioperative morbidity.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
58	Mura P, Cossu AP, Musu M, et al. Pituitary apoplexy after laparoscopic surgery: a case report. Eur Rev Med Pharmacol Sci. 2014;18(22):3524-3527.	Intra-abdominal pressure may be the cause, but should also consider systemic hypotension, anticoagulant drugs, and air embolism. Assessment of the ocular symptoms such as ptosis, anisocoria should lead to further work up of the patient.	VC	Case report	N/A	N/A	N/A	N/A	N/A

59	Hackethal A, Brennan D, Rao A, et al. Consideration for safe and effective gynaecological laparoscopy in the obese patient. Arch Gynecol Obstet. 2015;292(1):135-141.	Given the increasing rate of obesity amongst the population, developing laparoscopic surgical skills and sharing experience and techniques for this group is the key to enable patients to benefit from this favorable surgical approach and minimizing complications. Recommend a pneumoperitoneum of 15 mmHg to improve the visualization and is generally tolerated by patients with BMI >35. The PP can be reduced to 10-12 mmHg if cardiopulmonary changes occur that would indicate a need the patient is not tolerating the higher IAP. Also recommend a higher IPA of 25mmHg during the veress needle insertion to provide a safer distance from the abdominal wall to the abdominal viscera. A pressure of 25 mmHg will increase this distance to 5.6cm.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
60	Meftahuzzaman SM, Islam MM, Chowdhury KK, et al. Haemodynamic and end tidal CO2 changes during laparoscopic cholecystectomy under general anaesthesia. Mymensingh Med J. 2013;22(3):473-477.	A statistically significant increase in end-tidal CO2 from the base line occurred at 40 minutes after insufflation and positioning of the patient. Recommends hemodynamic and end-tidal CO2 monitoring during laparoscopic cholecystectomy.	IIIB	Non-experimental	Patients undergoing laparoscopic cholecystectomy under general anesthesia.	N/A	N/A	50	End-tidal CO2, SpO2, and ECG
61	Kim SH, Park KS, Shin HY, Yi JH, Kim DK. Paradoxical carbon dioxide embolism during endoscopic thyroidectomy confirmed by transesophageal echocardiography. J Anesth. 2010;24(5):774-777.		VC	Case study	N/A	N/A	N/A	N/A	N/A
62	Pandey V, Varghese E, Rao M, et al. Nonfatal air embolism during shoulder arthroscopy. Am J Orthop (Belle Mead NJ). 2013;42(6):272-274.	Case report of air embolism with shoulder arthroscopy.	VC	Case report	N/A	N/A	N/A	N/A	N/A
63	Kocher MS, Frank JS, Nasreddine AY, et al. Intraabdominal fluid extravasation during hip arthroscopy: a survey of the MAHORN group. Arthroscopy. 2012;28(11):1654-1660.	Symptomatic IAFE after hip arthroscopy is a rare occurrence, with an approximate prevalence of 0.16%. Prevention of IAFE should include close intraoperative and postoperative monitoring of abdominal distention, core body temperature, and hemodynamic stability. Concomitant iliopsoas tenotomy and high pump pressures may be risk factors leading to symptomatic IAFE.	IIIB	Qualitative	Hip arthroscopists	N/A	N/A	15	N/A

64	Yousef AA, Suliman GA, Elashry OM, Elsharaby MD, Elgamasy AEK. A randomized comparison between three types of irrigating fluids during transurethral resection in benign prostatic hyperplasia. BMC Anesthesiol. 2010;10:7.	Endoscopic TURP performed using either glucose 5% or saline 0.9% irrigating solution during and after surgery is associated with lower incidence of TUR syndrome, lower catheterization period, shorter hospital stay and no cardiac toxicity in comparison with glycine 1.5% solution.	1B	RCT	Patients with symptomatic BPH	Three different types of irrigation fluid.	Glycine 1.5% versus glucose 5% and normal saline 0.9% as irrigating solutions during TURP.	360	Heart rate, mean arterial blood pressue and central venous pressure.
65	Munro MG, Christianson LA. Complications of hysteroscopic and uterine resectoscopic surgery. Clin Obstet Gynecol. 2015;58(4):765-797.	Adverse events associated with hysteroscopic procedures are generally rare, but, with increasing operative complexity, it is now apparent that they are experienced more often. There exists a spectrum of complications that relate to generic components of procedures, such as patient positioning, anesthesia, and analgesia, to a number that are specific to intraluminal endoscopic surgery that largely comprise perforation and injuries to surrounding structures and blood vessels. Whereas a number of endoscopic procedures require the use of distending media, the response of premenopausal women to excessive absorption of nonionic fluids used for hysteroscopy is somewhat unique, and deserves special attention on the part the surgeon. There is also an increasing awareness of uncommon but problematic sequelae related to the use of monopolar radiofrequency uterine resectoscopes that involve thermal injury to the vulva and vagina. Furthermore, the uterus that has previously undergone hysteroscopic surgery may behave in unusual ways, at least in premenopausal women who experience menstruation or who become pregnant. Fortunately, better understanding of the mechanisms involved in these adverse events, as	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A

66	Edwards DS, Davis I, Jones NA, Simon DW. Rapid tracheal deviation and airway compromise due to fluid extravasation during shoulder arthroscopy. J Shoulder Elbow Surg. 2014;23(7):e163-e165.	Case report of rapid tracheal deviation and subsequent airway compromise in an otherwise healthy woman undergoing elective shoulder arthroscopy. The most likely cause was irrigation fluid passage from the glenohumeral joint through the tissue planes into the pharyngeal structures. It has been reported that airway compromise caused by soft tissue swelling due to irrigation fluid can occur but after significantly longer periods of operative time have elapsed but never with such a rapid onset. Recommend careful placement of drapes and evaluation of soft tissue recommended for assessing extravasation of fluid.	VC	Case Report	N/A	N/A	N/A	N/A	N/A
67	Jo YY, Jeon HJ, Choi E, Choi YS. Extreme hyponatremia with moderate metabolic acidosis during hysteroscopic myomectomy—a case report. Korean J Anesthesiol. 2011;60(6):440-443.	Case report of an extreme hyponatremia, caused by using an electrolyte-free 5 : 1 sorbitol/mannitol solution as distention/irrigation fluid for hysteroscopic myomectomy. A 34-year-old female developed severe pulmonary edema and extreme hyponatremia (83 mmol/L) during transcervical endoscopic myomectomy. A brain computed tomography showed mild brain swelling without pontine myelinolysis. Meticulous attention should be paid to intraoperative massive absorption of fluid distention media, even during a simple hysteroscopic procedure.	VC	Case report	N/A	N/A	N/A	N/A	N/A
68	Khan F, Padmanabha S, Shantaram M, Aravind M. Airway compromise due to irrigation fluid extravasation following shoulder arthroscopy. J Anaesthesiol Clin Pharmacol. 2013;29(4):578-579.	This author describes a case of fluid extravasation in shoulder arthroscopy which led to airway complications. Patients at risk are in cases with long duration (>90-120min), amount of fluid absorbed, weight gain and increased pump pressure.	VC	Case report	N/A	N/A	N/A	N/A	N/A
69	Manjuladevi M, Gupta S, Upadhyaya KV, Kutappa AM. Postoperative airway compromise in shoulder arthroscopy: a case series. Indian J Anaesth. 2013;57(1):52-55.	Risk factors for upper airway compromise are longer surgery time, increased pump pressure, large volume of irrigation fluid used, lateral decubitus position and obesity	VC	Case report	N/A	N/A	N/A	N/A	N/A
70	Wegmuller B, Hug K, Meier Buenzli C, Yuen B, Maggiorini M, Rudiger A. Life-threatening laryngeal edema and hyponatremia during hysteroscopy. Crit Care Res Pract. 2011;2011:140381.	Recommends good communication on clinical observation between anesthesia and surgeon, exact determination of fluid balance, terminate the procedure if fluid absorption reaches 2000ml, and minimize resection time to less than 60 minutes.	VC	Case report	N/A	N/A	N/A	N/A	N/A

71	Woo YC, Kang H, Cha SM, et al. Severe intraoperative hyponatremia associated with the absorption of irrigation fluid during hysteroscopic myomectomy: a case report. J Clin Anesth. 2011;23(8):649-652.	Complications from fluid overload in hysteroscopy include hyponatremia, fluid overload and pulmonary or cerebral edema.	VC	Case report	N/A	N/A	N/A	N/A	N/A
72	Yang BJ, Feng LM. Symptomatic hyponatremia and hyperglycemia complicating hysteroscopic resection of intrauterine adhesion: a case report. Chin Med J. 2012;125(8):1508-1510.	Surgical teams must be vigilant in fluid deficit monitoring and serum electrolyte analysis.	VC	Case report	N/A	N/A	N/A	N/A	N/A
73	Stocker L, Umranikar A, Moors A, Umranikar S. An overview of hysteroscopy and hysteroscopic surgery. Obstet Gynaecol Reprod Med. 2013;23(5):146-153.	Hysteroscopic surgery should be performed by an appropriately trained gynecologist to ensure safe practice and good patient outcomes.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
74	Van Kruchten PM, Vermelis JMFW, Herold I, Van Zundert AAJ. Hypotonic and isotonic fluid overload as a complication of hysteroscopic procedures: two case reports. Minerva Anestesiol. 2010;76(5):373-377.	Complications such as cervical laceration, uterine perforation, absorption of irrigation solutions and, rarely, gas or air embolism may occur. Hypotonic as well as isotonic distention media can cause serious complications. Factors that may increase the risk of fluid overload should be known to both anesthesiologists and gynecologists.	VC	Case study	N/A	N/A	N/A	N/A	N/A
75	Rademaker BMP, van Kesteren PJM, de Haan P, Rademaker D, France C. How safe is the intravasation limit in hysteroscopic surgery? J Minim Invasive Gynecol. 2011;18(3):355-361.	During transcervical resection of myomas, physiological changes that could be attributed to gaseous embolism occurred in 33% to 43% of patients with 1000 to 2500 mL fluid intravasation. Nearly half of those patients had cardiovascular disturbances that indicated the formation of emboli. Therefore cardiovascular disturbances that indicate gaseous embolism during transcervical resection of myomas may occur despite the limitation of intravasation according to current view.	IIIB	Non-experimental	Hysteroscopic myoma resection patient records.	N/A	The occurrence of physiological changes that indicate the formation of emboli was retrospectively determined In addition, these changes were related to the amount of fluid intravasation.	234	Physiological changes that could be attributed to gaseous embolism.
76	Morton PJ. Implementing AORN recommended practices for minimally invasive surgery: part I. AORN J. 2012;96(3):295-314.	Collaboration and collegiality among members of the surgical team are essential for ensuring all pertinent aspects of care are recognized and considered.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A

77	Darwish AM, Hassan ZZ, Attia AM, Abdelraheem SS, Ahmed YM. Biological effects of distension media in bipolar versus monopolar resectoscopic myomectomy: a randomized trial. J Obstet Gynaecol Res. 2010;36(4):810-817.	The use of bipolar resectoscope utilizing 0.9% saline as a distention media is not associated with hyponatremia or hyposmolarity unlike monopolar resectoscope utilizing 1.5% glycine distending media in cases with submucosa myomas of considerable size.	IB	RCT	Hysteroscopic myomectomy patients	Type of energy generating device and irrigation solution.	bipolar resectoscopic myomectomy utilizing 0.9% saline in group A, and monopolar resectoscopic myomectomy utilizing 1.5% glycine in group B.	155	Intraoperative difference with regards to fluid volume and subsequent systemic changes
78	Park JT, Lim HK, Kim SG, Um DJ. A comparison of the influence of 2.7% sorbitol-0.54% mannitol and 5% glucose irrigating fluids on plasma serum physiology during hysteroscopic procedures. Korean J Anesthesiol. 2011;61(5):394-398.	No clinical evidence of hyponatremic hypoosmolality in any of the patients. No difference between 2.7% sorbitol-0.54% mannitol and 5% glucose as an irrigating fluid for hysteroscopic procedures with mild to moderate irrigant absorption.	IIC	Quasi-experimental	Hysteroscopic patients	N/A	2.7% sorbitol-0.54% mannitol solution vs 5% glucose as an irrigating fluid	30	Intraoperative and postoperative levels of serum sodium, potassium, chloride, glucose and osmolality.
79	Silva JM Jr, Barros MA, Chahda MAL, Santos IM, Marubayashi LY, Malbouisson LM. Risk factors for perioperative complications in endoscopic surgery with irrigation. Braz J Anesthesiol. 2013;63(4):327-333.	Patients with complications amounted to 21.8%, with higher prevalence in endoscopic prostate surgery, followed by hysteroscopy, bladder, knee, and shoulder arthroscopy (58.1%, 36.9%, 19.4%, 3.8%, 3.2% respectively). When comparing both groups, we found association with complications in univariate analysis: age, sex, smoking, heart disease, ASA, serum sodium at the end of surgery, total irrigation administered, TURP, and hysteroscopy. However, in multiple regression analysis for complications, only age (OR = 1.048), serum sodium (OR = 0.962), and volume of irrigation administered during surgery (OR = 1.001) were independent variables.	IIIA	Non-experimental	Patients aged ≥ 18 years undergoing endoscopic surgery with the use of irrigation fluids.	N/A	Patients with complications from fluid used during endoscopic procedures to patients without complications.	142	Serum sodium at the end of surgery and total irrigation administered.
80	Bergeron ME, Ouellet P, Bujold E, et al. The impact of anesthesia on glycine absorption in operative hysteroscopy: a randomized controlled trial. Anesth Analg. 2011;113(4):723-728.	Less glycine absorption occurred when local anesthesia was the method of anesthesia	IA	RCT	Patients undergoing hysteroscopy for abnormal uterine bleeding.	Type of anesthesia	General Anesthesia vs. local anesthesia	95	Glycine absorption

81	Kumar A, Kumar A. New hysteroscopy pump to monitor real-time rate of fluid intravasation. J Minim Invasive Gynecol. 2012;19(3):369-375.	This article describes the benefit of monitoring the intravasation rate and traditional measurement of fluid deficit in hysteroscopy procedures. The intravasation rate is the rate, in milliliters per minute, at which fluid enters the systemic circulation, whereas fluid deficit is the amount of irrigation fluid, in milliliters, already absorbed by the patient. A pump was developed to calculate and display the real-time intravasation rate and the fluid deficit on an LCD screen.	VA	Organizational experience	N/A	N/A	N/A	N/A	N/A
82	Ladner B, Nester K, Cascio B. Abdominal fluid extravasation during hip arthroscopy. Arthroscopy. 2010;26(1):131-135.	Awareness of fluid extravasation during a hip arthroscopy and assessment of the abdomen should be performed periodically.	VC	Case report	N/A	N/A	N/A	N/A	N/A
83	Cavaignac E, Pailhe R, Reina N, Chiron P, Laffosse JM. Massive proximal extravasation as a complication during arthroscopic anterior cruciate ligament reconstruction. Knee Surg Rel Res. 2013;25(2):84-87.	Using adequate equipment to measure the fluid inflow and outflow and pressure from arthroscopy pump decreases the risk of fluid extravasation in arthroscopy. In prolonged procedures the surgeon should be notified when the fluid volume exceeds 15L. The extravasation was caused by a fault in the pressure sensor due to the fact that the reservoir was over-filled. The irrigation pressure was therefore too high, and the irrigation fluid was able to diffuse, despite the presence of a pneumatic tourniquet, up past the thigh.	VC	Case Report	N/A	N/A	N/A	N/A	N/A
84	Stafford GH, Malviya A, Villar RN. Fluid extravasation during hip arthroscopy. Hip Int. 2011;21(6):740-743.	There was a significant correlation between the volume of extravasated fluid and both the length of operation and the volume of infused fluid used. During arthroscopic hip surgery more than a liter of irrigation fluid may be extravasated into the soft tissues. In order to reduce problems related to this the authors in this one facility attempt to keep operating times low, and maintain intra-operative fluid pressures as low as possible.	VA	Organizational experience	Hip arthroplasty patients	N/A	N/A	28	

85	Verma M, Sekiya JK. Intrathoracic fluid extravasation after hip arthroscopy. Arthroscopy. 2010;26(9 Suppl):S90-S94.	Development of hyperthermia may be an early warning for extravasation. The five warning signs of fluid extravasation (1) inability to distend the joint, (2) increased fluid requirements to maintain distention, (3) frequent cutoff of pump irrigation systems, (4) abdominal and thigh distension, and (5) acute hypothermia. Fluid extravasation during hip arthroscopy can lead to abdominal compartment syndrome, hypotension and cardiac arrest.	VC	Case report	N/A	N/A	N/A	N/A	N/A
86	Hermanns T, Fankhauser CD, Hefermehl LJ, et al. Prospective evaluation of irrigation fluid absorption during pure transurethral bipolar plasma vaporisation of the prostate using expired-breath ethanol measurements. BJU Int. 2013;112(5):647-654.	Significant intra-operative fluid absorption can occur during BPV of the prostate. Care must be taken if using this procedure in patients with significant cardiovascular comorbidities. Respecting the anatomical borders of the prostate seems to play a relevant role in preventing fluid absorption during the procedure. Venous pH could be used to detect potentially dangerous fluid absorption if intra-operative monitoring of breath ethanol measurements are not available.	IIIB	Non-experimental	Patients undergoing BPV of the prostate	N/A	N/A	55	Ethanol absorption
87	Lee KC, Kim HY, Lee MJ, Koo JW, Lim JA, Kim SH. Abdominal compartment syndrome occurring due to uterine perforation during a hysteroscopy procedure. J Anesth. 2010;24(2):280-283.	Abdominal compartment syndrome occurred during a hysteroscopic procedure. Fluid migrated into the peritoneal space from the uterine cavity. The patient experienced increased peak inspiratory airway pressure, increase end tidal CO2 and decreased O2 saturation. The abdomen was distended and tense and there was no awareness of the in-out irrigation fluid. A suspected uterine perforation and decision to perform a laparoscopy resulted in drainage of 8000ml of clear fluid from the peritoneal cavity.	VC	Case report	N/A	N/A	N/A	N/A	N/A
88	Guideline for medication safety. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:289-332.	Provide guidance on safe use of medications in the perioperative environment.	IVA	Guideline	N/A	N/A	N/A	N/A	N/A
89	Boyd HR, Stanley C. Sources of error when tracking irrigation fluids during hysteroscopic procedures. J Am Assoc Gynecol Laparosc. 2000;7(4):472-476.	Provided information on the miscalculation of fluid loss by healthcare personnel when estimating the fluid calculations from IV bags, containers and spills on the floor.	VA	Expert opinion	N/A	N/A	N/A	N/A	

90	Dubeck D. Robotic-assisted surgery: focus on training and credentialing. Penn Patient Saf Advis. 2014;11(3):93-101.	Since 2005, healthcare facilities have reported 722 safety events involving robotic-assisted surgery (RAS) to the Pennsylvania Patient Safety Authority. Five hundred forty-five (75.5%) were categorized as Incidents that did not result in patient harm. Of the 545 Incidents reported, 344 (63.1%) of the events were categorized as complications of a procedure/treatment/test or errors related to a procedure/treatment/test. One hundred seventy-seven (24.5%) were reported as Serious Events that resulted in patient injury, including 10 events that resulted in patient fatality. Complications of a procedure/treatment/test (n = 131) and errors related to a procedure/treatment/test (n = 44) comprised 98.9% of the serious events. Further review of these cases showed that the event type subcategories of unintended laceration/puncture, bleeding/hemorrhage, other events related to patient positioning complications, retained foreign body, and infection made up 75.1% of the serious events. The rapid growth of RAS has presented new challenges as this technology has emerged as an alternative treatment option to many laparoscopic and open procedures. Current literature supports that a steep learning curve exists as surgeons develop skills to perform	VA	Literature review	N/A	N/A	N/A	N/A	N/A
91	Aubé C, Schmidt D, Brieger J, et al. Influence of NaCl concentrations on coagulation, temperature, and electrical conductivity using a perfusion radiofrequency ablation system: an ex vivo experimental study. Cardiovasc Intervent Radiol. 2007;30(1):92-97.	In an ex vivo model, continuous perfusion with high NaCl concentrations does not significantly improve the volume of thermal-induced coagulation. This may be because the use of a low-power generator cannot sufficiently exploit the potential advantage of better tissue conductivity provided by NaCl perfusion.	IIA	Quasi-experimental	Twenty-eight RF ablations were performed using continuous NaCl infusion in fresh excised bovine liver.	RF ablation performed with 0.9% to 25% concentrations of NaCl.	Temperature, the amount of energy, and the dimensions of thermal-induced white coagulation were assessed for each ablation.	25	Volume of coagulation, short-axis diameter, and amount of energy.
92	Brace CL, Laeseke PF, Prasad V, Lee FT. Electrical isolation during radiofrequency ablation: 5% dextrose in water provides better protection than saline. Conf Proc IEEE Eng Med Biol Soc. 2006;1:5021-5024.	D5W provides significantly more electrical isolation than saline, which reduces unwanted heating of the adjacent tissue. Saline actually increased the amount of RF current in the adjacent tissue. Based on these results, we conclude that D5W is preferable to saline as a protective fluid.	IIB	Quasi-experimental	Phantom tissue model experiments.	Ablation of phantom tissue model.	0.9% NaCl (saline) and 5% dextrose in water (D5W)	One model	Output current, voltage, power total circuit impedance and electrode tip-temperature

93	Closon F, Tulandi T. Future research and developments in hysteroscopy. Best Pract Res Clin Obstet Gynaecol. 2015;29(7):994-1000.	Hysteroscopy has become an important tool to evaluate intrauterine pathology. In most cases, the pathology can be diagnosed and treated in the office or outpatient setting. The ability to use normal saline as a distending medium allows the procedure to be performed using bipolar energy.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A
94	Culp WC Jr, Kimbrough BA, Luna S, Maguddayao AJ, Eidson JL, Paolino DV. Use of the electrosurgical unit in a carbon dioxide atmosphere. J Med Eng Technol. 2016;40(2):29-34.	Electro surgery can be performed in carbon dioxide environments, although surgeons should be aware of potentially altered ESU performance.	IIB	Quasi experimental	Cow feet and beef steak	ESU	Air v. carbon dioxide for gas insufflation	72	Spark gap distance.
95	Curtin B, Friebe I. Dermal burn during hip arthroscopy. Orthopedics. 2014;37(8):e746-e749.	The use of radiofrequency devices can lead to extra articular complications because of the effect of elevated irrigant fluid temperatures on the patient's skin. Sufficiently high temperatures were generated inside the joint, causing a superficial second-degree burn from the outflow irrigant. In the course of instrument switching from sucker/shaver to radiofrequency wand, the outflow valve was inadvertently left open with no attached suction while the radiofrequency wand was in use. Most second-degree burns like the one reported require only conservative therapy with cool compresses to decrease the temperature of the wound. The authors did recommend bacitracin ointment to prevent superficial wound infection, however unlikely with no disruption of the skin. The authors continue to use radiofrequency devices in hip arthroscopy, but are vigilant to maintain dedicated suction at the outflow tubing throughout the procedure. Surgeons should take strict precautions to avoid this preventable complication and follow all manufacturer instructions on the use of such devices.	VA	Case report	N/A	N/A	N/A	N/A	N/A

96	Deffieux X, Gauthier T, Menager N, Legendre G, Agostini A, Pierre F. Hysteroscopy: guidelines for clinical practice from the French College of Gynaecologists and Obstetricians. Eur J Obstet Gynecol Reprod Biol. 2014;178:114-122.	Vaginoscopy should be the standard technique for diagnostic hysteroscopy (Grade A) using a miniature (3.5mm sheath) (Grade A) rigid hysteroscope (Grade C), using normal saline solution distension medium (Grade C), without any anesthesia (conscious sedation should not be routinely used), without cervical preparation (Grade B), without vaginal disinfection and without antibiotic prophylaxis (Grade B). Misoprostol (Grade A), vaginal estrogens (Grade C), or GnRH agonist routine administration is not recommended before operative hysteroscopy. Before performing hysteroscopy, it is important to purge the air out of the system (Grade A). The uterine cavity distention pressure should be maintained below the mean arterial pressure and below 120mm Hg. The maximum fluid deficit of 2000 ml is suggested when using normal saline solution and 1000 ml is suggested when using hypotonic solution. When uterine perforation is recognized during operative hysteroscopy using monopolar or bipolar loop, the procedure should be stopped and a laparoscopy should be performed in order to eliminate a bowel injury. Diagnostic or operative hysteroscopy is allowed when an endometrial cancer is suspected (Grade B). Implementation of this guideline should	IVA	Position statement	N/A	N/A	N/A	N/A	N/A

97	Faul P, Schlenker B, Gratzke C, Stief CG, Reich O, Gustaw Hahn R. Clinical and technical aspects of bipolar transurethral prostate resection. Scand J Urol Nephrol. 2008;42(4): 318-323	This review aims to provide an overview and critical assessment of the developments in transurethral electro resection in non-conductive and conductive irrigants. In the 1970s, measurements of the electric pathway in saline were performed for different locations of the neutral electrode. It was then concluded that the current pathway and the possible hazards of burn injuries to the patient should be investigated separately for each arrangement of the neutral electrode. The position and shape of the neutral electrode have decisive effects on the current flow in the patient. Thus, different electrode arrangements of the various bipolar resection systems need to be analyzed separately. Furthermore, not only electrical power, but also conductivity and quality of the lubricant gel have to be considered as critical factors with regard to electrothermal injuries of the urethra. The supposedly better cutting quality seems to be based more on subjective observations than on scientific valid data. When performing ''bipolar'' TUR it is necessary to consider all electrotechnical and clinical aspects, particularly with regard to the potential risk of thermoelectrically urethral damage.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
98	Groenman FA, Peters LW, Rademaker BMP, Bakkum EA. Embolism of air and gas in hysteroscopic procedures: pathophysiology and implication for daily practice. J Minim Invasive Gynecol. 2008;15(2):241-247.	Guidelines for operating department personnel, surgeons, and anesthesiologists to reduce the risk of venous gas or air embolism during hysteroscopic procedures.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
99	Huang S, Gateley D, Moss ALH. Accidental burn injury during knee arthroscopy. Arthroscopy. 2007;23(12):1363.e1-1363.e3.	A case is described in which hot irrigation fluid used during a routine knee arthroscopy caused severe morbidity. The patient sustained full-thickness skin burns requiring debridement, a muscle flap, and split-skin grafting. The extent of the joint damage required fusion. The underlying factors included equipment failure but also a delay in appreciating the severity of the soft-tissue damage. This case highlights the need for a robust protocol for the management of warming the irrigation fluid, as well as monitoring the actual fluid temperature.	VB	Case report	N/A	N/A	N/A	N/A	N/A

100	Laeseke PF, Sampson LA, Brace CL, Winter TC III, Fine JP, Lee FT Jr. Unintended thermal injuries from radiofrequency ablation: protection with 5% dextrose in water. Am J Roentgenol. 2006;186(5 Suppl):S249-S254.	Instillation of D5 into the peritoneal cavity before hepatic radiofrequency ablation decreases the risk and severity of diaphragm and lung injuries compared with no pretreatment or pretreatment with 0.9% saline in this animal model. Pretreatment with D5 may increase both the safety of and the number of patients eligible for treatment with thermal therapies.	IIA	Quasi-experimental	Female domestic swine	Radiofrequency ablation	Dextrose 5% vs. 0.9 Saline	10	Thermal injury
101	Ubee SS, Philip J, Nair M. Bipolar technology for transurethral prostatectomy. Expert Rev Med Devices. 2011;8(2):149-154.	Head-to-head comparisons between the monopolar and bipolar TURP, the operation times, transfusion rates, retention rates after catheter removal and urethral complications did not differ significantly. Irrigation and catheterization duration was significantly longer with monopolar TURP.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
102	Vilos GA, Newton DW, Odell RC, Abu-Rafea B, Vilos AG. Characterization and mitigation of stray radiofrequency currents during monopolar resectoscopic electrosurgery. J Minim Invasive Gynecol. 2006;13(2):134-140.	During resectoscopic electrosurgery, baseline, most likely capacitive coupled, currents were always present. In addition, high values of working element currents occurred frequently, and they surged up to 0.60 A for significant periods of time. Without the modification of the resectoscopic device, these currents have the capability of flowing through the patient's genital tract and causing burns. Since monopolar electrosurgery remains an integral part of most hysteroscopic procedures, active electrode monitoring may offer a solution in protecting the patient and the surgeon from stray electrosurgical burns.	VA	Organizational experience	N/A	N/A	N/A	N/A	N/A
103	Craciunas L, Sajid MS, Howell R. Carbon dioxide versus normal saline as distension medium for diagnostic hysteroscopy: a systematic review and metaanalysis of randomized controlled trials. Fertil Steril. 2013;100(6):1709-1714.	A meta-analysis from the available moderate quality trials suggests that NS might be superior to CO2 for use in diagnostic hysteroscopy. Owing to problems of clinical diversity, statistical heterogeneity, and risk of bias, it is clear that additional pragmatic multicenter RCTs are needed to corroborate these findings before firm evidence-based guidelines can be given.	IA	Systematic Review	Women undergoing diagnostic hysteroscopy	CO2 or NS as distension medium for diagnostic hysteroscopy	Carbon dioxide (CO2) distention media vs. normal saline (NS) distension medium	10	Shoulder pain and side effects, satisfaction, quality of view, and duration of procedure.

104	Mandapathil M, Teymoortash A, Güldner C, Wiegand S, Mutters R, Werner JA. Establishing a transoral robotic surgery program in an academic hospital in Germany. Acta Otolaryngol. 2014;134(7):661-665.	Due to significant differences in the health-care system and divergent developments of the use of transoral surgery in the treatment of laryngeal and pharyngeal malignancies in the last decade between North America and Europe, there are unique barriers and challenges to introducing TORS in these two parts of the world. This article describes experiences in developing a TORS program at an academic hospital in Germany. Specifically, steps that were required to obtain institutional approval and financial support, as well as to train surgeons and allied health-care personnel, and to establish a sufficient and adequate technique for reprocessing the used instruments are presented. Introducing a TORS program in Europe is still a challenge in regard to financial issues, acceptance, and practicability and therefore it is only practiced in specialized centers, although systems are widely available and often used in the same hospital by urology departments.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A
105	Steenwyk B, Lyerly R 3rd. Advancements in robotic-assisted thoracic surgery. Anesthesiol Clin. 2012;30(4):699-708.	Advancements in RATS present potential advantages for patients as well as new challenges for the anesthesia and surgery teams. It has become increasingly used as a technique to facilitate less invasive thoracic surgery. As surgical approaches change, it is necessary to understand the impacts these changes have to modify the perioperative care to optimize operative success, safety, and patient satisfaction.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A

106	Corrigan K. Pediatric robotic surgery program requires multidisciplinary team collaboration. AORN J. 2014;99(3):7-8.	At BCH, perioperative nurses on the robotics team feel like an integral part of the surgical team because of the value that BCH leaders placed on multidisciplinary collaboration and effective communication. Reduction in surgical times and improved patient outcomes for the pediatric patient undergoing robotic-assisted laparoscopic surgery are crucial in encouraging and reinforcing the acceptance and use of new and emerging technologies. The improvement in surgical outcomes during a seven-year period at BCH emphasizes that a dedicated and properly trained team can achieve long-term results as safely and often more efficiently using robotic-assisted MIS compared to conventional open surgery procedures.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
107	Pandey R, Garg R, Chandralekha, et al. Robotassisted thoracoscopic thymectomy: perianaesthetic concerns. Eur J Anaesthesiol. 2010;27(5):473-477.	Refinement of the surgical technique is required to avoid compression by robotic arms on any portion of the patient, particularly the upper extremities. The use of beanbag for positioning of the ipsilateral arm needs to be evaluated further. The double lumen tube is to be positioned in such a way as to avoid any obstacle in the movement of robotic arm. We suggest pulse oximeter and arterial blood pressure monitoring in the abducted arm ipsilateral to the surgical approach. The airway pressure and capnography are to be monitored continuously for detection of capnothorax. Patient of robot-assisted thoracoscopic thymectomy should be observed for any nerve injury.	VA	Organizational experience	Patients undergoing RAT	N/A	N/A	17	N/A
108	Best J, Day L, Ingram L, Musgrave B, Rushing H, Schooley B. Comparison of robotic vs standard surgical procedure on postoperative nursing care of women undergoing total abdominal hysterectomy. Medsurg Nurs. 2014;23(6):414-421.	Statistically significant differences in intraoperative fluids, estimated blood loss, and postoperative pain levels were identified, but no significant differences in complication rates were found between the two groups.	IIIA	Research retrospective	Reviewed the records of patients undergoing a traditional TAH and RAS	N/A	Robotic assisted total abdominal hysterectomy (TAH) vs traditional (open) TAH.	104	Blood loss, postoperative pain levels, and complication rates.

109	Nayeemuddin M, Daley SC, Ellsworth P. Modifiable factors to decrease the cost of robotic-assisted procedures. AORN J. 2013;98(4):343-352.	Information on the cost of robotic surgery for various procedures. Two modifiable factors that contribute to increasing the annual caseload are increasing the number of surgeons capable of using the system and having a properly educated perioperative nursing team. An educated surgical team decreases turnover time, facilitates proper flow of each surgical procedure, and is able to actively and passively solve intraoperative problems.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
110	Yuh B. The bedside assistant in robotic surgery—keys to success. Urol Nurs. 2013;33(1):29-32.	Taking on the position of bedside assistant for a surgical robotic team can be a daunting task. Keys to success include preparation, proper operation set up, effective use of instruments to augment the actions of the console surgeon, and readiness for surgical emergencies. Effective communication, repetitive execution, and readiness facilitate the efforts of the surgical team.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
111	Larson JA, Johnson MH, Bhayani SB. Application of surgical safety standards to robotic surgery: five principles of ethics for nonmaleficence. J Am Coll Surg. 2014;218(2):290-293.	Robotic laparoscopic surgery is growing rapidly and offers an opportunity for patients and surgeons to enjoy benefits of minimally invasive surgery. Responsible training and credentialing become paramount as increasing numbers of health care organizations and surgeons adopt this new complex technology. The culture of safety must serve as the ethical paradigm and the author discusses 5 ethical principles to implement a robotic surgery program. By basing ethical considerations on a just culture, we can embrace a system that values transparency, provides support for surgeons performing robotic surgery, and enables organizations to place patients at the forefront of safe care.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A

112	Christie S. Electromagnetic navigational bronchoscopy and robotic-assisted thoracic surgery. AORN J. 2014;99(6):750-763.	With the use of electromagnetic navigational bronchoscopy and robotics, lung lesions can be diagnosed and resected during one surgical procedure. Global positioning system technology allows surgeons to identify and mark a thoracic tumor, and then robotics technology allows them to perform minimally invasive resection and cancer staging procedures. Nurses on the perioperative robotics team must consider the logistics of providing safe and competent care when performing combined procedures during one surgical encounter. Instrumentation, OR organization and room setup, and patient positioning are important factors to consider to complete the procedure systematically and efficiently. This revolutionary concept of combining navigational bronchoscopy with robotics requires a team of dedicated nurses to facilitate the sequence of events essential for providing optimal patient outcomes in highly advanced surgical procedures.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
113	Kawachi H, Kawachi Y, Ikeda C, Takagi R, Katakura A, Shibahara T. Oral and maxillofacial surgery with computer-assisted navigation system. Bull Tokyo Dent Coll. 2010;51(1):35-39.	This author adapted a commercially available wireless passive marker system which allows calibration and tracking of virtually every instruments in maxillofacial surgery. Virtual computer-generated anatomical structures are displayed intraoperatively in a semi-immersive head-up display. Continuous observation of the operating field facilitated by computer assistance enables surgical navigation in accordance with the physician's preoperative plans. The case report document the potential for augmented visualization concepts in surgical reaction of tumors in the oral and maxillofacial region.	VC	Case report	N/A	N/A	N/A	N/A	N/A

114	Metz P, Adam J, Gerken M, Jalali B. Compact, transmissive two-dimensional spatial disperser design with application in simultaneous endoscopic imaging and laser microsurgery. Appl Opt. 2014;53(3):376-382.	This paper presents a highly scalable, entirely transmissive axial design for a spectral 2D spatial disperser. The proposed design employs a grating prism and a virtual imaged phased array (VIPA). A reasonable imaging performance can be achieved with system diameters of below 5 mm, which renders the proposed 2D spatial disperser design highly suitable for use in future endoscope heads that combine mechanical scan-free imaging and laser microsurgery.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A
115	Muns A, Meixensberger J, Arnold S, et al. Integration of a 3D ultrasound probe into neuronavigation. Acta Neurochir. 2011;153(7):1529-1533.	Case report about using a new ultrasound probe in neurosurgery demonstrated the use of the 3D ultrasound image to merge with navigation system for biopsy through a small craniotomy. 2D ultrasound video images are transferred to navigation system using a analog S-video output. The analog data may mean a loss of quality of the signal and can lead to holes in the volume if the sweep of the probe was not uninterrupted. 3D information is transferred via an Ethernet and is not distorted. The 3D probe does not require a sweeping method but is held still during the image acquisition. This may decrease the risk of injury tot the patient.	VA	Case report	N/A	N/A	N/A	N/A	N/A
116	Kaduk WMH, Podmelle F, Louis PJ. Surgical navigation in reconstruction. Oral Maxillofac Surg Clin North Am. 2013;25(2):313-333.	Equipment required to perform surgical navigation (SN) includes: (1) infrared camera, (2) advanced images of the patient on computer using the navigation software, and (3) an interactive display monitor. Steps in SN include: (1) advanced imaging, (2) data analysis, (3) planning phase, (4) surgical phase, and (5) assessment of results. Because of the complexity of SN a series of check lists have been developed: (1) preoperative, (2) preoperative planning, (3) operating room, (4) intraoperative imaging, and (5) postoperative. SN can be used to manage simple and complex cases. As the surgeon becomes more familiar with SN, more surgical cases can be aided by the use of this technology.	VB	Expert Opinion	N/A	N/A	N/A	N/A	N/A

117	Young PS, Findlay H, Patton JTS, Mahendra A. (iii) Computer assisted navigation in musculoskeletal oncology. Orthop Trauma. 2014;28(5):294-302.	The use of computer navigation in musculoskeletal oncology allows three dimensional integration of local anatomy and tumor extent to identify bony transection points accurately, whilst preserving key structures. The author discussed the indications for navigation assistance in musculoskeletal oncology, along with the limitations and developments within this advancing field.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
118	Mavrogenis AF, Savvidou OD, Mimidis G, et al. Computer-assisted navigation in orthopedic surgery. Orthopedics. 2013;36(8):631-642.	Computer-assisted navigation has a role in some orthopedic procedures. This article reviews the available types of computer-assisted navigation, summarizes the clinical applications and reviews the results of related series using navigation, and informs surgeons of the disadvantages and pitfalls of computer assisted navigation in orthopedic surgery.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
119	Kenngott HG, Wagner M, Gondan M, et al. Real-time image guidance in laparoscopic liver surgery: first clinical experience with a guidance system based on intraoperative CT imaging. Surg Endosc. 2014;28(3):933-940.	The use of intraoperative CBCT and AR for laparoscopic liver resection is feasible and could be considered an option for future liver surgery in complex cases.	VA	Case report	N/A	N/A	N/A	N/A	N/A
120	Zullo MD, McCarroll ML, Mendise TM, et al. Safety culture in the gynecology robotics operating room. J Minim Invasive Gynecol. 2014;21(5):893-900.	Quality of communication and collaboration in the gynecology robotics operating room is high between most positions; however, safety attitude responses are low overall. No differences after RORCC implementation and low response rates may highlight lack of staff support.	IIA	Quasi experimental	Gynecology surgical staff	Safety Attitudes Questionnaire	Scores before and after implementation of safety checklist.	32	Survey results
121	Zender J, Thell C. Developing a successful robotic surgery program in a rural hospital. AORN J. 2010;92(1):72-86.	The next progression for robotic surgery is a move to rural venues. For many small, rural hospitals, however, obtaining a robot may be cost prohibitive, and these facilities may need to explore sources of funding for the program. Developing a robotics program requires intense training by surgeons and all surgical team members. Effective marketing of the program and the dedication and hard work of surgical team members and administrators are vital to ensure the success of the program.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A

122	Gkegkes ID, Karydis A, Tyritzis SI, Iavazzo C. Ocular complications in robotic surgery. Int J Med Robot. 2015;11(3):269-274.	Meticulous preoperative ophthalmological assessment, restriction of intravenous fluids, 'rest stops', eyelid taping and ocular dressings are the major protective measures suggested by the literature. Collaboration between the surgical team and the anesthetist is also essential.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
123	Hung CF, Yang CK, Cheng CL, Ou YC. Bowel complication during robotic-assisted laparoscopic radical prostatectomy. Anticancer Res. 2011;31(10):3497-3501.	Bowel injury during RALP can be managed intraoperatively; unrecognized bowel injury may present with atypical acute abdomen and dissemination of the presentation and management of bowel injury, and modifications to avoid complications might help to produce improved outcomes in RALP.	VA	Case report	N/A	N/A	N/A	N/A	N/A
124	Sarmanian JD. Robot-assisted thoracic surgery (RATS): perioperative nursing professional development program. AORN J. 2015;102(3):241-253.	Competency and training of personnel for robot-assisted thoracic surgery (RATS) is less established compared with other robot assisted specialties. This article provides a RATS perioperative nursing development program for RN circulators and scrub personnel. Development of perioperative nursing knowledge and skills through implementation of targeted training programs enables nurses to provide a safe surgical experience for patients undergoing RATS.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
125	Quinn D, Moohan J. Optimal laparoscopic ergonomics in gynaecology. Obstet Gynaecol. 2015;17(2):77-82.	To date, little attention has been paid to the teaching of operating ergonomics. Suboptimal positioning of the patient or imaging equipment may result in injury to the clinician. In addition, current laparoscopic instruments are not tailored to surgeons of different hand size or stature. This will inevitably have a detrimental effect on surgical productivity and may even result in injury to the patient.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
126	Facility Guidelines Institute; American Society for Healthcare Engineering. Guidelines for Design and Construction of Hospitals and Outpatient Facilities. Chicago, IL: American Society for Healthcare Engineering; 2014.		IVA	Guideline	N/A	N/A	N/A	N/A	N/A

127	Aston G. The hybrid OR. Hosp Health Netw. 2014;88(3):34-37.	A new type of operating room allows breakthrough surgical and interventional procedures, sometimes at the same time. Hospitals are overcoming cost and design challenges and professional turf wars to benefit patients and attract top-notch medical staff.	VC	Expert opinion	N/A	N/A	N/A	N/A	N/A
128	Kirkpatrick AW, Vis C, Dube M, et al. The evolution of a purpose designed hybrid trauma operating room from the trauma service perspective: the RAPTOR (resuscitation with angiography percutaneous treatments and operative resuscitations). Injury. 2014;45(9):1413-1421.	This facility's trauma program conceived, designed, built, and operationalized a purpose-designed hybrid trauma operating room, designated as the resuscitation with angiographic percutaneous techniques and operative resuscitation (RAPTOR) suite, which we believe to be the first such resource designed primarily to serve the exsanguinating trauma patient. The project was initiated after consultations between the trauma programmed and private philanthropists regarding the greatest potential impacts on regional trauma care. The initial capital construction costs were thus privately generated but coincided with a new hospital wing construction allowing the RAPTOR to be purpose-designed for the exsanguinating patient. This manuscript describes the many considerations in the design and refinement of the physical build, equipment selection, human factors evaluation of new combined treatment paradigms, and the final introduction of a RAPTOR protocol.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
129	Baillie J. Dual hybrid suite “a first” for the UK. Health Estate. 2014;68(7):53-58.	Facility experience with installation of a Hybrid OR in a UK hospital. Discussed the design of Hybrid suite in Manchester Royal Infirmary with an emphasis on endovascular minimally invasive procedures.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A

130	Kleiman N. Room considerations with TAVR. Methodist Debakey Cardiovasc J. 2012;8(2):19-21.	While transcatheter aortic valve replacement is considered a viable alternative to traditional surgery for patients with critical aortic stenosis, it is still a cardiac surgical procedure with a steep learning curve. Space consideration is a key aspect of the procedure's success. A TAVR program requires the commitment from and investment of institutional resources, the outfitting of an appropriate procedure room, and meticulous training of a multidisciplinary TAVR team. Careful integration of the various imaging modalities, medical specialties, and equipment is necessary to ensure the safety and efficacy of the procedure and to treat complications that may arise.	VC	Expert opinion	N/A	N/A	N/A	N/A	N/A
131	Knudson L. Hybrid ORs set the stage for cuttingedge care. AORN J. 2012;96(2):C1, C8-C9.	Hybrid ORs are becoming more common throughout the U.S. and are transforming the standard of care.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A
132	Kpodonu J. Hybrid cardiovascular suite: the operating room of the future. J Card Surg. 2010;25(6):704-709.	The evolving specialty of cardiovascular hybrid surgery that involves the integration of advanced interventional techniques into cardiovascular surgery requires sophisticated angiographic imaging capabilities in the operating room (hybrid suite). This new operating-room concept enables new cardiac-surgery therapies and will play a vital role for the advancement of minimally invasive cardiovascular surgery. Careful planning and professional expertise is a key factor for every hybrid room project.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
133	Odle TG. Managing transition to a hybrid operating room. Radiol Technol. 2011;83(2):165-181.	This article presents an overview of the transition to hybrid procedures and designs, the benefits and challenges of the new delivery method, and change management issues for managers of cardiovascular and vascular interventional departments.	VB	Literature review	N/A	N/A	N/A	N/A	N/A
134	Tsagakis K, Konorza T, Dohle DS, et al. Hybrid operating room concept for combined diagnostics, intervention and surgery in acute type A dissection. Eur J Cardiothorac Surg. 2013;43(2):397-404.	Results over a seven-year period of treating acute type A dissection (AAAD) in a hybrid OR are presented. The hybrid OR concept enables the exact diagnosis of coronary status and downstream malperfusion sites and influences the design of surgical and/or endovascular treatment, without time delay and at negligible risk to the patient.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A

135	Schaadt J, Landau B. Hybrid OR 101: a primer for the OR nurse. AORN J. 2013;97(1):81-100.	Because demand for procedures that can be performed in a hybrid OR is increasing, many institutions are considering or are in the process of building a hybrid OR. Currently, no standards exist relative to a hybrid OR's location, design, procedure volumes, patient types, staffing requirements, skill sets, or workflow. The unique technology and equipment inherent to a hybrid OR affects the OR workflow. The ability to successfully plan, design, and implement a hybrid OR program requires strategic vision and the cohesive efforts of a multidisciplinary team, of which the OR nurse is a key member.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
136	Richter PH, Yarboro S, Kraus M, Gebhard F. One year orthopaedic trauma experience using an advanced interdisciplinary hybrid operating room. Injury. 2015;46(Suppl 4):S129-S134.	The use of a hybrid operating room resulted in no higher rate of complication than expected from the same cases in a conventional operating room. The hybrid room did however allow the surgeon to confidently place implants for orthopedic trauma cases, and was most advantageous for spine and pelvis cases, both minimally invasive and conventional. Further, appropriate reduction and implant position was confirmed with 3D imaging prior to leaving the operating room and obviated the need for postoperative CT scan. The hybrid operating room is a useful and safe tool for orthopedic trauma surgery.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
137	Klein LW, Miller DL, Balter S, et al. Occupational health hazards in the interventional laboratory: time for a safer environment. J Radiol Nurs. 2010;29(3):75-82.	Orthopedic injuries occur due to the heavy lead aprons and long hours standing with the weight. Occupational radiation exposure increases the risk for cataracts, cancers and possibly other diseases.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
138	Lauck S, Achtem L, Boone RH, et al. Implementation of processes of care to support transcatheter aortic valve replacement programs. Eur J Cardiovasc Nurs. 2013;12(1):33-38.	The unique needs of TAVR patients and programs require the implementation of unique processes of care and tailored assessment.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
139	Patel SR, Gohel MS, Hamady M, et al. Reducing errors in combined open/endovascular arterial procedures: influence of a structured mental rehearsal before the endovascular phase. J Endovasc Ther. 2012;19(3):383-389.	A structured mental rehearsal before critical stages of procedures may reduce the rate and severity of intraoperative error.	IIA	Quasi-experimental	Combined open/endovascular procedures	Structured mental rehearsal.	Pre and post error rates.	16	Error rate

140	Shunk KA, Zimmet J, Cason B, Speiser B, Tseng EE. Development of a Veterans Affairs hybrid operating room for transcatheter aortic valve replacement in the cardiac catheterization laboratory. JAMA Surg. 2015;150(3):216-222.	The primary factor for development of a successful TAVR program is integration of the heart valve team. Particular adaptations to the cardiac catheterization laboratory environment are required to accommodate an uncompromised HOR in which cardiac and vascular surgeons can be as comfortable as their interventional cardiology colleagues.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A
141	Urbanowicz JA. The hybrid suite—sweet. J Radiol Nurs. 2011;30(2):62-66.	Describe the hybrid OR function, team, nursing care, quality of care and future. Recommend an extended time-out and introduction of each member of the team. This is important in emergency situations so that team members are familiar with the people in the room.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
142	Childs S, Bruch P. Successful management of risk in the hybrid OR. AORN J. 2015;101(2):223-234.	At one facility, implementation of an MRI/OR intervention suite has enhanced surgical care and outcomes. Achieving the benefits of intraoperative MRI can occur with a multidisciplinary, interdepartmental approach to the design and layout of the hybrid environment and through implementation of education and safety protocols, including patient screening and prep for scanning. Personnel, including perioperative nurses, must receive expert hands-on training to successfully mitigate risk and provide care in the hybrid OR setting.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
143	Varu VN, Greenberg JI, Lee JT. Improved efficiency and safety for EVAR with utilization of a hybrid room. Eur J Vasc Endovasc Surg. 2013;46(6):675-679.	Routine EVAR performed in a hybrid fixed-imaging suite affords greater efficiency and less harmful exposure of contrast and possible radiation to the patient. Accurate imaging quality and deployment is associated with less need for additional endograft components, which should lead to improved cost efficiency. Confirmation of these findings might be necessary in a randomized control trial to fully justify the capital expenditure necessary for hybrid endovascular suites.	VA	Organizational experience	N/A	N/A	N/A	N/A	N/A

144	Speiser B, Dutra-Brice C. Transcatheter aortic valve replacement. Dimens Crit Care Nurs. 2014;33(5):262-274.	The authors describe the procedures performed in the hybrid OR TAVR program and how the agency developed protocols. A centralize team was developed to ensure room readiness and staff competency. The use of the Health Failure Mode and Effects Analysis can define high-risk clinical processes and conduct a hazard analysis. Worksheets can show potential failure modes and their probabilities, along with action and outcome measures, team collaboration, extensive screening and selection process.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
145	AORN Position Statement on One Perioperative Registered Nurse Circulator Dedicated to Every Patient Undergoing an Operative or Other Invasive Procedure. AORN, Inc. http://www.aorn.org/guidelines/clinicalresources/position-statements. Accessed October 26, 2016.		IVA	Position statement	N/A	N/A	N/A	N/A	N/A
146	D'Amours SK, Rastogi P, Ball CG. Utility of simultaneous interventional radiology and operative surgery in a dedicated suite for seriously injured patients. Curr Opin Crit Care. 2013;19(6):587-593.	Hybrid suites offer tremendous potential to expedite hemorrhage control in trauma patients. Outcome evaluations from trauma units that currently have operational hybrid suites are required to establish clearer guidelines and criteria for patient management.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
147	Katzen BT, Kiah J, Smith D, Denny D, Stoia M. Hybrid interventional radiology. Perioper Nurs Clin. 2010;5(2):215-227.	The expanding scope of interventional work to intricate cardiology, neuroradiology, oncology, and pulmonary applications in the hybrid interventional environment requires well-trained and highly competent staff that can perform in the most simple to complex combined interventional and open surgical procedures.	VB	Organizational experience	N/A	N/A	N/A	N/A	N/A
148	Karkos CD, Menexes GC, Patelis N, Kalogirou TE, Giagtzidis IT, Harkin DW. A systematic review and metaanalysis of abdominal compartment syndrome after endovascular repair of ruptured abdominal aortic aneurysms. J Vasc Surg. 2014;59(3):829-842.	Abdominal compartment syndrome (ACS) rate was calculated at 8% in patients who had endovascular repair of ruptured abdominal aortic aneurysm (RAAA).	IIA	Systematic review	N/A	N/A	N/A	N/A	N/A

149	Contrera P, Cushing M. Transcatheter aortic valve replacement. AANA J. 2013;81(5):399-408.	30% of elderly patients are not considered candidates for aortic valve replacement because the presence of comorbidities makes the risk of sternotomy and cardiopulmonary bypass prohibitively high. Transcatheter aortic valve replacement (TAVR) is an innovative, high-tech, less invasive alternative. The procedure is usually performed using general anesthesia and a multidisciplinary team from interventional cardiology and cardiothoracic surgery in a "hybrid" operating environment with advanced imaging capabilities. TAVR is considered the treatment of choice for patients who are not surgical candidates and is a proven alternative for high-risk surgical candidates.	VB	Expert opinion	N/A	N/A	N/A	N/A	N/A
150	Smeltzer HG, Scott JR, Frey SA, et al. Collaboration between interventional neurosurgery and vascular surgery in the hybrid operating room. J Radiol Nurs. 2014;33(3):127-131.	This case study illustrates how the hybrid OR environment enables collaboration between surgeons from complementary subspecialties that results in net benefit to this patient with aneurysmal subarachnoid hemorrhage and forbiddingly tortuous vasculature.	VC	Case report	N/A	N/A	N/A	N/A	N/A
151	Guideline for radiation safety. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:333-368.		IVA	Guideline	N/A	N/A	N/A	N/A	N/A
152	Mason SL, Kuruvilla S, Riga CV, et al. Design and validation of an error capture tool for quality evaluation in the vascular and endovascular surgical theatre. Eur J Vasc Endovasc Surg. 2013;45(3): 248-254.	The ICECAP may be a valid instrument for the identification of errors in the vascular and endovascular OR environment when used by an observer as a contemporaneous record. This information can help the team develop efficiencies and assess the impact of interventions to reduce error rates.	IIIA	Non-experimental	Members of vascular surgery team.	N/A	Six primary categories (communication, equipment, procedure independent pressures, technical, safety awareness and patient related) and 20 error sub-categories.	12	Error rate

153	Robbins DA. Current modalities for abdominal aortic aneurysm repair: implications for nurses. J Vasc Nurs. 2010;28(4):136-146.	Four studies were identified during the search. Study trends suggest a perioperative advantage using endovascular repair. However, this advantage does not appear to be maintained in the long term. Each type of repair carries its own risk profile that is likely influenced by additional factors, such as the patient's age and comorbidities. It is critical that healthcare providers are aware of the risks associated with each approach in order to provide optimal patient care.	IIB	Systematic review	N/A	N/A	N/A	N/A	N/A
154	Practice advisory on anesthetic care for magnetic resonance imaging: an updated report by the American Society of Anesthesiologists task force on anesthetic care for magnetic resonance imaging. Anesthesiology. 2015;122(3):495-520.		VA	Position statement					
155	ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013;37(3):501-530.	Guidance on best practices for MRI safety.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A
156	Zhao Y, Chen X, Wang F, et al. Integration of diffusion tensor-based arcuate fasciculus fibre navigation and intraoperative MRI into glioma surgery. J Clin Neurosci. 2012;19(2):255-261.	AF neuronavigation, combined with 1.5 T iMRI, is a feasible method of maximizing resection and minimizing language deficits when removing gliomas that involve the AF.	VA	Organizational experience.	N/A	N/A	N/A	N/A	N/A
157	Ocazionez D, Dicks DL, Favinger JL, et al. Magnetic resonance imaging safety in cardiothoracic imaging. J Thorac Imaging. 2014;29(5):262-269.	Patient safety is a priority for patients undergoing magnetic resonance imaging (MRI).	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A
158	Henrichs B, Walsh RP. Intraoperative MRI for neurosurgical and general surgical interventions. Curr Opin Anaesthesiol. 2014;27(4):448-452.	The increased utilization of MRI during the intraoperative period warrants the anesthesia provider to assure that patients and staff are unharmed because of increased risk of the powerful magnet.	VA	Expert opinion	N/A	N/A	N/A	N/A	N/A

159	Hemingway M, Kilfoyle M. Safety planning for intraoperative magnetic resonance imaging. AORN J. 2013;98(5):508-524.	An intraoperative magnetic resonance imaging (MRI) suite (i.e., a type of hybrid OR) is a high-risk zone that requires well-defined safety procedures to avoid adverse events related to magnetic forces. At one facility, the opening of an MRI suite necessitated the creation of a safety plan to establish guidelines, procedures, education, and nursing care specific to the use of MRI technology in the operative environment. Formation of a steering committee enabled a multidisciplinary approach to planning and implementation. The addition of two new perioperative nursing roles (i.e., MRI control room monitor, MRI safety nurse) addressed staffing challenges related to strictly enforcing MRI safety procedures and delineating duties different from those of the RN circulator. Benefits of a safe approach to an MRI-integrated operative setting included the elimination of an entire surgical experience for patients who underwent additional resection of the tumor during their initial surgical procedure instead of postoperatively or during a subsequent return to the OR.	VB	Expert Opinion	N/A	N/A	N/A	N/A	N/A
160	Oluigbo CO, Rezai AR. Magnetic resonance imaging safety of deep brain stimulator devices. Handb Clin Neurol. 2013;116:73-76.	Deep brain stimulation (DBS) is now an established part of the armamentarium for the treatment of chronic movement disorders.	VB	expert opinion	N/A	N/A	N/A	N/A	N/A
161	Ramsey R. Robotic gynecologic surgery: trends and nurse involvement at a regional hospital. OR Nurse. 2012;6(2):41-44.	The author describes implementation of a robotic GYN program at a community hospital.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A
162	Korb W, Geisler N, Straus G. Solving challenges in inter- and trans-disciplinary working teams: lessons from the surgical technology field. Artif Intell Med. 2015;63(3):209-219.	The intention of this paper is to propose an innovative cooperative working culture for the interdisciplinary field of computer-assisted surgery.	VA	Literature review	N/A	N/A	N/A	N/A	N/A
163	Taylor D. The implementation of a da Vinci Surgical System at The Royal Wolverhampton NHS Trust. J Perioper Pract. 2014;24(3):4-12.	This article describes the implementation of robotic assited surgery.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A
164	Seder CW, Cassivi SD, Wigle DA. Navigating the pathway to robotic competency in general thoracic surgery. Innovations (Phila). 2013;8(3):184-189.	Robot-assisted thoracic surgery can be safely learned when skill acquisition is guided by a structured, competency-based pathway.	VC	Organizational experience	N/A	N/A	N/A	N/A	N/A