

AORN Guideline for Sterile Technique
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
1	Standards of perioperative nursing. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2015:693-732.	Consensus	n/a	n/a	n/a	n/a	This document discusses the standards of perioperative nursing.	IVB
2	Guideline for team communication. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:745-772.	Guideline	n/a	n/a	n/a	n/a	Guidance for team communication in the perioperative setting.	IVB
3	AORN's Perioperative Explications for the ANA Code of Ethics for Nurses with Interpretive Statements. AORN, Inc. https://www.aorn.org/guidelines/clinical-resources/code-	Position Statement	n/a	n/a	n/a	n/a	This document includes explanations of ethical statements to perioperative nurses.	IVB
4	Guideline for surgical attire. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:105-128.	Guideline	n/a	n/a	n/a	n/a	Guidance for surgical attire in the perioperative setting.	IVB
5	Guideline for hand hygiene. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:29-50.	Guideline	n/a	n/a	n/a	n/a	Guidance for hand hygiene in the perioperative setting.	IVB
6	Guideline for medical device and product evaluation. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:183-190.	Guideline	n/a	n/a	n/a	n/a	Guidance for medical device and product evaluation in the perioperative setting.	IVB
7	Guideline for prevention of unplanned patient hypothermia. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:549-572.	Guideline	n/a	n/a	n/a	n/a	Guidance for prevention of unplanned patient hypothermia in the perioperative setting.	IVB
8	Berrios-Torres SJ, Umscheid CA, Bratzler DW, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg. 2017;152(8):784-791.	Guideline	n/a	n/a	n/a	n/a	Reaffirms recommendations from the 1999 edition of the guideline for wearing masks during surgery. Plastic adhesive drapes are not necessary for the prevention of SSI.	IVA
9	O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. Am J Infect Control. 2011;39(4 Suppl 1):S1-S34.	Guideline	n/a	n/a	n/a	n/a	CDC Guideline. States that maximal barrier protections are recommended for the placement of central venous catheters (CVCs), placement of peripherally inserted central catheters (PICCs), and guidewire exchanges.	IVA
10	Siegel JD, Rhinehart E, Jackson M, Chiarello L; Health Care Infection Control Practices Advisory Committee. 2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings. Am J Infect Control. 2007;35(10 Suppl 2):S65-S164.	Guideline	n/a	n/a	n/a	n/a	Recommends glove changes after each patient.	IVA
11	Weber DJ, Rutala WA. Central line-associated bloodstream infections: prevention and management. Infect Dis Clin North Am. 2011;25(1):77-102.	Guideline	n/a	n/a	n/a	n/a	Provides recommendations on prevention and management of CLABSIs, including mask use during placement of central venous catheters (CVCs), placement of peripherally inserted central catheters (PICCs), and guidewire exchanges.	IVB

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12	Chan D, Downing D, Keough CE, et al. Joint practice guideline for sterile technique during vascular and interventional radiology procedures: from the Society of Interventional Radiology, Association of periOperative Registered Nurses, and Association for Radiologic and Imaging Nursing, for the Society of Interventional Radiology (Wael Saad, MD, Chair), Standards of Practice Committee, and Endorsed by the Cardiovascular Interventional Radiological Society of Europe and the Canadian Interventional Radiology Association. J Radiol Nurs. 2012;31(4):130-143.	Case Report	n/a	n/a	n/a	n/a	Masks are required during spinal anesthesia. Cases of bacterial meningitis have been reported even after the 2007 HICPAC recommendation for surgical masks during spinal procedures.	VA
13	Berger SA, Kramer M, Nagar H, Finkelstein A, Frimmerman A, Miller HI. Effect of surgical mask position on bacterial contamination of the operative field. J Hosp Infect. 1993;23(1):51-54.	Literature Review	n/a	n/a	n/a	n/a	Includes information from case reports on the use of masks in spinal anesthesia and epidural catheter placements. Includes a recommendation of surgical mask use during regional anesthesia.	VB
14	Edmiston CE Jr, Seabrook GR, Cambria RA, et al. Molecular epidemiology of microbial contamination in the operating room environment: is there a risk for infection? Surgery. 2005;138(4):573-582.	Guideline	n/a	n/a	n/a	n/a	Makes recommendations for the practice of sterile technique in the Interventional Radiology setting.	IVB
15	McLure HA, Talboys CA, Yentis SM, Azadian BS. Surgical face masks and downward dispersal of bacteria. Anaesthesia. 1998;53(7):624-626.	RCT	30 cardiac catheterization procedures	No mask use and mask use but placement below the level of the nose	Standard mask use over the mouth and nose	Bacterial contamination of settle plates	After completing 30 procedures many of the settle plates were found to have heavy growth associated with no mask usage. Though the study had small sample size and may be limited by a potential for a type 2 error the results showed that a significantly higher number of bacteria were found when no mask was worn versus wearing a full mask.	IB
16	Ha'eri G, Wiley AM. The efficacy of standard surgical face masks: an investigation using "tracer particles." Clin Orthop Relat Res. 1980;(148):160-162.	Nonexperimental	Three separate studies with results merged.	n/a	n/a	Bacterial contamination, nasal swab results, and comparison bacterial results	85.7% of all 70 procedures had strains of coagulase-negative staphylococci (CNS) present of which 51.4% was found to be within 0.5 to 1m from the surgical incision. The researchers concluded that OR personnel do contribute significantly to the contamination with that space. When a surgical mask was worn compared to no mask it was found that it significantly reduced the amount of nasopharyngeal shedding but only for the first 90 minutes. Concluded that mask barrier properties quickly decline and that personnel should consider mask changes at 60-90 minutes especially with rhinorrhea symptoms.	IIB

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17	Chamberlain GV, Houang E. Trial of the use of masks in the gynaecological operating theatre. <i>Ann R Coll Surg Engl.</i> 1984;66(6):432-433.	Quasi-experimental	20 volunteers	Volunteers who talked for 20 min.	n/a	Bacterial contamination of agar plates.	When a mask was worn there was a significant reduction in bacterial contamination. The authors concluded that when a procedure lasts less than 15 min, a face mask should be worn especially when the face will be close to the surgical wound and speaking will be necessary.	IIB
18	Philips BJ, Fergusson S, Armstrong P, Anderson FM, Wildsmith JA. Surgical face masks are effective in reducing bacterial contamination caused by dispersal from the upper airway. <i>Br J Anaesth.</i> 1992;69(4):407-408.	Nonexperimental	20 initial and 10 additional major orthopedic surgeries	n/a	n/a	The presence of albumin in the wound irrigation prior to wound closure.	Albumin was found in all 20 of the initial cases when masks were worn on the outside of a hood style disposable hat. During the second set of 10 additional cases the mask was worn on the inside of the hood style disposable hat. None of the subsequent 10 cases had albumin recovered from the irrigation. Researchers concluded that the leakage of the mask was from the vented areas on the sides and wearing the mask under the hood style disposable hat eliminated venting.	IIIB
19	Alwitry A, Jackson E, Chen H, Holden R. The use of surgical facemasks during cataract surgery: is it necessary? <i>Br J Ophthalmol.</i> 2002;86(9):975-977.	RCT	41 gynecological surgery patients	25 patients had masks worn during the procedure	16 patients had no masks worn during the procedure	SSI and settle plate contamination.	The RCT was stopped early due to SSIs in the unmasked group. There were only infections in the unmasked group but the sample size was very small and it was not reported as significant.	IC
20	29 CFR 1910.1030: Bloodborne pathogens. Occupational Safety and Health Administration. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10051&p_table=STANDARDS . Accessed September 11, 2018.	Quasi-experimental	25 anesthesiologist volunteers	After the 5 minute control period was completed, a clean mask was worn and the volunteer continued speaking for 15 minutes.	The volunteers sat on a chair in a room that was draft free with an agar plate positioned on a wall 30 cm away.	Bacterial contamination of settle plates	The researchers found that wearing of a mask in a simulated setting "almost completely abolished" contamination. Researchers recommended mask use during regional anesthetic blocks.	IIC
21	Mitchell NJ, Hunt S. Surgical face masks in modern operating rooms—a costly and unnecessary ritual? <i>J Hosp Infect.</i> 1991;18(3):239-242.	RCT	221 cataract patients	Wearing a new mask during the procedure	Not wearing any mask during the procedure	Bacterial contamination of settle plates	Masks significantly decrease bacterial contamination.	IB
22	Ritter MA. Operating room environment. <i>Clin Orthop Relat Res.</i> 1999;(369):103-109.	Regulatory	n/a	n/a	n/a	n/a	OSHA Toxic and Hazardous Substances: Bloodborne Pathogens	n/a
23	Ritter MA, Eitzen H, French ML, Hart JB. The operating room environment as affected by people and the surgical face mask. <i>Clin Orthop Relat Res.</i> 1975;(111):147-150.	Nonexperimental	Did not state	n/a	n/a	Bacterial contamination	The researchers concluded that while mask use is appropriate for those at the sterile field, especially during high risk surgery, personnel located one meter back from the OR table may not require masks when forced ventilation is used	IIIB
24	Laslett LJ, Sabin A. Wearing of caps and masks not necessary during cardiac catheterization. <i>Cathet Cardiovasc Diagn.</i> 1989;17(3):158-160.	Quasi-experimental	68 settle plates, 20 in OR hallway corridor and 6 in each of the 8 ORs	No mask use	Mask use	Bacterial contamination	Surgical face mask use had no statistical reduction effect on the bacterial counts in the hallway or the OR.	IIB

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25	Orr NW. Is a mask necessary in the operating theatre? Ann R Coll Surg Engl. 1981;63(6):390-392.	Nonexperimental	The study had two phases with settle plates used in the hallway and in ORs and had study participants vary mask use on a specific schedule.	n/a	n/a	Contamination of air settle plates reported in CFU/ft ² /hr.	Most of the environmental contamination was from people. The closed OR rooms without personnel only had 13.3 CFUs/ft ² /hr. while the ORs with masked personnel was 447.4 CFU/ft ² /hr. Authors also concluded that the fiberglass face masks did not contain but only redirect microorganisms outside the sides of the mask. The researchers concluded that the mask should be worn when surgery is in progress to change the projectile effect of the airflow during breathing and talking.	IIIC
26	Tunevall TG. Postoperative wound infections and surgical face masks: a controlled study. World J Surg. 1991;15(3):383-7; discussion 387-8.	Nonexperimental	504 cardiac catheter procedures	n/a	n/a	SSI	Personnel in the procedure room also did not routinely wear a hat and mask. The study was limited by interventionalist's and fellow's choice about whether to wear a hat or mask. No SSI was found for patients with or without hat and mask use.	IIIB
27	Webster J, Croger S, Lister C, Doidge M, Terry MJ, Jones I. Use of face masks by non-scrubbed operating room staff: a randomized controlled trial. ANZ J Surg. 2010;80(3):169-173.	Nonexperimental	No sample size given. No masks worn in 1 OR over a 6 month period.	n/a	n/a	SSI	SSI rates did not increase. When compared over a five year period there was a significant decrease in infection rates.	IIIC
28	Schweizer RT. Mask wiggling as a potential cause of wound contamination. Lancet. 1976;2(7995):1129-1130.	RCT	3088 patients	No mask use by surgical team in 1551 procedures except in cold or allergic rhinitis symptoms.	Surgical mask use by team in 1537 procedures.	SSI	There was slight more SSIs in the masked group but the difference was not significant and the researchers concluded that mask use may need to be reconsidered.	IB
29	Romney MG. Surgical face masks in the operating theatre: re-examining the evidence. J Hosp Infect. 2001;47(4):251-256.	RCT	811 urological, breast, orthopedic, general, gynecological, obstetric emergency or elective procedures	No mask for non-scrubbed personnel only. N = 410	Mask use. N = 401	SSI	While SSIs were 11.5% for the masked group and 9.0% for the non mask group (non-scrubbed personnel only) the difference was not significant.	IA
30	Vincent M, Edwards P. Disposable surgical face masks for preventing surgical wound infection in clean surgery. Cochrane Database Syst Rev. 2016;4:CD002929.	Nonexperimental	29 in molded mask wiggling group. 15 in molded mask talking group. 15 in fiberglass mask talking group	n/a	n/a	Bacterial contamination of settle plates	Significantly more bacterial contamination was seen on the settle plates from the molded mask wiggling group. Researchers concluded that the type of mask used could be causing skin shedding from the face and contaminating the sterile field.	IIIB
31	Guideline for transmission-based precautions. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018. In press.	Literature Review	n/a	n/a	n/a	n/a	There are numerous pieces of evidence both for and against mask use. The research has many barriers to provide a synthesized result. More research on mask use for the prevention of SSIs is needed before a change in recommendation is made.	VB

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32	Guideline for surgical smoke safety. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:469-498.	Systematic Review	n/a	n/a	n/a	n/a	The systematic review only looked at clean surgical procedures because the authors concluded that these cases were more likely to experience a SSI due to contamination from a mask than a complex case. The results of the analysis showed that while there is no clear evidence that masks decreased the rate of SSI. However, the results cannot be generalizable due to the inclusion parameters (clean cases) and the limited levels and low quality of the evidence included. In order to make conclusions about mask use in surgery for the purposes reducing SSI rates more research is needed.	IIA
33	Jensen PA, Lambert LA, Iademarco MF, Ridzon R; CDC. Guidelines for preventing the transmission of mycobacterium tuberculosis in health-care settings, 2005. MMWR Recomm Rep. 2005;54(RR-17):1-141.	Guideline	n/a	n/a	n/a	n/a	Guidance for prevention of transmissible infections in the perioperative setting.	IVB
34	Hospital Respiratory Protection Program Toolkit. Resources for Respirator Program Administrators. Washington, DC: Occupational Safety and Health Administration; Department of Health and Human Services (NIOSH); 2015.	Guideline	n/a	n/a	n/a	n/a	Guidance for surgical smoke safety for perioperative personnel.	IVB
35	Implementing Respiratory Protection Programs in Hospitals: A Guide for Respirator Program Administrators. Richmond, CA: Occupational Health Branch: California Department of Public Health; 2015.	Guideline	n/a	n/a	n/a	n/a	States that PAPRs should not be used in the presence of a sterile field.	IVA
36	Guidance on personal protective equipment (PPE) to be used by healthcare workers during management of patients with confirmed Ebola or persons under investigation (PUIs) for Ebola who are clinically unstable or have bleeding, vomiting, or diarrhea in U.S. hospitals, including procedures for donning and doffing PPE. Centers for Disease Control and Prevention. https://www.cdc.gov/vhf/ebola/healthcare-us/ppe/guidance.html . Updated August 27, 2015. Accessed September 11, 2018.	Regulatory	n/a	n/a	n/a	n/a	Toolkit outlines resources for hospital respiratory protection programs.	n/a
37	Roberts V. To PAPR or not to PAPR? Can J Respir Ther. 2014;50(3):87-90.	Regulatory	n/a	n/a	n/a	n/a	Discusses implementation of respiratory protection programs.	n/a
38	Guideline for medication safety. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:295-330.	Regulatory	n/a	n/a	n/a	n/a	Guidance on PPE for Ebola, includes information on PAPRs.	n/a

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39	AAMI TIR11:2005. Selection and Use of Protective Apparel and Surgical Drapes in Health Care Facilities. Arlington, VA: Association for the Advancement of Medical Instrumentation; 2005.	Expert Opinion	n/a	n/a	n/a	n/a	Clarity in organizational policy for PAPR use is crucial. Training in donning and doffing N95s and PAPRs is critical. Use of PAPRs without a respiratory protection program in place (including training and policy for use) can lead to increased risk for personnel exposures during the doffing process.	VB
40	ANSI/AAMI PB70:2012. Liquid Barrier Performance and Classification of Protective Apparel and Drapes Intended for Use in Health Care Facilities. Arlington, VA: Association for the Advancement of Medical Instrumentation; 2012.	Guideline	n/a	n/a	n/a	n/a	Guidance for medication safety in the perioperative setting.	IVB
41	Infection Control Devices Branch Division of General and Restorative Devices. Guidance on Premarket Notification [510(k)] Submissions for Surgical Gowns and Surgical Drapes. US Food and Drug Administration. https://www.fda.gov/downloads/medicaldevices/deviceregulationandguidance/guidancedocuments/ucm081305.pdf . Published 1993. Accessed September 11, 2018.	Expert Opinion	n/a	n/a	n/a	n/a	Design of barrier materials is dependent on many factors.	VC
42	Meyer KK, Beck WC. Gown-glove interface: a possible solution to the danger zone. Infect Control Hosp Epidemiol. 1995;16(8):488-490.	Guideline	n/a	n/a	n/a	n/a	Makes recommendations regarding drapes and surgical gowns for liquid barrier performance and classification levels.	IVC
43	Fraser JF, Young SW, Valentine KA, Probst NE, Spangehl MJ. The gown-glove interface is a source of contamination: a comparative study. Clin Orthop Relat Res. 2015;473(7):2291-2297.	Regulatory	n/a	n/a	n/a	n/a	Provides guidance on labeling for reusable gowns.	n/a
44	Ritter MA, Eitzen HE, Hart JB, French ML. The surgeon's garb. Clin Orthop Relat Res. 1980;(153):204-209.	Nonexperimental	Three tests, sample sizes of each was not provided	n/a	n/a	Wetness of the forearm	The gown-glove interface is the weakest part of the barrier and the most frequently exposed site for the wearer. The surgical glove should completely cover the knitted material at the gown cuff.	IIIB
45	Wendlandt R, Thomas M, Kienast B, Schulz AP. In-vitro evaluation of surgical helmet systems for protecting surgeons from droplets generated during orthopaedic procedures. J Hosp Infect. 2016;94(1):75-79.	Nonexperimental	5 gown types (some toga and some gown/hood combinations)	n/a	n/a	Ultraviolet powder contamination at the gown-glove interface as read by Likert scale from 0-4.	All 5 types of gowns had contamination at the gown-glove interface, one toga style surgical helmet system had more than other types. This interface site is an area of concern for contamination.	IIIB
46	Hirpara KM, O'Halloran E, O'Sullivan M. A quantitative assessment of facial protection systems in elective hip arthroplasty. Acta Orthop Belg. 2011;77(3):375-380.	Quasi-experimental	100 consecutive total hip replacement procedures, random selection of head covering worn.	Head covering of various configurations H	Head covering control - no head covering	Bacterial contamination	Wrap-around gowns worn over surgical attire reduced environmental contamination by 51%	IIB

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47	Putzer D, Lechner R, CoracaHuber D, Mayr A, Nogler M, Thaler M. The extent of environmental and body contamination through aerosols by hydro-surgical debridement in the lumbar spine. Arch Orthop Trauma Surg. 2017;137(6):743-747.	Quasi-experimental	10 trials for the 2 groups in hip arthroplasty and 10 trials for the 2 groups in knee arthroplasty.	Surgical helmet system toga	Conventional gown	Simulated contamination through fluorescent droplet spray.	The study found that the forehead and neck had a 30% chance of being contaminated with splatter or spray during knee and hip arthroplasty procedures and that the surgical helmet system toga was more protective than the conventional gown.	IIB
48	Information statement: preventing the transmission of bloodborne pathogens. American Association of Orthopaedic Surgeons. https://www.aaos.org/uploadedFiles/PreProduction/About/Opinion_Statements/advistmt/1018%20Preventing%20the%20Transmission%20of%20Bloodborne%20Pathogens.pdf . Updated 2008. Accessed September 11, 2018.	Nonexperimental	102 Surgical helmet system hoods from 34 total hip arthroplasty procedures	n/a	n/a	Mask splatter	Splatter was present on 100% of hoods. The percentage of unprotected area covered by goggles was 50.60% and for visors was 45.40%. This led the researchers to conclude that visors and goggles are insufficient PPE against splatter for scrubbed team members in total hip arthroplasty cases. A surgical helmet system is preferred for PPE.	IIIB
49	Tokars JI, Chamberland ME, Schable CA, et al. A survey of occupational blood contact and HIV infection among orthopedic surgeons. The American Academy of Orthopaedic Surgeons Serosurvey Study Committee. JAMA. 1992;268(4):489-494.	Quasi-experimental	Six trials performed on a single male cadaver	Three experiments performed with a hydrosurgical device and a clear plastic cover drape with a window	Three experiments performed with a hydro-surgical device without a cover drape	Bacterial contamination of the OR environment and personnel	Contamination of the environment and personnel was present both with and without the drape when a high-pressure hydro-surgical device was used. However, the addition of the disposable tent cover drape with an open window did significantly reduce contamination of the OR and reduce contamination of personnel, but did not eliminate contamination completely.	IIB
50	Panlilio AL, Foy DR, Edwards JR, et al. Blood contacts during surgical procedures. JAMA. 1991;265(12):1533-1537.	Consensus	n/a	n/a	n/a	n/a	Recommendations for preventing transmission and exposures to bloodborne pathogens in orthopedic surgery.	IVB
51	Noguchi C, Koseki H, Horiuchi H, et al. Factors contributing to airborne particle dispersal in the operating room. BMC Surg. 2017;17(1):78.	Nonexperimental	3420 surgeons attending conference	n/a	n/a	survey results	Found that 87.4% of surgeons had experienced skin exposure to a potentially infectious material within the previous month. There are high rates of blood contact with potential for surgical exposure to potentially infectious material.	IIIB
52	Heal JS, Blom AW, Titcomb D, Taylor A, Bowker K, Hardy JR. Bacterial contamination of surgical gloves by water droplets spilt after scrubbing. J Hosp Infect. 2003;53(2):136-139.	Nonexperimental	206 observed trauma, burn or emergency orthopedic procedures	n/a	n/a	Bloodborne pathogen exposures	30.1% of the observed procedures had a bloodborne pathogen exposure. 90% of the exposures were skin contacts. 50% of the skin contact exposures were from soaked clothing.	IIIB

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53	Bible JE, Biswas D, Whang PG, Simpson AK, Grauer JN. Which regions of the operating gown should be considered most sterile? Clin Orthop Relat Res. 2009;467(3):825-830.	Nonexperimental	Draping the instrument table, gowning and removing gloves and draping a knee were each performed five times and reviewed for particles that were counted by a particle visualizer.	n/a	n/a	particle counts	Donning gowns and removing gloves were correlated to high particle dispersal rates. The researchers concluded that donning sterile gowns and removing sterile gloves should be completed away from the sterile field.	IIIB
54	Laufman H, Eudy WW, Vandernoot AM, Harris CA, Liu D. Strike-through of moist contamination by woven and nonwoven surgical materials. Ann Surg. 1975;181(6):857-862.	Nonexperimental	2 stages. Stage 1 looked at the bacterial content of water droplets from the upper limbs of 15 surgeons who had scrubbed. Stage 2 reviewed the paper glove wrapper (of 2 types) for permeability to bacteria.	n/a	n/a	Bacterial contamination	Overall, 6 of the 15 scrubbed surgeons grew bacteria. The paper trials showed that after 2 minutes of being wet, gram-positive organisms can strike through the paper glove wrappers. The researchers concluded that impermeable glove wrapper should be used and that the gloves should not be opened on the gown.	IIC
55	Jones C, Brooker B, Genon M. Comparison of open and closed staff-assisted glove donning on the nature of surgical glove cuff contamination. ANZ J Surg. 2010;80(3):174-177.	Quasi-experimental	100 sterile gowns	Cultures taken in 6" increments down the front of 50 sterile disposable sterile gowns. Also cultured both elbow crease from two inches below to two inches above the elbow.	Assessed another 50 sterile gowns as negative controls. The negative control samples were obtained after donning but prior to entering the sterile field area.	Bacterial contamination	All 50 of the intervention gowns were positive for bacterial contamination. Only one of the control gowns was positive for bacterial contamination near the bottom of the gown. The rate of bacterial contamination of the intervention gowns varied from 6-48% depending on the location. Overall bacterial contamination was most prevalent above the chest and below the level of the sterile table. The elbow crease swabs also showed a high rate of contamination in the elbow area.	IIC
56	Mischke C, Verbeek JH, Saarto A, Lavoie MC, Pahwa M, Ijaz S. Gloves, extra gloves or special types of gloves for preventing percutaneous exposure injuries in healthcare personnel. Cochrane Database Syst Rev. 2014(3):CD009573.	Nonexperimental	Permeability testing of 7 woven and 8 non-woven surgical gown and drape materials	n/a	n/a	Bacterial contamination	Not all surgical gown and drape material is impermeable to moisture for equal periods of time. The sterile gown cuffs may cause immediate exposure to potentially infectious material.	IIC
57	de Oliveira AC, Gama CS. Evaluation of surgical glove integrity during surgery in a Brazilian teaching hospital. Am J Infect Control. 2014;42(10):1093-1096.	RCT	Two surgeons were gloved 20 times after their fingers and hands were covered with an ultraviolet powder.	Closed-assisted gloving	Open-assisted gloving	Ultraviolet powder contamination	When open-assisted gloving was used there was significantly more ultraviolet contamination of the glove cuff area than when closed-assisted gloving was used.	IB

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58	Korniewicz D, El-Masri M. Exploring the benefits of double gloving during surgery. <i>AORN J.</i> 2012;95(3):328-336.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Double gloving significantly reduces the risk of glove perforations and is a recommended practice. Indicator systems reduce the number of perforations per glove.	IA
59	Kuroyanagi N, Nagao T, Sakuma H, et al. Risk of surgical glove perforation in oral and maxillofacial surgery. <i>Int J Oral Maxillofac Surg.</i> 2012;41(8):1014-1019.	Nonexperimental	1090 gloves from 100 procedures including gastroenterology, cardiovascular, and pediatrics	n/a	n/a	Glove perforations	Surgeries over 150 minutes were significantly associated with perforations. Double-gloving with a perforator indicator system is crucial.	IIIB
60	Guideline for sharps safety. In: <i>Guidelines for Perioperative Practice.</i> Denver, CO: AORN, Inc; 2018:415-438.	Nonexperimental	702 participants from two medical centers and one trauma center that included 37,794 gloves from 4580 surgeries or events, of which 8,723 pairs were donned in a double glove manner of which 5,725 included a green indicator system.	n/a	n/a	Visible glove defects, glove water leaks, and perceptions related to gloving and double gloving.	Visible defects were not seen frequently but water leaks were found in 6.3% of all gloves in a single glove system and 1.9% of all inner gloves in a double glove system. Meaning that defects might not be seen but could be present up to 6.3% of the time in a single glove method. This supports the idea that to reduce exposures for patient and personnel that double gloving is ideal to reduce inner glove non-visible perforations down to 1.9%. This study also supported use of indicator double gloving systems, which researchers found increased the frequency of glove changes, supporting the idea that perforations are easier to identify.	IIIA
61	Revised statement on sharps safety. American College of Surgeons. https://www.facs.org/about-ac/s/statements/94-sharps-safety . Updated October 1, 2016. Accessed September 11, 2018.	Nonexperimental	1436 gloves from 150 oral and maxillofacial procedures.	n/a	n/a	Glove perforation rates	The scrub person had the highest rate of glove perforations at 17.4% of the total perforation rate. The researchers stated this percentage to be a rate of 1 perforation per orthognathic cases. Less experienced scrub nurses (less than 4 years) were significantly more likely to have a perforation. Most perforations occurred on the non-dominant hand, first forefinger. The researchers concluded that double gloving offers a 95.2% protection rate in orthognathic surgery. The researchers also recommended glove changes during short intervals in cases prone to perforation. The time duration for glove changes was not stated and requires further study.	IIIB
62	Global Guidelines for the Prevention of Surgical Site Infection. Geneva, Switzerland: World Health Organization; 2016.	Guideline	n/a	n/a	n/a	n/a	Guidance for sharps safety in the perioperative setting.	IVB
63	Han CD, Kim J, Moon SH, Lee BH, Kwon HM, Park KK. A randomized prospective study of glove perforation in orthopaedic surgery: is a thick glove more effective? <i>J Arthroplasty.</i> 2013;28(10):1878-1881.	Position Statement	n/a	n/a	n/a	n/a	ACS revised statement on sharps safety addressing double gloving.	IVB

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64	Tanner J, Parkinson H. Double gloving to reduce surgical cross-infection. Cochrane Database Syst Rev. 2009;3:CD003087.	Guideline	n/a	n/a	n/a	n/a	Makes recommendations on surgical hand asepsis, drapes, plastic incise drapes, wound protectors, surgical gloves, and laminar air flow.	IVA
65	Edlich RF, Wind TC, Hill LG, Thacker JG. Creating another barrier to the transmission of bloodborne operative infections with a new glove gauntlet. J Long Term Eff Med Implants. 2003;13(2):97-101.	Nonexperimental	1170 gloves taken from 70 total knee arthroplasties and 40 tactile sensitivity tests	n/a	n/a	Glove perforations and tactile sensitivity	Researchers found that thick outer latex gloves reduced tactile sensitivity but were not correlated with greater protection from perforation than conventional outer gloves. The surgeon was more likely to have perforation in the outer glove than any other scrubbed team member.	IIIA
66	Kojima Y, Ohashi M. Unnoticed glove perforation during thoracoscopic and open thoracic surgery. Ann Thorac Surg. 2005;80(3):1078-1080.	Nonexperimental	Gloves from the surgeon from 47 thoracic procedures including 24 laparoscopic and 23 open procedures. Including contaminated and changed gloves.	n/a	n/a	Length of time worn and perforation rates	There were significantly less perforations in laparoscopic procedures than in open procedures. The perforation rate was significantly higher in thoracoscopic procedures that were longer than 2 hours.	IIIB
67	Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee, HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. MMWR Recomm Rep. 2002;51(RR-16):1-45, quiz CE1-4.	Nonexperimental	Eight volunteers donned one of the three types of disposable surgical gowns then randomly donned either a narrow or normal sized glove gauntlet.	n/a	n/a	Force necessary to separate the glove gauntlet from the gown cuff.	Glove-gown interface is weakest part of the barrier protection and can be permeable to water. All the glove cuffs of all the gown types were permeable to water and could allow for exposure to potentially infectious materials. The narrow glove gauntlet increased the security of the cuff by almost 2 fold no matter which gown was worn.	IIIB
68	Harnoss JC, Partecke LI, Heidecke CD, Hubner NO, Kramer A, Assadian O. Concentration of bacteria passing through puncture holes in surgical gloves. Am J Infect Control. 2010;38(2):154-158.	Expert Opinion	n/a	n/a	n/a	n/a	Gown-glove interface is the weakest point for the gown and glove barrier system during surgery.	VB
69	Hubner NO, Goerd AM, Stanislowski N, et al. Bacterial migration through punctured surgical gloves under real surgical conditions. BMC Infect Dis. 2010;10:192.	Quasi-experimental	47 thoracic procedures including 24 thoracoscopic and 23 open procedures	Gloves used during the procedures by a single surgeon	23 unused sterile gloves	Rate of unnoticed glove perforations	The glove and procedure perforation rates were significantly lower in thoracoscopic procedures (25%) than open procedures (70%). There was no difference in perforation rate between gloves worn on any specific hand. When gloves were worn for more than 2 hours during thoracoscopic procedures there was a significantly higher perforation rate.	IIB
70	Partecke LI, Goerd AM, Langner I, et al. Incidence of microperforation for surgical gloves depends on duration of wear. Infect Control Hosp Epidemiol. 2009;30(5):409-414.	Guideline	n/a	n/a	n/a	n/a	Reviews basic hand hygiene information along with types of antiseptics, timing for various types of hand hygiene practices and evidenced-based strategies to improve hand hygiene.	IVA

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71	Guideline for a safe environment of care. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:e103-e132.	Quasi-experimental	128 outer gloves and 122 inner gloves from 20 septic laparotomies.	Intraoperative swab of the outer glove	Bacterial contamination from the inner glove	Bacterial contamination and glove perforations	The average perforation rate of the outer glove was 15%. 82% of perforations were unnoticed by the perioperative team. Most (86%) of perforations occurred in the non-dominant hand with the index finger being the most likely place of perforation at 36%. Bacterial contamination of the outer glove from the inner glove was 4.7%.	IIA
72	Thomas S, Padmanabhan TV. Methyl methacrylate permeability of dental and industrial gloves. N Y State Dent J. 2009;75(4):40-42.	Nonexperimental	194 gloves consisting of 98 outer and 96 inner gloves were collected from 20 consecutive elective and emergency laparotomy procedures.	n/a	n/a	Bacterial contamination and glove perforations	During an average of 100 minutes of wear, the outer glove perforation rate was 10%. Most perforations occurred in the non-dominant hand with the index finger being the most likely area of perforation at 25%. Six of the procedures had bacterial contamination intraoperatively on the outer glove that was linked to bacterial contamination of the inner glove. For perforated gloves the calculated bacterial migration from inner to outer glove was 50%.	IIIB
73	Waegemaekers TH, Seutter E, den Arend JA, Malten KE. Permeability of surgeons' gloves to methyl methacrylate. Acta Orthop Scand. 1983;54(6):790-795.	RCT	898 pairs of used surgical gloves	Use of surgical gloves	Compared against length of time until perforation, role of the team member with the perforation, and different hands and digits that became perforated	micro perforations	Gloves that were worn for 90 minutes or less had the least amount of perforations. Perforations increased with time worn. No difference was found in the rate of perforations for the role of the scrubbed person. Most perforations were on the left hand and mostly the left index finger. Recommends changing gloves after 90 minutes of surgery.	IA
74	Edwards TB, Habetz S, D'Ambrosia RD. The effect of polymethyl methacrylate on latex-free surgical gloves. J Arthroplasty. 2001;16(4):541-542.	Guideline	n/a	n/a	n/a	n/a	Guidance for a safe environment of care in the perioperative setting.	IVB
75	Bible JE, O'Neill KR, Crosby CG, Schoenecker JG, McGirt MJ, Devin CJ. Microscope sterility during spine surgery. Spine (Phila Pa 1976). 2012;37(7):623-627.	Nonexperimental	7 of each of the following glove types latex, vinyl, and industrial neoprene gloves.	n/a	n/a	Monomer estimation over time done by spectrophotometer.	MMA permeability is dependent on the type of glove used and the duration it is worn. Both vinyl and latex gloves were permeable to MMA from the first minute. Neoprene industrial gloves were impervious for over 25 minutes. Recommended to read the manufacturer's instructions prior to use.	IIIB
76	Peters PG, Laughlin RT, Markert RJ, Nelles DB, Randall KL, Prayson MJ. Timing of C-arm drape contamination. Surg Infect (Larchmt). 2012;13(2):110-113.	Nonexperimental	7 surgeon gloves, three examination gloves, and a household glove	n/a	n/a	Glove density, water permeability,	The low molecular weight content in surgical gloves dissolves when in contact with MMA. The surgeon's gloves as a whole became less permeable to water after exposure to MMA. Vinyl had the highest initial permeability. Polyethylene copolymer had the best protection from MMA diffusion but is not recommended due to limited elasticity. Better glove material is needed to protect from MMA exposure and reduce the potential for glove permeability.	IIIB

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77	Singh VK, Hussain S, Javed S, Singh I, Mulla R, Kalairajah Y. Sterile surgical helmet system in elective total hip and knee arthroplasty. J Orthop Surg (Hong Kong). 2011;19(2):234-237.	Nonexperimental	not reported	n/a	n/a	Glove holes	Alleguard latex-free gloves are susceptible to hole formation after handling bone cement.	IIIC
78	Kearns KA, Witmer D, Makda J, Parvizi J, Jungkind D. Sterility of the personal protection system in total joint arthroplasty. Clin Orthop Relat Res. 2011;469(11):3065-3069.	Nonexperimental	25 single surgeon spine procedures that used a microscope	n/a	25 microscope drapes were swabbed after application for negative controls and an undraped technician console was swabbed on each microscope as a positive control.	Bacterial contamination	The negative control drapes had no contamination. All of the technician console positive controls were contaminated. 96% of the used drapes were contaminated. Of the used drapes, all of the seven swabbed areas had contamination rates between 12% to 44%. The areas of the used drapes with significant contamination included the shafts of the optic eye pieces on the main surgeon side, the forehead position on both the surgeon and assistant side, and the overhead portion of the drape. Researchers recommended changing gloves after touching the optic eyepieces and avoiding handling any part of the drape above the eyepieces.	IIIB
79	Young S, Chisholm C, Zhu M. Intraoperative contamination and space suits: a potential mechanism. Eur J Orthop Surg Traumatol. 2014;24(3):409-413.	Nonexperimental	30 consecutive fracture fixation procedures using full size c-arm	n/a	n/a	Contamination of the c-arm cover, time to contamination, number of personnel and door openings.	In five cases the c-arm was not contaminated and in 5 cases the c-arm was contaminated from the start. The contamination rates were as follows 17% at draping, 50% at 20 min, 57% at 40 min, 80% at 80 minutes. The lateral movement of the c-arm was significantly positively correlated to time to contamination. The researchers suggest limiting contact with the c-arm.	IIIB
80	Carter AH, Casper DS, Parvizi J, Austin MS. A prospective analysis of glove perforation in primary and revision total hip and total knee arthroplasty. J Arthroplasty. 2012;27(7):1271-1275.	Quasi-experimental	40 elective total hip and knee arthroplasty procedures	20 procedures with laminar air flow	20 procedures without laminar air flow	Surgical helmet system contamination	The surgical helmet systems had an 80% contamination rate. Researchers recommend avoiding contact with the surgical helmet system during the procedure and changing gloves if contact is made.	IIC
81	Beldame J, Lagrave B, Lievain L, Lefebvre B, Frebourg N, Dujardin F. Surgical glove bacterial contamination and perforation during total hip arthroplasty implantation: when gloves should be changed. Orthop Traumatol Surg Res. 2012;98(4):432-440.	Nonexperimental	5 swabs of the surgical helmet systems worn during 61 primary total hip arthroplasty and 41 total knee arthroplasty procedures	n/a	n/a	Intraoperative contamination rates of surgical helmet systems	At the initial donning of the surgical helmet system the contamination rate was 22%. At the end of the procedure the average contamination rate was 47%. The researchers concluded that the surgical helmet system cannot be assumed to be sterile after it is removed from the initial packaging and that gloves should be changed after it is touched or adjusted during the procedure.	IIIC

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82	Mazurek MJ, Rysz M, Jaworowski J, et al. Contamination of the surgical field in head and neck oncologic surgery. <i>Head Neck</i> . 2014;36(10):1408-1412.	Nonexperimental	12 simulated procedures with 4 different sterile gown configurations	n/a	n/a	Presence of fluorescent powder	All surgical helmet system toga evaluations had migration of powder onto the flexor area of both arms, but most was found on the surgeon's right dominant hand in the flexor area. Only the standard gown group had no powder any areas of the gown. Recommended surgical helmet systems be used for PPE only and that drape tape should be used around the inner glove-gown interface area.	IIIB
83	Li X, Li M, Li J, et al. Glove perforation and contamination in fracture fixation surgeries. <i>Am J Infect Control</i> . 2017;45(4):458-460.	Nonexperimental	3863 gloves from total joint arthroplasty procedures	n/a	n/a	Glove perforation rates	When both outer and inner gloves were perforated the inner glove perforation was only noticed 81% of the time. Meaning careful inspection is warranted when an outer glove perforation is noticed. Revision procedures had a significant number of perforations for the surgeon. Glove perforations were more likely during the critical portions of the case, such as from exposure to implantation in total joint arthroplasty procedures.	IIIB
84	Ward WG, Cooper JM, Lippert D, Kablawi RO, Neiberg RH, Sherertz RJ. Glove and gown effects on intraoperative bacterial contamination. <i>Ann Surg</i> . 2014;259(3):591-597.	Nonexperimental	28 cases with gloves collected from all scrubbed personnel	n/a	n/a	Glove perforation and contamination rates	Glove contamination was found in 53.6% of the procedures. Most of the contamination happened during the joint reduction part of the arthroplasty case. Only 3.5% of the gloves studied had perforations, most from the surgeon on their dominant hand. Perforations were significantly more likely to occur during the incision and implantation stages of the procedure. The perforations were not associated with increased risk of bacterial contamination.	IIIB
85	Young SW, Zhu M, Shirley OC, Wu Q, Spangehl MJ. Do "surgical helmet systems" or "body exhaust suits" affect contamination and deep infection rates in arthroplasty? A systematic review. <i>J Arthroplasty</i> . 2016;31(1):225-233.	Nonexperimental	50 reconstructive head and neck resections. A total of 336 swabs were collected from the surgical field and the drapes within 10cm of exposed skin.	n/a	n/a	Bacterial contamination	Of all the swabs 71% were contaminated and 45% of the contaminated swabs were contaminated with over 1 bacteria source. The researchers reported a larger number of contaminated samples occurring in the second hour. In 15 surgeries one or more swabs was negative after a contaminated sample had already been taken. There was no link between SSI and surgical field contamination, but that contamination of surgical field increases with the duration of the procedure. Recommend decreasing contact with patient's skin and frequent glove changes.	IIIB

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86	Hanselman AE, Montague MD, Murphy TR, Dietz MJ. Contamination relative to the activation timing of filtered-exhaust helmets. <i>J Arthroplasty</i> . 2016;31(4):776-780.	Nonexperimental	408 gloves from 28 procedures of open reduction and internal fixation were used.	n/a	n/a	Bacterial contamination and glove perforations	123 of the 408 gloves were contaminated but were not linked to a specific point in the surgery. Surgeon glove contamination and perforation rates were significantly higher than other scrubbed personnel. Gloves became perforated more frequently during work on the fracture and fixation with plates. The researchers concluded that gloves should be changed regularly to reduce contamination and perforations.	IIIC
87	Anderson DJ, Podgorny K, Berrios-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. <i>Infect Control Hosp Epidemiol</i> . 2014;35(Suppl 2):S66-S88.	Nonexperimental	Glove study had 102 participants. Laboratory strike-through study compared 27 paper gowns and 27 reusable gowns. Glove study two had 251 participants.	n/a	n/a	Bacterial contamination and strike-through	The authors suggest the use of disposable gowns over reusable gowns, especially for implant procedures but to be considered for all procedures. The researchers also recommend the exchange of the outer gloves prior to handling implants. The study also suggests that outer glove exchange be considered during other clinical relevant points during the procedure.	IIIB
88	Dalstrom DJ, Venkatarayappa I, Manternach AL, Palcic MS, Heyse BA, Prayson MJ. Time-dependent contamination of opened sterile operating-room trays. <i>J Bone Joint Surg Am</i> . 2008;90(5):1022-1025.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Body exhaust suits have shown more potential to reduce OR contamination than Surgical Helmet Systems, which have not been shown to reduce deep SSI rates during arthroplasty.	IIIB
89	de Araujo Moriya GA, de Souza RQ, Gomes Pinto FM, Graziano KU. Periodic sterility assessment of materials stored for up to 6 months at continuous microbial contamination risk: laboratory study. <i>Am J Infect Control</i> . 2012;40(10):1013-1015.	Nonexperimental	3 tests of airflow spray pattern from a surgical helmet fan and 8 trials of fan activation	n/a	n/a	Airflow spray pattern measured in distance from the surgical helmet system and ultraviolet particle contamination	Surgical helmet systems may contaminate the OR environment if turned on prior to the helmet and gown donning process being complete. The findings from this study do not explicitly state but do seem to support that surgical helmet systems turned on prior to surgical hand asepsis may potentially contaminate the hands and forearms.	IIIB
90	Menekse G, Kuscu F, Suntutur BM, et al. Evaluation of the time-dependent contamination of spinal implants: prospective randomized trial. <i>Spine</i> . 2015;40(16):1247-1251.	Consensus	n/a	n/a	n/a	n/a	Provides guidance on the use of wound protectors and plastic adhesive incise drapes.	IVA

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91	Panahi P, Stroh M, Casper DS, Parvizi J, Austin MS. Operating room traffic is a major concern during total joint arthroplasty. Clin Orthop Relat Res. 2012;470(10):2690-2694.	RCT	Three groups of 15 instrument trays each exposed for 4 hours.	1 group of 15 trays that were opened and immediately covered with a sterile towel. The trays were left in a locked OR for 4 hours.	One group of 15 instrument trays uncovered with no traffic, another group of 15 instrument trays uncovered with light traffic.	Bacteria and fungal contamination	None of the covered trays were contaminated. Three uncovered instrument trays had immediate contamination and were eliminated from the results. Of the 27 remaining trays at 30 minutes 4% were contaminated and at one hour 15% were contaminated, at 2 hours 22% were contaminated, and at 4 hours 30% were contaminated. Contamination was progressive with time, traffic did not make a difference. Open instruments only when needed and cover when not in use.	IC
92	Bible JE, O'Neill KR, Crosby CG, Schoenecker JG, McGirt MJ, Devin CJ. Implant contamination during spine surgery. Spine J. 2013;13(6):637-640.	RCT	175 containers in four different sterile packaging styles	Contamination of the outer packaging of 150 of the packages	25 packs were opened after the sterilization process	Contamination of the sterile packages	None of the packages opened grew microbial contaminants, suggesting that event related sterility crucial for unopened packages that have not experienced a damaging event (eg, holes, strikethrough)	IB
93	Edmiston CE Jr, Sinski S, Seabrook GR, Simons D, Goheen MP. Airborne particulates in the OR environment. AORN J. 1999;69(6):1169-1179.	Quasi-experimental	2 groups of spinal pedicle screws from implant instrument trays were used.	Group 2 had the implant tray opened and covered immediately with a towel (n=22).	Group 1 had the implant tray opened and left uncovered (n=20).	Screw contamination rates	Neither group had contamination at moment 0 (at opening). At the 30 minute mark a significant difference in contamination began, with the uncovered groups being more contaminated. Contamination started later in the covered group and was significantly less than the uncovered group for the remaining duration of the study period (120 min). Contamination levels were not linked to a risk for postoperative SSIs.	IIA
94	Reason J. Safety in the operating theatre—part 2: human error and organisational failure. Qual Saf Health Care. 2005;14(1):56-60.	Nonexperimental	80 primary total joint procedures and 36 revision total joint procedures	n/a	n/a	Door openings and causes of door openings, personnel category of those opening the door	Door opening averaged 60 in primary procedures and 135 in revision procedures and nurses and manufacturer's representative contributed to the majority of the door openings. Additionally 47% of door opening had no clear cause, leading researchers to question the necessity of opening the door. Since revision cases were significantly higher in traffic the researchers suggest strategies to reduce door opening such as storage of supplies and education of personnel. Researchers also suggested limiting supply opening to right before the supply is needed to limit the exposure of the supply to the increased traffic and potential contaminants.	IIIB

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95	Chosky SA, Modha D, Taylor GJS. Optimisation of ultraclean air. J Bone Joint Surg Br. 1996;78-B(5):835-837.	RCT	105 spinal implant procedures performed by one surgeon	54 procedures were randomized to the covered implant group	51 procedures were in the uncovered implant group	spinal implant contamination	Implants were either randomly covered with a sterile towel on opening or left open to air in one of two non-laminar air flow rooms. Swabs were taken from the top of the implant tray at the end of the implantation phase of the case. The positive control was the outer wrapper of the instrument trays which was swabbed for culture. Covered implants were significantly less contaminated than uncovered implants (2.0% versus 16.7%). Interestingly, none of the following was correlated to implant contamination, length of time open, implant type, amount of implants used, or number of scrubbed personnel. The researchers recommended not opening implants until needed when possible, but need to balance that recommendation with the understanding delayed opening may lead to surgical treatment delays.	IB
96	Andersson AE, Petzold M, Bergh I, Karlsson J, Eriksson BI, Nilsson K. Comparison between mixed and laminar airflow systems in operating rooms and the influence of human factors: experiences from a Swedish orthopedic center. Am J Infect Control. 2014;42(6):665-669.	Quasi-experimental	28 periods of sampling in 38 major vascular surgeries.	Textiles (scrubs, drapes, sterile pack material) made of wood pulp polyester	Textiles made of polypropylene fabric	Types of airborne particulates and bacteria	The study found that the particulates consisted mostly of wood pulp fibers from disposable gowns and drapes. Airborne bacterial identified several pathogenic organisms. The researcher suggested further study on the impact of airborne particulates and bacteria in the OR environment on SSIs.	IIB
97	Guideline for sterilization. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2018:e76-e101.	Expert Opinion	n/a	n/a	n/a	n/a	Classifies human failures, discussed problems with data interpretation of human errors, and discusses how organizational, workplace, and person error pathways occur.	VA
98	Zach J. A review of the literature on bowel technique. ACORN. 2004;17(4):14-19.	Nonexperimental	41 total joint replacements in varying laminar air flow ORs.	n/a	n/a	Bacterial contamination	Bacterial fallout was only present during instrument preparation and not during the operation. Setting up in laminar air flow environments and covering instruments after set up until the patient is transferred to the OR table reduced contamination levels by 28 fold. Excluding covering, the reduction in bacterial contamination was 24-fold for instrument preparation in a laminar air flow room instead of an instrument preparation room.	IIIB
99	Bruen E. Clean/dirty scrub technique: is it worth the effort? Br J Perioper Nurs. 2001;11(12):532-537.	Nonexperimental	63 orthopedic implant procedures with 164 samples from laminar air flow ORs and 91 samples from direct ventilation rooms.	Continuous active air collection during the procedure at the side of the surgical wound or on the mayo stand.	n/a	Colony forming unit results from the filters placed on the plates every 20 minutes. Mean number of people and door openings.	This study supported the use of laminar air flow over directional ventilation in surgery. Also concluded that environmental contamination of adjacent areas may play a factor in the OR and that OR personnel need to understand how ventilation systems work. Door opening rates and number of people also contribute significantly to air contamination. Every door opening increased the CFU by 3% and every person increased the CFUs by 13%.	IIIA
100	Porteous J, Gembey D, Dieter M. Bowel technique in the OR: is it really necessary? Can Oper Room Nurs J. 1996;14(1):11-14.	Guideline	n/a	n/a	n/a	n/a	Guidance for sterilization in the perioperative setting.	IVB

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101	Hao WL, Lee YK. Microflora of the gastrointestinal tract: a review. <i>Methods Mol Biol.</i> 2004;268:491-502.	Literature Review	n/a	n/a	n/a	n/a	Only found 3 articles. Found that infection rates are higher in large bowel procedures than other specialties. One article was a research study on instrument contamination. The other two studies described methods for bowel technique. While the article discussed three methods, two were essentially the same. One method involved setting up a single set up and the second involved a dual set up with the second set up used exclusively for closure.	VB
102	Bures J, Cyraný J, Kohoutová D, et al. Small intestinal bacterial overgrowth syndrome. <i>World J Gastroenterol.</i> 2010;16(24):2978-2990.	Literature Review	n/a	n/a	n/a	n/a	This literature review found 15 related articles discussing topics related to isolation technique. The literature review also synthesized these literature review results into perioperative nursing practice recommendations on both single and dual set ups for isolation technique. The authors also included information about a clinical audit that was completed on isolation technique and found that the practice was varied and inconsistent but that the concept was generally recognized.	VA
103	Husebye E. The pathogenesis of gastrointestinal bacterial overgrowth. <i>Chemotherapy.</i> 2005;51 (Suppl 1):1-22.	Quasi-experimental	60 cultures taken from surgical instruments. 40 from elective large bowel procedures and 20 from elective small bowel procedures.	Two instruments (needle holder used during anastomosis and tissue forceps used to grasp bowel mucosa) from each of the 20 procedures were tested for 40 cultures total from the large bowel group.	20 cultures from the needle holder and tissue forceps from small bowel procedures	Bacterial contamination	Found that surgical instruments used in large bowel resections were significantly more heavily contaminated than instruments used in small bowel resections.	IIA
104	Watanabe A, Kohnoe S, Shimabukuro R, et al. Risk factors associated with surgical site infection in upper and lower gastrointestinal surgery. <i>Surg Today.</i> 2008;38(5):404-412.	Expert Opinion	n/a	n/a	n/a	n/a	This article reviewed the specifics of the microflora in the gastrointestinal tract.	VA
105	Saito Y, Kobayashi H, Uetera Y, Yasuhara H, Kajiura T, Okubo T. Microbial contamination of surgical instruments used for laparotomy. <i>Am J Infect Control.</i> 2014;42(1):43-47.	Expert Opinion	n/a	n/a	n/a	n/a	Discusses the complexities of the microbiome in the small intestine.	VA
106	Hashimoto D, Chikamoto A, Arima K, et al. Unused sterile instruments for closure prevent wound surgical site infection after pancreatic surgery. <i>J Surg Res.</i> 2016;205(1):38-42.	Expert Opinion	n/a	n/a	n/a	n/a	This article discusses diseases related to bacterial overgrowth in the gastrointestinal tract.	VA

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107	Johnson MP, Kim SJ, Langstraat CL, et al. Using bundled interventions to reduce surgical site infection after major gynecologic cancer surgery. <i>Obstet Gynecol.</i> 2016;127(6):1135-1144.	Nonexperimental	941 gastrointestinal surgery patients	n/a	n/a	SSI	This study used multiple logistic regression analysis to find the independent risk factors for SSI in their patient population. The authors concluded that minimal blood loss and strict asepsis were crucial to reduce SSIs in the gastrointestinal surgery patient population.	IIB
108	Bekar A, Kahveci R, Tolunay S, Kahraman A, Kuytu T. Metastatic gliosarcoma mass extension to a donor fascia lata graft harvest site by tumor cell contamination. <i>World Neurosurg.</i> 2010;73(6):719-721.	Nonexperimental	140 pairs of forceps, 60 pairs were tissue forceps and 80 pairs were DeBakey forceps used in laparotomies.	n/a	n/a	colony forming units (CFUs) and ATP testing	There was a 31.4% contamination rate of forceps thought to be sterile. Meaning instruments without any probably reason to suspect contamination may be becoming contaminated on the sterile field. ATP cannot be reliably used as a measure of instrument contamination.	IIB
109	Zemmoura I, Ben Ismail M, Travers N, Jan M, Francois P. Maxillary surgical seeding of a clival chordoma. <i>Br J Neurosurg.</i> 2012;26(1):102-103.	Quasi-experimental	182 open pancreatic resection procedures	93 patients had the new closure technique	89 patients in the control group had the traditional closure method	incisional SSI rates up to 30 days after the procedure	The intervention group had significantly less incisional SSIs (2.2%) than the traditional closure group (12.4%), specifically related to the pancreaticoduodenectomy procedure. Researchers concluded that using unsterile forceps and drapes during closure was effective in reducing incisional SSIs, especially pancreaticoduodenectomy.	IIB
110	McLemore MS, Bruner JM, Curry JL, Prieto VG, Torres-Cabala CA. Anaplastic oligodendroglioma involving the subcutaneous tissue of the scalp: report of an exceptional case and review of the literature. <i>Am J Dermatopathol.</i> 2012;34(2):214-219.	Quasi-experimental	Total 825 open uterine and ovarian cancer procedures and with or without bowel resection	190 from the intervention phase	635 during the preintervention phase	SSI Rates	The study found the bundled elements decreased the overall SSI rate from 6.0% to 1.1%. The post intervention group only had 2 deep SSIs and no incisional SSIs. One of the bundled elements was a sterile closing tray.	IIB
111	Chang H, Ding Y, Wang P, Wang Q, Lin Y, Li B. Cutaneous metastases of the glioma. <i>J Craniofac Surg.</i> 2018;29(1):e94-e96.	Case Report	n/a	n/a	n/a	n/a	Case report of seeding from metastatic cancer case to a graft donor area. Researchers reported that surgical instruments helped the spread of metastatic tumor cells. Authors recommend removing the instrumentation used in resection before closure and irrigating the surgical site.	VA
112	Vogin G, Calugaru V, Bolle S, et al. Investigation of ectopic recurrent skull base and cervical chordomas: the Institut Curie's proton therapy center experience. <i>Head Neck.</i> 2016;38(Suppl 1):E1238-E1246.	Case Report	n/a	n/a	n/a	n/a	Case report of suspected surgical instrument seeding from clival chordoma.	VB
113	Illoreta AMC, Nyquist GG, Friedel M, Farrell C, Rosen MR, Evans JJ. Surgical pathway seeding of clivo-cervical chordomas. <i>J Neuro Surg Rep.</i> 2014;75(2):e246-e250.	Case Report	n/a	n/a	n/a	n/a	Case report of surgical seeding of the scalp from anaplastic oligodendroglioma.	VA

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114	Ortiz H, Armendariz P, Kreisler E, et al. Influence of rescrubbing before laparotomy closure on abdominal wound infection after colorectal cancer surgery: results of a multicenter randomized clinical trial. Arch Surg. 2012;147(7):614-620.	Case Report	n/a	n/a	n/a	n/a	Cutaneous seeding of cranial based astrocytoma possibly from surgical instruments.	VB
115	Bressan AK, Aubin JM, Martel G, et al. Efficacy of a dual-ring wound protector for prevention of surgical site infections after pancreaticoduodenectomy in patients with intrabiliary stents: a randomized clinical trial. Ann Surg. 2018;268(1):35-40.	Nonexperimental	371 patients reviewed for relapse. 5 were identified with seeding along the surgical pathway	n/a	n/a	relapse of cancer	5 of the 13 identified relapse patients had seeding along the biopsy or surgical pathway.	IIIC
116	Papaconstantinou HT, Ricciardi R, Margolin DA, et al. A novel wound retractor combining continuous irrigation and barrier protection reduces incisional contamination in colorectal surgery. World J Surg. 2018;42(9):3000-3007.	Case Report	n/a	n/a	n/a	n/a	Case report of clivo-cervical chordoma seeding after initial open surgery at the skin.	VB
117	Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med. 2006;355(26):2725-2732.	RCT	9 site multicenter study of 969 laparotomy for colorectal cancer resection	N=453. Removal of all drapes, rescrubbing by team members with new drapes and instruments used in closure	N=516. Scrubbed team member glove changes, old drapes covered with new drapes and new instruments used in closure	SSIs - superficial and deep	There were 146 SSIs in the post operative period. 12.8% were from the control group and 17.7% were from the intervention group. Replacement of drapes and re-scrubbing of team members did not make a statistically significant difference in SSI rates. Both groups used new drapes on the surface and new instruments and new gloves.	IA
118	Barnes S. Infection prevention: the surgical care continuum. AORN J. 2015;101(5):512-518.	RCT	107 pancreaticoduodenectomy (PD) patients with a preoperative biliary stent	57 patients were randomized to the group using a dual-ring wound protector	50 patients had no wound protector use	Incisional SSI	The use of a dual-ring wound protector significantly reduced risk for incisional SSIs in PD patients with a preoperative biliary stent. Of the 31.2% of incisional SSIs, 44% occurred in the control group as compared to 21.1% which occurred in the wound protector group. There was also a decreased risk of incisional SSIs found for PD patients and palliative operations.	IB
119	Biswas D, Bible JE, Whang PG, Simpson AK, Grauer JN. Sterility of C-arm fluoroscopy during spinal surgery. Spine (Phila Pa 1976). 2008;33(17):1913-1917.	Nonexperimental	84 from 7 referral centers in the USA.	n/a	n/a	Bacterial contamination	New wound protector device with attached irrigation and suction significantly reduced bacterial contamination of the wound edge including enteric bacteria.	IIIA
120	Gershkovich GE, Tiedeken NC, Hampton D, Budacki R, Samuel SPDE, Saing M. A comparison of three C-arm draping techniques to minimize contamination of the surgical field. J Orthop Trauma. 2016;30(10):e351-e356.	Nonexperimental	1981 ICU months and 375,757 catheter-days	Used bundled interventions.	n/a	Catheter-related bloodstream infections per 1000 catheter-days. Catheter-days	Decreased from 2.7 infections per 1000 catheter-days at baseline to no infections at three months after implementation of the study intervention.	IIIB

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121	Webster J, Alghamdi A. Use of plastic adhesive drapes during surgery for preventing surgical site infection. <i>Cochrane Database Syst Rev.</i> 2015;(4):CD006353.	Expert Opinion	n/a	n/a	n/a	n/a	When basic infection prevention measures are applied reliably, even low infection rates can be reduced. Staff need to be knowledgeable and there should be strong relationships between surgery and IP personnel. Practice of sterile technique should not be different in different hospital locations (eg OR, IR, Cath Lab).	VB
122	Bejko J, Tarzia V, Carrozzini M, et al. Comparison of efficacy and cost of iodine impregnated drape vs. standard drape in cardiac surgery: study in 5100 patients. <i>J Cardiovasc Transl Res.</i> 2015;8(7):431-437.	Quasi-experimental	25 spinal procedures with a regular size fluoroscopy machine performed by 2 spine surgeons.	25 c-arm machine drapes used during spinal procedures by two spine surgeons. Drapes were swabbed from 5 specific locations after being used during a procedure.	25 c-arm drapes were cultured immediately after draping as a positive control group. The c-arm console was also swabbed as a negative control in each of the 25 cases.	Bacterial contamination	100% of the intervention drapes used were contaminated. 96% of the swabs from the c-arm console were also contaminated. The upper portion of the c-arm drape is highly contaminated. The researchers concluded that the top of the c-arm drape should not be considered sterile.	IIB
123	Rezapor M, Tan TL, Maltenfort MG, Parvizi J. Incise draping reduces the rate of contamination of the surgical site during hip surgery: a prospective, randomized trial. <i>J Arthroplasty.</i> 2018;33(6):1891-1895.	Nonexperimental	Three different c-arm draping methods were used in 5 simulations.	n/a	n/a	Drape contamination taken as an average in distance	The traditional three-quarter sheet draping method was contaminated at a level that was within the area of the sterile field when the c-arm was brought into a lateral position. Additionally, the traditional three quarter method of c-arm draping caused the "surgeon's" gown and gloves to be contaminated when the other two methods did not.	IIIB
124	The APSIC Guidelines for the Prevention of Surgical Site Infections. Asian Pacific Society of Infection Control. http://apsic-apac.org/wp-content/uploads/2018/05/APSIC-SSI-Prevention-guideline-March-2018.pdf . Accessed September 11, 2018.	Systematic Review	n/a	n/a	n/a	n/a	There was no new evidence for this Cochrane systematic review update from the 2011 version. Plastic adhesive drapes are not shown to prevent SSIs and there is some evidence to suggest that they may cause SSIs. More randomized control trial research is needed for inclusion in future versions.	IA
125	Surgical site infections: prevention and treatment. Clinical guideline [CG74]. National Institute for Health and Care Excellence. https://www.nice.org.uk/guidance/cg74 . Updated February 2017. Accessed September 11, 2018.	Quasi-experimental	1616	Iodine impregnated plastic adhesive drape	Non-iodine impregnated plastic adhesive drape	SSI	Overall SSI rate and superficial SSI rate was significantly lower in iodine-impregnated plastic adhesive group.	IIA
126	Prävention postoperativer Wundinfektionen: Empfehlung der Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut [Article in German]. <i>Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz.</i> 2018;61(4):448-473.	RCT	Single center, single surgeon. 101 hip procedures, of which 85 were femoral acetabular osteoplasties and the remaining 16 were periacetabular osteomies	50 subjects in the iodine impregnated incise drape group	51 patients with no plastic adhesive drape used	Deep SSI within 6 months with organism identification and postoperative wound complications.	Patients in the iodine-impregnated plastic adhesive drape group had a 12% rate of positive bacterial cultures compared with a positive culture rate of 27.4% in the comparison group. There was also a non-significant increase in bacterial contamination when the iodine-impregnated drape was found to be separated from the skin. The study was stopped early due because of reductions in bacterial counts.	IA

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127	Milandt N, Nymark T, Kolmos HjØ, Emmeluth C, Overgaard S. Iodine-impregnated incision drape and bacterial recolonization in simulated total knee arthroplasty. Acta Orthop. 2016;87(4):380-385.	Guideline	n/a	n/a	n/a	n/a	Provides guidelines on SSI prevention including mention of plastic adhesive drapes. States not to use non-antimicrobial incise drapes. When using an antibiotic-impregnated incise drape only use if the patient does not have an allergy to iodine.	IVB
128	Casey AL, Karpanen TJ, Nightingale P, Conway BR, Elliott TS. Antimicrobial activity and skin permeation of iodine present in an iodine-impregnated surgical incise drape. J Antimicrob Chemother. 2015;70(8):2255-2260.	Guideline	n/a	n/a	n/a	n/a	Provides guidelines on plastic adhesive drapes. States not to use non-antimicrobial incise drapes. When using an antibiotic-impregnated incise drape only use if the patient does not have an allergy to iodine.	IVC
129	Lakhan P, Faoagali J, Steinhardt R, Olesen D. Shelf life of sterilized packaged items stored in acute care hospital settings: factors for consideration. Healthc Infect. 2013;18(3):121-129.	Guideline	n/a	n/a	n/a	n/a	Provides guidelines on plastic adhesive drapes. States that non-antimicrobial incise drapes may increase risk for SSI, but antimicrobial-impregnated incise drapes may decrease SSIs.	IVC
130	Barker CS, Soro V, Dymock D, Fulford M, Sandy JR, Ireland AJ. Time-dependent recontamination rates of sterilised dental instruments. Br Dent J. 2011;211(8):E17.	RCT	20, 13 women and 7 men in simulated total knee arthroplasty procedures.	Use of iodine-impregnated plastic adhesive incise drape on one of the subject's knees	No drape used on the non-selected knee of the same patient, the subjects acted as their own control	Bacterial contamination	There was no statistical differences between the bacterial recolonization of draped or undraped knees. The researchers concluded that the use of iodine-impregnated plastic adhesive drapes did not increase knee recolonization. These findings led the researchers to question the need for these drapes in total knee arthroplasty procedures for the prevention of bacterial recolonization.	IA
131	Butt WE, Bradley DV Jr, Mayhew RB, Schwartz RS. Evaluation of the shelf life of sterile instrument packs. Oral Surg Oral Med Oral Pathol. 1991;72(6):650-654.	Quasi-experimental	20 full thickness skin grafts obtained with consent from women who had apronectomies.	Inoculated skin had a piece of the iodine impregnated drape or the non-iodine impregnated drape placed on the skin and then removed according to a schedule. Skin cultures performed using a scrub cup technique.	Same technique was used with a non-iodine impregnated drape and skin without a drape.	Microbial skin cultures and skin permeability	Overall, the research found that the iodine-impregnated drape had statistically significant antimicrobial properties compared with the non-antimicrobial plastic adhesive incise drape. The study also found skin permeation of iodine down to the deep skin layers	IIB
132	Webster J, Lloyd W, Ho P, Burrige C, George N. Rethinking sterilization practices: evidence for event-related outdated. Infect Control Hosp Epidemiol. 2003;24(8):622-624.	Literature Review	n/a	n/a	n/a	n/a	Authors concluded that event related sterility is dependent on packaging, sterilization, storage and maintenance processes.	VB
133	McCann MT, Gilmore BF, Gorman SP. Staphylococcus epidermidis device-related infections: pathogenesis and clinical management. J Pharm Pharmacol. 2008;60(12):1551-1571.	Quasi-experimental	25 used dental mirrors went through a washer-disinfector cycle, individual packaging, and sterilization	Removed 5 mirrors at 0 (immediately after sterilization), 31, 60, 90, and 124 days	n/a	Bacterial contamination	None of the mirrors has aerobic or anaerobic bacterial contamination at any point in the testing window (0-124 days).	IIB

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134	ANSI/AAMI ST79: Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities. Arlington, VA: Association for the Advancement of Medical Instrumentation (AAMI); 2017.	RCT	7200 packs filled with 3 glass rods. For 12 months 100 packs of paper envelopes, peel pouches, and nylon sleeves were opened and evaluated.	Monthly storage up to 12 months of paper envelopes, peel pouches, and nylon sleeves evaluated. Opened 100 of each type each month until they reached one year.	After initial sterilization, half of all the pouches (1200 paper envelopes, 1200 peel pouches, and 1200 nylon sleeves) were opened	Bacterial contamination	There was no reported difference in contamination rates of the control packs. There was also no statistical difference between paper envelopes and peel pouches. Nylon sleeves had a significant difference between the control and intervention groups. The authors state that this is because the packs were difficult to open in a sterile manner and therefore the items were contaminated upon opening. Most importantly the study results show that there was no increase in contamination of the sterile stored items over time indicating that items can be sterilized and stored in proper conditions for a year with no impact on the sterility of their contents.	IA
135	Rutala WA, Weber DJ; Healthcare Infection Control Practices Advisory Committee (HICPAC). Guideline for disinfection and sterilization in healthcare facilities, 2008. Centers for Disease Control and Prevention. https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines.pdf . Accessed September 12, 2018.	Quasi-experimental	131 sterilized packs containing 262 test items	Every 3 months several sterile test packs were retrieved, opened and tested		Bacterial contamination	All the items were found to be sterile during the two year test period. Researchers concluded that when items are correctly wrapped and sterilized they will remain sterile unless the wrapping is damaged.	IIB
136	21 CFR 801: Labeling. US Government Publishing Office. https://www.gpo.gov/fdsys/granule/CFR-2011-title21-vol8/CFR-2011-title21-vol8-part801 . Accessed September 12, 2018.	Literature Review	n/a	n/a	n/a	n/a	Device-related infections increase morbidity and mortality. The pathogen most responsible for implant biofilm development is often multidrug resistant.	VB
137	21 CFR 801.5: Medical devices; adequate directions for use. US Government Publishing Office. https://www.gpo.gov/fdsys/granule/CFR-2012-title21-vol8/CFR-2012-title21-vol8-sec801-5 . Accessed September 12, 2018.	Guideline	n/a	n/a	n/a	n/a	Provides recommendations on steam sterilization.	IVC
138	Chang CY, Furlong LA. Microbial stowaways in topical antiseptic products. N Engl J Med. 2012;367(23):2170-2173.	Guideline	n/a	n/a	n/a	n/a	CDC/HIPAC Guideline for Sterilization.	IVA
139	Edmiston CE Jr, Leaper D, Spencer M, et al. Considering a new domain for antimicrobial stewardship: topical antibiotics in the open surgical wound. Am J Infect Control. 2017;45(11):1259-1266.	Regulatory	n/a	n/a	n/a	n/a	Code of Federal Regulations Labeling requirement section.	n/a
140	Taaffe K, Lee B, Ferrand Y, et al. The influence of traffic, area location, and other factors on operating room microbial load. Infect Control Hosp Epidemiol. 2018;39(4):391-397.	Regulatory	n/a	n/a	n/a	n/a	Code of Federal Regulations adequate instructions for use of medical devices section	n/a
141	Sadrizadeh S, Tammelin A, Ekolind P, Holmberg S. Influence of staff number and internal constellation on surgical site infection in an operating room. Particuology. 2014;13:42-51.	Expert Opinion	n/a	n/a	n/a	n/a	Update and guidance from the FDA regarding the situation of microbial contamination of skin antiseptic agents.	VB

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142	Mobley KS, Jackson JB 3rd. A prospective analysis of clinical detection of defective wrapping by operating room staff. <i>Am J Infect Control.</i> 2018;46(7):837-839.	Expert Opinion	n/a	n/a	n/a	n/a	Antibiotics used in the OR should be part of a facility antibiotic stewardship program. Consideration of FDA approved antiseptics in place of topical antibiotics should be reviewed.	VB
143	Trier T, Bello N, Bush TR, Bix L. The role of packaging size on contamination rates during simulated presentation to a sterile field. <i>PLoS One.</i> 2014;9(7):e100414.	Nonexperimental	27 recorded procedures	n/a	n/a	Microbial load	Found that microbial loads are correlated to movement. Increased amounts of traffic in a location correlates greater microbial loads. However, number of people and door openings did not correlate to microbial load. Recommends minimizing traffic by sterile field.	IIIC
144	National Patient Safety Goals effective January 2018: hospital accreditation program. In: <i>The Joint Commission Comprehensive Accreditation and Certification Manual. E-dition.</i> Oakbrook Terrace, IL: The Joint Commission; 2017. https://www.jointcommission.org/hap_2017_npsgs/ . Accessed September 12, 2018.	Nonexperimental	Studied simulated 2 OR configurations with equipment and 4 or 10 simulated personnel.	n/a	n/a	Active and passive bacteria-carrying particle dispersion discussed as CFU/m3	Heat discussed as rising thermals from the OR staff, lights and equipment over the OR table can impact airflow. The farther the particle source (i.e. personnel) is from the sterile field the less particles come in contact with it. Recommended limiting personnel in cases with high risk of SSI to no more than five to size people in the OR. This number was cited to limit bacteria to no higher than 10 cfu/m3, based on their results from OR staffing levels and BCP counts.	IIIA
145	National Patient Safety Goals effective January 2018: critical access hospital accreditation program. In: <i>The Joint Commission Comprehensive Accreditation and Certification Manual. E-dition.</i> Oakbrook Terrace, IL: The Joint Commission; 2017. https://www.jointcommission.org/cah_2017_npsgs/ . Accessed September 12, 2018.	Nonexperimental	959 instrument wrap identification of holes and tears by 48 staff on 20 instrument wrappers	n/a	n/a	Correct identification of a hole or tear in an instrument wrapper	Trained OR personnel using standard processes for identification only correctly determined if an instrument wrapper was intact or had a hole or tear 56.1% of the time.	IIIB
146	National Patient Safety Goals effective January 2018: ambulatory health care accreditation program. In: <i>The Joint Commission Comprehensive Accreditation and Certification Manual. E-dition.</i> Oakbrook Terrace, IL: The Joint Commission; 2017. https://www.jointcommission.org/ahc_2017_npsgs/ . Accessed September 12, 2018.	Nonexperimental	97 people for a total of 582 trials.	n/a	n/a	Contamination in the form of ultraviolet powder	Large peel pouches were significantly more contaminated than small peel pouches. Medium sized peel pouches were not as contaminated as large peel pouches but were more contaminated than small peel pouches but it was not a significant finding.	IIIB
147	National Patient Safety Goals effective January 2018: office-based surgery accreditation program. In: <i>The Joint Commission Comprehensive Accreditation and Certification Manual. E-dition.</i> Oakbrook Terrace, IL: The Joint Commission; 2017. https://www.jointcommission.org/obs_2017_npsgs/ . Accessed September 12, 2018.	Accreditation	n/a	n/a	n/a	n/a	2018 Hospital NPSGs	n/a

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148	Tosh PK, Disbot M, Duffy JM, et al. Outbreak of Pseudomonas aeruginosa surgical site infections after arthroscopic procedures: Texas, 2009. <i>Infect Control Hosp Epidemiol.</i> 2011;32(12):1179-1186.	Accreditation	n/a	n/a	n/a	n/a	2018 Critical Access Hospital NPSGs	n/a
149	Parada SA, Grassbaugh JA, DeVine JG, Arrington ED. Instrumentation-specific infection after anterior cruciate ligament reconstruction. <i>Sports Health.</i> 2009;1(6):481-485.	Accreditation	n/a	n/a	n/a	n/a	2018 ASC NPSGs	n/a
150	Blevins FT, Salgado J, Wascher DC, Koster F. Septic arthritis following arthroscopic meniscus repair: a cluster of three cases. <i>Arthroscopy.</i> 1999;15(1):35-40.	Accreditation	n/a	n/a	n/a	n/a	2018 Office Based Surgery NPSGs	n/a
151	Hopper WR, Moss R. Common breaks in sterile technique: clinical perspectives and perioperative implications. <i>AORN J.</i> 2010;91(3):350-364; quiz 365-367.	Case Report	n/a	n/a	n/a	n/a	7 cases of organ/deep space SSI were found at a hospital and linked to residual bioburden in arthroscopic instrument lumens.	VB
152	Smith K, Araoye I, Gilbert S, et al. Is retained bone debris in cannulated orthopedic instruments sterile after autoclaving? <i>Am J Infect Control.</i> 2018;46(9):1009-1013.	Case Report	n/a	n/a	n/a	n/a	An outbreak of 5 SSIs in a fourteen week period was found to be related to bioburden inside a small cannula hex driver used during ACL reconstruction.	VB
153	Markel TA, Gormley T, Greeley D, Ostojic J, Wagner J. Covering the instrument table decreases bacterial bioburden: an evaluation of environmental quality indicators. <i>Am J Infect Control.</i> 2018. doi: 10.1016/j.ajic.2018.02.032.	Case Report	n/a	n/a	n/a	n/a	An outbreak of three cases of septic arthritis from Staphylococcus epidermidis was found during a four day time frame after arthroscopic meniscus repair. The investigation found bioburden in the meniscus repair cannulas and determined that the cannulas were the source of the outbreak.	VB
154	Sommerstein R, Ruegg C, Kohler P, Bloemberg G, Kuster SP, Sax H. Transmission of Mycobacterium chimaera from heater-cooler units during cardiac surgery despite an ultraclean air ventilation system. <i>Emerg Infect Dis.</i> 2016;22(6):1008-1013.	Expert Opinion	n/a	n/a	n/a	n/a	There are different levels of breaks in sterile technique.	VB
155	Schreiber PW, Kuster SP, Hasse B, et al. Reemergence of Mycobacterium chimaera in heater-cooler units despite intensified cleaning and disinfection protocol. <i>Emerg Infect Dis.</i> 2016;22(10):1830-1833.	Quasi-experimental	15 inoculated 5 by 8 mm long cylindrical bone plugs in a cannulated drill bit	3 cannulated drill bits with bone plugs from drilling were inoculated with a mixture of different bacteria and then sterilized at 60, 120, and 180 minutes.	3 negative controls (only were exposed to sterile water), 3 positive controls (were not sterilized)	Bacterial contamination from the drill bit after sterilization with the inoculated bone in place.	89% of the drill bits in the intervention group had no bacterial contamination after sterilization. 11% had contamination. Researchers concluded that sterilization processes may not be effective in eradication of bacteria when bone debris is found in a cannulated instrument. Also concluded that when organic debris is found the instrument should be considered contaminated and removed from the sterile field.	IIB

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156	Stocks GW, Self SD, Thompson B, Adame XA, O'Connor DP. Predicting bacterial populations based on airborne particulates: a study performed in nonlaminar flow operating rooms during joint arthroplasty surgery. <i>Am J Infect Control.</i> 2010;38(3):199-204.	Nonexperimental	Static Testing 9 tables total for each 4, 8, & 24 hour time frames. Dynamic Testing - 9 tests for 1 hour each.	n/a	n/a	Bacterial contamination	Static testing revealed significant decreases in contamination below the two table cover types at the 4 and 8 hour point. There was no difference in bacterial contamination below and above the cover at 24 hours. Found velocity of air at the approximated site of surgical incision was significantly higher than the velocity of the air at the instrument table which was negatively correlated with the significantly high contamination levels at the instrument tables than at the approximate site of surgical incision. The study results supported covering at least portions of the sterile instrument table (eg implants) even during the procedure.	IIIB
157	Andersson AE, Bergh I, Karlsson J, Eriksson BI, Nilsson K. Traffic flow in the operating room: an explorative and descriptive study on air quality during orthopedic trauma implant surgery. <i>Am J Infect Control.</i> 2012;40(8):750-755.	Nonexperimental	One OR with two tests (smoke dispersal and particle counts).	n/a	n/a	Smoke dispersal, particle measurements, and agar plate contamination	It only took 23 seconds for smoke from the heater-cooler device to reach the ultraclean air in the surgical field. When off the heater-cooler device had an average particle count of 5.2 particles a minute. Whereas when the heater-cooler device was on and oriented toward the field it had an average of 139 particles/min and 14.8 particles/min when it was on but oriented away from the surgical field. Researchers concluded that airflow generating devices pointing towards the operative field were more likely to cause airflow into the surgical field than airflow generating devices that were turned off or away from the surgical field.	IIIC
158	Smith EB, Raphael IJ, Maltenfort MG, Honsawek S, Dolan K, Younkins EA. The effect of laminar air flow and door openings on operating room contamination. <i>J Arthroplasty.</i> 2013;28(9):1482-1485.	Nonexperimental	134 water samples and 91 air samples.	n/a	n/a	The presence of mycobacterium chimaera	Heater cooler units in cardiac operating room underwent an intensive water and air sampling protocol to determine contamination. An intensive cleaning protocol was unable to prevent contamination in the water samples, but the air samples showed limited contamination decreasing the likelihood of a risk for surgical site infections. One conclusion was that the manufacturer's recommendations for cleaning of the heater cooler units may not have been effective.	IIIC
159	Teter J, Guajardo I, AlRammah T, Rosson G, Perl TM, Manahan M. Assessment of operating room airflow using air particle counts and direct observation of door openings. <i>Am J Infect Control.</i> 2017;45(5):477-482.	Nonexperimental	22 joint arthroplasties (hip and knee) performed in two ORs	n/a	n/a	Particle counts and size and bacterial contamination	Particles $\geq 10\mu\text{m}$ made up 41% of all particles. Numbers of staff and surgical duration were significantly correlated to particles over $10\mu\text{m}/\text{m}^3$ size and associated (but not significantly) to higher CFUs. Suggests limiting staff.	IIIB
160	Alfonso-Sanchez JL, Martinez IM, Martin-Moreno JM, Gonzalez RS, Botia F. Analyzing the risk factors influencing surgical site infections: the site of environmental factors. <i>Can J Surg.</i> 2017;60(3):155-161.	Nonexperimental	91 samples	n/a	n/a	Bacterial contamination, traffic flow, and number of people in the OR	57% of the air samples collected in the displacement ventilated ORs were over the recommended level of CFUs. Traffic flow per operation was strongly positively correlated to increased CFUs. Increased numbers of people present also increased CFUs.	IIIB

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161	Hansen D, Krabs C, Benner D, Brauksiepe A, Popp W. Laminar air flow provides high air quality in the operating field even during real operating conditions, but personal protection seems to be necessary in operations with tissue combustion. <i>Int J Hyg Environ Health</i> . 2005;208(6):455-460.	Quasi-experimental	642 settle plates, 2 used during each of the 81 orthopedic procedures of varying types.	1 settle plate was placed in a sterile basin inside of the laminar air flow curtain for 30 min of exposure from incision to the completion of the procedure	1 settle plate was placed in a sterile basin outside of the laminar air flow curtain for 30 min of exposure from incision to the completion of the procedure	Bacterial contamination, surgical duration, door openings, number of people, and temperature and humidity	The contamination rate was almost always lower inside the LAF curtain than outside. The study showed that the LAF does keep contamination levels down for surgeries 90 minutes or less. When compared to door openings the LAF was shown to reduce CFUs due to increased door openings but it did not completely negate the effect. The longer the case, the more door openings were recorded. Interestingly the researchers found that any door opening at all increased the number of CFUs significantly - by 70%. Therefore, the first door opening was what was most associated with contamination risk. LAF decreased microbial contamination by 36.6%. Therefore, all parts of the sterile field should be kept in the LAF curtain.	IIIB
162	Namba RS, Inacio MC, Paxton EW. Risk factors associated with deep surgical site infections after primary total knee arthroplasty: an analysis of 56,216 knees. <i>J Bone Joint Surg Am</i> . 2013;95(9):775-782.	Nonexperimental	1 OR with 7 plastic surgery cases over 5 days, 660 air measurements were taken	n/a	n/a	Air particle counts compared against door openings and numbers of personnel	Door openings were significantly positively correlated to increased particles greater than 0.5µ in size. The increase in particles was not associated with a particular door that was opened (eg outer corridor door versus sterile core door). The study found that one or more doors were open during almost half of all measurements taken. Particle counts did not correlate to the number of people in the OR. A third of all door openings was from circulating nurses.	IIIA
163	Agodi A, Auxilia F, Barchitta M, et al. Italian Study Group of Hospital Hygiene. Operating theatre ventilation systems and microbial air contamination in total joint replacement surgery: results of the GISIO-ISChIA study. <i>J Hosp Infect</i> . 2015;90(3):213-219.	Nonexperimental	8 hospitals on the Mediterranean coast of Spain with 18,910 patients (on a Mediterranean diet) of which 1267 experienced an SSI	n/a	n/a	SSI rates based on procedure wound classification and ASA physical status classification correlated to various factors	The SSI rate was minimal in the absence of CFUs, environmental or surface contamination when the surgery was not classified as dirty (bacteria or fungi present), meaning keeping an OR as clean as possible and reducing environmental contamination is crucial. Superficial SSIs were significantly correlated to environmental contamination and surface contamination, meaning that OR personnel can affect superficial SSI rates by activities that keep the levels of OR contamination down. Deep or organ space SSIs were associated with ASA classification, patient factors (eg, age, sex, nutrition), transfusion, type of intervention and days of preoperative stay.	IIIB
164	Diab-Elschahawi M, Berger J, Blacky A, et al. Impact of different-sized laminar air flow versus no laminar air flow on bacterial counts in the operating room during orthopedic surgery. <i>Am J Infect Control</i> . 2011;39(7):e25-e29.	Nonexperimental	105 consecutive surgical procedures under laminar air flow in three ORs lasting an average of 75 minutes	n/a	n/a	Air particle and bacterial contamination at the surgical site and instrument table	Particle levels were significant during tissue coagulation at the surgical site. This finding is important because the authors also found that increased particle levels above 5µm was significantly linked to the number of bacteria. CFUs were also significantly higher prior to incision at the instrument table and surgical site. The researchers concluded that CFU elevation prior to the procedure start may be linked to increased activity prior to incision. Particle counts were not correlated to the amount of conversation.	IIIB

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165	Radcliff KE, Rasouli MR, Neusner AK, Christopher K, et al. Preoperative delay of more than 1 hour increases the risk of surgical site infection. <i>Spine</i> . 2013;38(15):1318-1323.	Nonexperimental	Retrospective review of 56,216 primary total knee arthroplasty cases	n/a	n/a	Deep SSI	Every 15 minute increment in increased surgical time was linked to a 9% increase in deep SSI risk.	IIIA
166	Lynch RJ, Englesbe MJ, Sturm L, et al. Measurement of foot traffic in the operating room: implications for infection control. <i>Am J Med Qual</i> . 2009;24(1):45-52.	Nonexperimental	28 ORs at multiple sites in Northern Italy during 1228 elective orthopedic total hip and knee procedures	n/a	n/a	Bacterial contamination, number of personnel, and number of door openings	There is considerable variability of microbial air contamination between OR ventilation types and in some cases between similar forms of ventilation types, many of which do not meet the standard requirements based on type. Facilities cannot assume that the airflow is providing an environment of acceptable microbial contamination even when it is built, monitored for function, and working correctly. Personnel need to be aware of how ventilation systems work and factors that impact it. The number of personnel and door openings were also significantly correlated with increased bacterial counts.	IIIB
167	Darnley J, Denham Z, Phieffer LS, et al. Cracking the case: should orthopaedic case carts be subjected to more stringent regulations? <i>Curr Orthop Pract</i> . 2017;28(5):453-458.	Nonexperimental	80 procedures, 40 in OR without laminar air flow (LAF), 21 in small ORs with LAF, and 19 in large ORs with LAF.	n/a	n/a	Bacterial contamination	The instrument table had significant numbers of CFUs associated with the smaller size of the laminar air flow system. They did not find an association with the amount of surgical time or number of people present. The authors state that hospitals using LAF systems that are smaller in size (120X240) vs (320x320) may have insufficient coverage of the LAF system in the area over the surgical site and team which may also cause turbulent air in the areas around it where the sterile table is.	IIIB
168	Salvati EA, Robinson RP, Zeno SM, Koslin BL, Brause BD, Wilson PDJ. Infection rates after 3175 total hip and total knee replacements performed with and without a horizontal unidirectional filtered air-flow system. <i>J Bone Joint Surg Am</i> . 1982;64(4):525-535.	Nonexperimental	7991 spine cases at a single center	n/a	n/a	SSI rates against minutes between in room time and incision time	Of the 7991 cases, 276 had SSIs. Patients that had an average in room delay prior to incision of over an hour were significantly more likely to have an SSI. The authors also found a statistically significant correlation between month of surgery and preoperative delay although it was weak.	IIIB
169	Letts RM, Doermer E. Conversation in the operating theater as a cause of airborne bacterial contamination. <i>J Bone Joint Surg Am</i> . 1983;65(3):357-362.	Nonexperimental	3071 door openings in 28 procedures	n/a	n/a	Traffic by service, traffic during specific parts of the procedure, reasons for door openings, traffic compared to procedural duration	Surgical traffic as measured as door openings per hour was varied across surgical specialties. The preincision time frame included 30%-50% of all the door openings recorded. Most door openings occurred because of information requests. As the duration of the procedure increased so did the numbers of door openings.	IIIB
170	Mathijssen NMC, Hannink G, Sturm PDJ, et al. The effect of door openings on numbers of colony forming units in the operating room during hip revision surgery. <i>Surg Infect (Larchmt)</i> . 2016;17(5):535-540.	Organizational Experience	33 orthopedic cases that involved implants	n/a	n/a	OR traffic per hour and length of time supplies were open prior to patient arrival and prior to incision	The supplies were open on average 43.2 minutes prior to patient arrival and 91.5 minutes prior to incision. In 18% of cases the supplies were open and uncovered for more than 2 hours. The preincision time frame was a period of greater activity and had higher traffic levels.	VB

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171	Ritter MA, Eitzen HE, French ML, Hart JB. The effect that time, touch and environment have upon bacterial contamination of instruments during surgery. <i>Ann Surg.</i> 1976;184(5):642-644.	Nonexperimental	3175 primary total hip (N = 2289) and total knee arthroplasty (N = 886) patients	n/a	n/a	Infection Rates	Total hip arthroplasty procedure infection rates decreased when performed in an horizontal unidirectional air flow OR. However, total knee arthroplasty procedures increased when performed in a horizontal unidirectional airflow OR. The researchers found that the scrubbed personnel in the total knee arthroplasty procedures were occasionally positioned between the horizontal unidirectional air flow and the patient's surgical incision site. There was also a statistically significant correlation between the number of people in the OR and the infection rates.	IIIB
172	Campbell BA, Manos J, Stubbs TM, Flynt NC. Pre-preparation of the sterile instrument table for emergency cesarean section. <i>Surg Gynecol Obstet.</i> 1993;176(1):30-32.	Quasi-experimental	Passive (n= 11 positions) and active air sampling while the OR was in use. Used albumin on surgical masks to simulate particles and droplets over a water bath simulating a surgical wound to study conversation	Empty OR's, Spoke aloud during the 5, 10, 20, 30, 40, 50 and 60 minute time periods	Occupied OR's, Spoke two words every 30 seconds	Bacterial contamination	Statistically significantly higher levels of contamination were found when the OR's were occupied. Time and amount of speaking were found to significantly increase bacterial contamination. However, when the mask was worn under a hood there was a reduction in bacteria found. Researcher state that conversations should be limited. Researchers concluded that personnel a main source of bacterial contamination in the OR. In areas of the OR with reduced traffic there was less bacteria found. However, areas in the OR near a door or supplies also has higher levels of bacteria found.	IIB
173	Dharan S, Pittet D. Environmental controls in operating theatres. <i>J Hosp Infect.</i> 2002;51(2):79-84.	Nonexperimental	69 total hip revision procedures from two facilities	n/a	n/a	Bacterial contamination	The authors found a significant correlation between door openings and a high level of CFUs. They did not find an association between OR contamination levels and number of personnel or surgical duration. The study had a consistently low rate of door openings and reported that both hospitals had a strict policy on door openings.	IIIB
174	Stocks GW, O'Connor DP, Self SD, Marcek GA, Thompson BL. Directed air flow to reduce airborne particulate and bacterial contamination in the surgical field during total hip arthroplasty. <i>J Arthroplasty.</i> 2011;26(5):771-776.	Quasi-experimental	520 samples of hemostats for a total of 13 samples during a total of 40 procedures.	1 rack of 13 hemostats was placed on the sterile instrument tables of 20 bilateral total hip arthroplasty procedures with laminar air flow.	1 rack of 13 hemostats was placed on the sterile instrument table of 20 open heart procedure back tables without laminar air flow.	microbial contamination	When in a conventional ventilation OR, the hemostats were statistically significantly more likely to be contaminated, the contamination rates increase with time, and the hemostats touched by the scrub person were more likely to be contaminated. However, in the laminar air flow OR the contamination rate was not high and was consistently low throughout the three hour period and was not dependent on whether the scrub nurse touched the hemostat.	IIB

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175	Fischer S, Thieves M, Hirsch T, et al. Reduction of airborne bacterial burden in the OR by installation of unidirectional displacement airflow (UDF) systems. <i>Med Sci Monit.</i> 2015;21:2367-2374.	Nonexperimental	100 cultures from part one involving 2 sterile instrument tables that were covered and tested each day for 4 days. 80 cultures from part two involving 4 sterile instrument tables that were covered and then uncovered with a rolled technique after seven days.	n/a	n/a	Bacterial and fungal contamination	The tables that were covered and uncovered daily only had two positive cultures found on the third day. However, the cultures taken from the same tables on subsequent days did not have positive cultures. The tables that were set up and covered for 7 days had two positive cultures on the initial culture prior to covering and the cultures taken after 7 days had three positive cultures from different sites than the initial positive cultures on the same tables. The authors concluded that setting up and covering tables for up to 24 hours presents minimal risk to the patient. This study used a rolled method to remove the table cover.	IIIC
176	Perez P, Holloway J, Ehrenfeld L, et al. Door openings in the operating room are associated with increased environmental contamination. <i>Am J Infect Control.</i> 2018;46(8):954-956.	Expert Opinion	n/a	n/a	n/a	n/a	Review of HVAC systems, bacterial and particle monitoring standards.	VB
177	Barr SP, Topps AR, Barnes NL, et al. Infection prevention in breast implant surgery—a review of the surgical evidence, guidelines and a checklist. <i>Eur J Surg Oncol.</i> 2016;42(5):591-603.	RCT	36 total hip arthroplasty patients.	Directed airflow using a portable laminar air flow device and a directed airflow system that was in place but off	Used current practice with no device in place	Particulate and bacterial contamination	The directed air flow group had significantly less bacterial and particle counts.	IB
178	Friberg B, Friberg S, Burman LG. Inconsistent correlation between aerobic bacterial surface and air counts in operating rooms with ultra clean laminar air flows: proposal of a new bacteriological standard for surface contamination. <i>J Hosp Infect.</i> 1999;42(4):287-293.	Quasi-experimental	1286 procedures	Unidirectional displacement airflow	Turbulent mixing ventilation	Bacterial contamination	Unidirectional displacement airflow reduces airborne bacteria.	IIA
179	Cao G, Storås MCA, Aganovic A, Stenstad L, Skogås JG. Do surgeons and surgical facilities disturb the clean air distribution close to a surgical patient in an orthopedic operating room with laminar airflow? <i>Am J Infect Control.</i> 2018. doi: 10.1016/j.ajic.2018.03.019.	Nonexperimental	48 orthopedic and general surgery procedures	n/a	n/a	Bacterial contamination compared to location, number of personnel, temperature, humidity, and active warming devices.	A positive correlation was found between increased door openings and increased levels of CFUs, but only for the subset of cultures done outside of the laminar air flow (not within the LAF). Within the LAF, only staff number was associated with increased levels of CFUs. There was an observational finding that the more people standing at the OR table the more likely that the instrument table would be outside of the LAF air curtain. Concluded that numbers of personnel should be reduced and LAF should be used.	IIIB

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180	De Korne DF, Van Wijngaarden JDH, Van Rooij J, Wauben LSLG, Hiddema UF, Klazinga NS. Safety by design: effects of operating room floor marking on the position of surgical devices to promote clean air flow compliance and minimise infection risks. <i>BMJ Qual Saf.</i> 2012;21(9):746-752.	Systematic Review	n/a	n/a	n/a	n/a	Recommended that personnel coming through doors should be minimized and that laminar air flow be used.	IIIB
181	Darouiche RO, Green DM, Harrington MA, et al. Association of airborne microorganisms in the operating room with implant infections: a randomized controlled trial. <i>Infect Control Hosp Epidemiol.</i> 2017;38(1):3-10.	Nonexperimental	15 tests in disposable attire in vertical laminar air flow of three different sizes, 5 tests with cotton attire in a small vertical laminar air flow unit, and 4 tests in disposable clothing in a horizontal laminar air flow unit.	n/a	n/a	Compared air and surface contamination rates	The surface and air contamination rates at the instrument table area was found to be significant and similar to those seen in turbulent air flow systems.	IIIB
182	Lapid-Gortzak R, Traversari R, van der Linden JW, Lesnik Oberstein SY, Lapid O, Schlingemann RO. Mobile ultraclean unidirectional airflow screen reduces air contamination in a simulated setting for intra-vitreous injection. <i>Int Ophthalmol.</i> 2017;37(1):131-137.	Nonexperimental	4 simulated supine patient cases	n/a	n/a	Air velocity distribution	The effectiveness of a laminar air flow system may be greatly impacted by rising thermals from surgical equipment and personnel. The position of the overhead surgical lights may also greatly influence the effectiveness of the LAF.	IIIB
183	Nilsson K, Lundholm R, Friberg S. Assessment of horizontal laminar air flow instrument table for additional ultraclean space during surgery. <i>J Hosp Infect.</i> 2010;76(3):243-246.	Mixed Method: Nonexperimental and Qualitative	An average of 206 observations were taken in 4 time frames (series)	n/a	n/a	Positioning of sterile field, equipment, and overhead lights in relation to the laminar flow air curtain	The instrument table and the mayo stand were increasingly positioned in the laminar air flow area, with more impact on the instrument table. Eye infections were decreased in the two years following the study. The visual floor marks provided the staff a fool-proof way of determining where the laminar air flow was. It became evident that corneal implants may be occasionally outside of the laminar flow area and that increased the staff's awareness of moving crucial items inside the air flow impact area. There needs to be a way to "mark" the area for the overhead surgical lights to move them out of the laminar flow impact area when not in use.	IIIB
184	Ferretti S, Pasquarella C, Fornia S, et al. Effect of mobile unidirectional air flow unit on microbial contamination of air in standard urologic procedures. <i>Surg Infect (Larchmt).</i> 2009;10(6):511-516.	RCT	294 total hip arthroplasty, vascular bypass graft, or spinal implantation procedures	148 had portable laminar air flow unit used	146 had no portable laminar air flow unit used	Bacterial contamination and SSI rates	Bacterial contamination at the surgical incision site was significantly lower when the portable laminar air flow unit was used. Additionally, the amount of airborne bacteria at the surgical incision site was also significantly related to the implant infection rates. Infections only occurred in the group with did not have a portable laminar airflow unit used.	IB

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185	Sossai D, Dagnino G, Sanguineti F, Franchin F. Mobile laminar air flow screen for additional operating room ventilation: reduction of intraoperative bacterial contamination during total knee arthroplasty. <i>J Orthop Traumatol.</i> 2011;12(4):207-211.	Quasi-experimental	20	Use of a portable unidirectional ultra clean air delivery system	No use of a unidirectional ultra clean air delivery system	particle counts	Mobile unidirectional ultraclean air flow unit significantly reduced the particle concentration over the surgical site and the instrument table.	IIB
186	Thore M, Burman LG. Further bacteriological evaluation of the TOUL mobile system delivering ultra-clean air over surgical patients and instruments. <i>J Hosp Infect.</i> 2006;63(2):185-192.	Quasi-experimental	2 total knee arthroplasty procedures	Use of a table mounted laminar air flow unit	Use a of second table during the same procedure that did not have a mobile laminar air flow unit	particle and bacterial counts	This study is severely limited by size. The first phase of the study showed that the use of a mobile laminar air flow unit mounted to an instrument table outside the main fixed ceiling mounted LAF unit did not affect the airflow of the fixed unit. The second phase of the study found decreased particle and bacteria counts on the instrument tables that used the portable laminar air flow unit.	IIC
187	Information for health care providers and staff at health care facilities. US Food and Drug Administration. https://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/CardiovascularDevices/Heater-CoolerDevices/ucm492583.htm . Accessed September 11, 2018.	Quasi-experimental	45 major urologic procedures	Use of a mobile ultra clean air flow unit	No mobile ultra clean air flow unit was used	Bacterial contamination	When the mobile unidirectional ultra clean air unit was used the instrument table had a statistically significant decrease in bacteria. The use of the mobile unit also significantly decreased bacteria during nephrectomies but not during prostatectomies.	IIB
188	Nagpal A, Wentink JE, Berbari EF, et al. A cluster of <i>Mycobacterium wolinskyi</i> surgical site infections at an academic medical center. <i>Infect Control Hosp Epidemiol.</i> 2014;35(9):1169-1175.	Quasi-experimental	34 total knee arthroplasty cases. The mobile LAF unit was also used on the instrument table for 6 surgeries and then six surgeries without it.	17 procedures had a mobile laminar air flow unit used positioned between two surgeons pointing at the incision site.	17 procedures had no mobile LAF unit	Bacterial contamination and particle counts reported as particles/m3.	Without the mobile LAF the bacterial air count at the surgical wound was 23.5 CFU/m3, with the mobile LAF it was 3.5 CFU/m3, this correlated to a significant 85% reduction.	IIB
189	Bowling FL, Stickings DS, Edwards-Jones V, Armstrong DG, Boulton AJM. Hydrodebridement of wounds: effectiveness in reducing wound bacterial contamination and potential for air bacterial contamination. <i>J Foot Ankle Res.</i> 2009;2(1):1-8.	Nonexperimental	3 different portable unidirectional ultraclean air delivery systems tested.	n/a	n/a	Bacterial deposition rates	Most units reduced the amount of contamination but in some cases it was dependent on the position and proximity to the target area.	IIB
190	Sönnergren HH, Strombeck L, Aldenborg F, Faergemann J. Aerosolized spread of bacteria and reduction of bacterial wound contamination with three different methods of surgical wound debridement: a pilot study. <i>J Hosp Infect.</i> 2013;85(2):112-117.	Expert Opinion	n/a	n/a	n/a	n/a	Provides an FDA recommendations on use of heater-cooler units in the OR.	VA

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191	Sönnergren HH, Polesie S, Strombeck L, Aldenborg F, Johansson BR, Faergemann J. Bacteria aerosol spread and wound bacteria reduction with different methods for wound debridement in an animal model. <i>Acta Derm Venereol.</i> 2015;95(3):272-277.	Nonexperimental	6 cardiothoracic surgery patients with SSI from <i>M. wolinskyi</i> .	n/a	n/a	SSI rates and microorganisms in two and a half years following the case control study.	Study that looked at an outbreak of <i>M. wolinskyi</i> at a single facility, identified the potential source as the perfusion heart-lung machine water supply or the cold-air blaster in one specific OR room. Concluded that alternate machines and processes should be reviewed. Once the cold air blaster was removed and the heart-lung machine water system was changed to a portable system that can be drained, disinfected, and refilled no further infections of <i>M. wolinskyi</i> were reported in the 2 and a half years following. Poor documentation was noted for sterile solution used on the field and for cleaning of the dampener of the cold-air blaster.	IIIB
192	Granick M, Rubinsky L, Parthiban C, Shanmugam M, Ramasubbu N. Dispersion risk associated with surgical debridement devices. <i>Wounds.</i> 2017;29(10):E88-E91.	Nonexperimental	4 joints from porcine specimen with 3 simulated wounds (superficial, deep, & deep with sinus) purposefully infected.	n/a	n/a	Bacterial contamination, electron microscopy scanning, and histology of the wounds.	Debridement did not significantly reduce bacterial contamination of the wound. However, statistically significant increases in passive and active air sampling were recorded. There was also a statistically significant increase in active air sampling when the wound dressing was removed. The air samples also showed a statistically significant increase in contamination even one hour after the therapy in a clinic room.	IIIB
193	Maragakis LL, Cosgrove SE, Song X, et al. An outbreak of multidrug-resistant <i>Acinetobacter baumannii</i> associated with pulsatile lavage wound treatment. <i>JAMA.</i> 2004;292(24):3006-11.	Nonexperimental	12 porcine inoculated specimens in 6 treatment groups control groups (curette, plasma mediated bipolar radiofrequency ablation, and hydrosurgery)	n/a	n/a	Bacterial contamination	Hydrosurgery significantly increased bacterial aerosolization but curette and plasma-mediated bipolar radiofrequency did not. Plasma-mediated bipolar radiofrequency was also found to reduce bacterial load in the specimen.	IIIB
194	Angobaldo J, Marks M, Sanger C. Prevention of projectile and aerosol contamination during pulsatile lavage irrigation using a wound irrigation bag. <i>Wounds.</i> 2008;20(6):167-170.	Nonexperimental	32 porcine inoculated specimens were divided in to 6 treatment groups (curette, plasma-mediated bipolar radiofrequency ablation, and hydrosurgery)	n/a	n/a	Bacterial contamination and electron microscope scan for the presence of biofilm formation	Results were similar to the study done by the same lead author in 2013, except for the confirmation that biofilm was present in the inoculated specimens prior to debridement.	IIIB

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195	Michailidis L, Kotsanas D, Orr E, et al. Does the new low-frequency ultrasonic debridement technology pose an infection control risk for clinicians, patients, and the clinic environment? <i>Am J Infect Control.</i> 2016;44(12):1656-1659.	Nonexperimental	Comparison of high-powered hydro-jet to direct-contact, low-frequency ultrasound debridement device	n/a	n/a	Bacterial contamination	There was minimal dispersal from both instruments with the ideal tissue (steak with no bone or grizzle). However, with tissue containing bone and grizzle the high-powered hydro-jet device created too many CFUs to count on the culture plate placed in front of the surgeon. Bacteria from the wound was shown to spray and contaminate the area of the sterile field and the scrubbed personnel (dispersion contamination). Recommended adequate PPE for scrubbed team members and for manufacturer modification of instrumentation to decrease dispersion.	IIIB
196	Tobias AM, Chang B. Pulsed irrigation of extremity wounds: a simple technique for splashback reduction. <i>Ann Plast Surg.</i> 2002;48(4):443-444.	Case Report	n/a	n/a	n/a	n/a	Eight patients had wound infections and three had sepsis and pneumonia and were admitted to ICU, two out of the three died. Researchers concluded that the <i>Acinetobacter baumannii</i> infection in these cases was disseminated during pulse lavage treatments contaminating the environment and also possible airborne transmission. Positive cultures from the treatment room were found from a stretcher that was clean, an open supply shelf, and a sink. While the device should be used in close proximity to the wound it may be difficult to do dependent on the wound which may contribute to splashing, environmental contamination, and increased potential for aerosolization. This procedure should use full PPE. The researchers also recommended surgical mask use for the person being treated and covering of all other wounds and invasive lines. Device training is necessary.	VB
197	Greene DL, Akelman E. A technique for reducing splash exposure during pulsatile lavage. <i>J Orthop Trauma.</i> 2004;18(1):41-42.	RCT	10 total patients with infected wounds	Pulse lavage with the use of the wound irrigation bag	Pulse lavage without the use of the wound irrigation bag	Bacterial contamination	Overall, the intervention group with the wound irrigation bag had significantly less contamination of all plates at only 0.24%, while the control group without the bag had 30.1% contamination. A significant decrease in contamination was found with bag use at all distances (1,2 and 3 feet). Researchers recommended additional measures to protect against dissemination of potentially infectious material to personnel and to the immediate vicinity.	IB
198	Bedard M, Pelletier-Roy R, Angers-Goulet M, Leblanc PA, Pelet S. Traffic in the operating room during joint replacement is a multidisciplinary problem. <i>Can J Surg.</i> 2015;58(4):232-236.	Nonexperimental	24 debridements in a patient room or clinical treatment room, done at two separate sites, half with suction, different settings	n/a	n/a	Bacterial contamination	During treatment higher CFU counts was associated with lower settings, lower saline flow rates, no suction and a larger wound area. No correlation was found for the presence of infection, environment performed, or duration of treatment. Environmental cleaning and PPE are crucial. Using a high setting, higher flow rate, and suction may reduce dispersion contamination.	IIIB

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199	Scaltriti S, Cencetti S, Rovesti S, Marchesi I, Bargellini A, Borella P. Risk factors for particulate and microbial contamination of air in operating theatres. <i>J Hosp Infect.</i> 2007;66(4):320-326.	Expert Opinion	n/a	n/a	n/a	n/a	Authors describe the use of an isolation bag method for minimizing splatter and spray.	VC
200	Guideline for radiation safety. In: <i>Guidelines for Perioperative Practice.</i> Denver, CO: AORN, Inc; 2018:331-366.	Expert Opinion	n/a	n/a	n/a	n/a	Authors show use of a cassette drape method to reduce environmental exposures.	VC
201	DiBartola AC, Patel PG, Scharschmidt TJ, et al. Operating room team member role affects room traffic in orthopaedic surgery: a prospective observational study. <i>Curr Orthop Pract.</i> 2017;28(3):281-286.	Nonexperimental	100 total joint arthroplasty procedures	n/a	n/a	number of door openings by phase of surgery and role of personnel who opened the door	The percentage of door openings is alarmingly high, could be linked to more personnel in the room, and potentially increase a patient's risk for infection. Study provides suggestions to limit door openings.	IIIB
202	Mears SC, Blanding R, Belkoff SM. Door opening affects operating room pressure during joint arthroplasty. <i>Orthopedics.</i> 2015;38(11):e991-e994.	Nonexperimental	23 operations in conventionally ventilated operation rooms	n/a	n/a	Particulate and bacteria contamination	Staff and visitor movement negatively correlated to increased levels of bacteria but was a negative predictor of higher levels of fine and large dust particles.	IIIB
203	Allo MD, Tedesco M. Operating room management: operative suite considerations, infection control. <i>Surg Clin North Am.</i> 2005;85(6):1291-1297, xii.	Guideline	n/a	n/a	n/a	n/a	Guidance for radiation safety in the perioperative setting.	IVB
204	Parikh SN, Grice SS, Schnell BM, Salisbury SR. Operating room traffic: is there any role of monitoring it? <i>J Pediatr Orthop.</i> 2010;30(6):617-623.	Nonexperimental	46 orthopedic cases with an implant	n/a	n/a	Door openings per minute	The overall rate of door openings per case was around 127 with a margin of 47 + or -. Procedures had an average time of 226 minutes and ranged from 90-521 minutes. This means that during each minute of the procedure the rate of door openings was between 0.2193 to 1.014. Nursing and surgical technologist traffic was the most significant group associated with door openings.	IIIA
205	Weiser MC, Shemesh S, Chen DD, Bronson MJ, Moucha CS. The effect of door opening on positive pressure and airflow in operating rooms. <i>J Am Acad Orthop Surg.</i> 2018;26(5):e105-e113.	Nonexperimental	191 cases including 91 primary hip and 100 primary knee arthroplasty procedures	n/a	n/a	Door openings and pressure readings	In 40.3% of cases the doors were open long enough for positive room pressure to be defeated. This caused air outside the OR to flow into the OR. How long the door was open had a significant correlation to the minimum room pressure recorded but did not affect the average OR pressures. The longer the surgery, the more door openings there were and the longer the door remained open as a procedural average. The door openings did not impact air exchanges.	IIIB
206	Sturm L, Sturm LK, Jackson J, Murphy S, Chenoweth C. Measurement and analysis of foot traffic in a university hospital operating room. <i>Am J Infect Control.</i> 2012;40(5):e124-e125.	Expert Opinion	n/a	n/a	n/a	n/a	Suggests limiting people, movement, and keeping the OR doors closed. Also discussed laminar air flow systems and maintaining positive pressure in the OR.	VC
207	Barbara D. Looking forward—infection prevention in 2017. <i>AORN J.</i> 2016;104(6):531-535.	Quasi-experimental	2 phase study including 4350 minutes of surgical time	Observing OR traffic with the knowledge of the personnel (N = 1908 minutes)	Observing OR traffic without the knowledge of the personnel (N = 2442 minutes)	Door opening rates and number of people	Known surveillance of traffic in the OR did not change behavior. Monitoring is important but other interventions may be needed to decrease door openings.	IIC

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208	Crolla RM, van der Laan L, Veen EJ, Hendriks Y, van Schendel C, Kluytmans J. Reduction of surgical site infections after implementation of a bundle of care. PLoS One. 2012;7(9):e44599.	Nonexperimental	6 ORs had 6 tests for pressure gradients with an additional smoke study	n/a	n/a	Pressure gradients and smoke patterns	No contaminated air entered the OR when the one main OR door was opened. However, when two OR doors were opened at the same time contaminated air from the hallway flowed into the OR.	IIIB
209	Young RS, O'Regan DJ. Cardiac surgical theatre traffic: time for traffic calming measures? Interact Cardiovasc Thorac Surg. 2010;10(4):526-529.	Nonexperimental	28 procedures from cardiac, orthopedic (spine and joint), plastics, general, and neurosurgery	n/a	n/a	Door opening rates, role and number of personnel, and reason for door opening	Door openings range per case was 13-316. Cardiac surgery had the most openings and general surgery had the least. The preincision time had the highest rate of door openings. Most door opening (27-54%) were attributed to information requests and checking on the case or paperwork, which could be replaced with other types of communication. Personnel break openings were attributed to 20-26% of door openings and supply traffic was 11-22%. The perioperative nurse and the core staff generated 37-51% of the door openings. May contribute to contamination in the room.	IIIB
210	Villafriuela JM, San José JF, Castro F, Zarzuelo A. Airflow patterns through a sliding door during opening and foot traffic in operating rooms. Build Environ. 2016;109:190-198.	Literature Review	n/a	n/a	n/a	n/a	Measures to decrease door openings in the OR include use of intercom systems, real-time video monitoring systems, glass windows, mobile phones, storage of frequently used supplies inside the room, pass-through windows, door signs, and automatic door counters.	VB
211	Wanta BT, Glasgow AE, Habermann EB, et al. Operating room traffic as a modifiable risk factor for surgical site infection. Surg Infect (Larchmt). 2016;17(6):755-760.	Quasi-experimental	1538 colorectal procedures	Bundle elements monitored.	No monitoring of bundle elements	Bundle element compliance	Monitoring the bundle elements increased compliance from 10% to 80%. There was a corresponding decrease in the SSI rate over time. Bundle element compliance was correlated to a decrease in SSI rate.	IIB
212	Elliott S, Parker S, Mills J, et al. STOP: can we minimize OR traffic? AORN J. 2015;102(4):409e1-409e7.	Nonexperimental	46 cardiac surgery patients in 2 ORs	n/a	n/a	Door opening rate and rate by minute and hour, frequency, and time door remains open	Total rate of door opening was 4273 for 46 cases. The average number of door openings per procedure 92.9. When the procedure duration was adjusted for the average rate of door opening per minute was 0.32 and per hours was 19.2. The doors took an average of 20 seconds to close. This meant that the door was open for an average of 31 minutes per procedure which totaled 10.7% of each hour. The researchers concluded that the rates of door openings was high and that it was unnecessary and would benefit from practice interventions to reduce these numbers. The researchers recommended education, training, auditing.	IIIC

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213	Rovaldi CJ, King PJ. The effect of an interdisciplinary QI project to reduce OR foot traffic. AORN J. 2015;101(6):666-681.	Nonexperimental	24 locations measures in three different testing scenarios and completed a smoke test	n/a	n/a	Direction and magnitude of air velocity in an OR doorway.	Without any door openings the OR maintains a positive pressure of 20 Pa, which does not allow air from the hall into the OR. More air from the corridor enters the OR when a person enters the OR than when they exit. During OR door openings in a LAF OR, the air flows out the bottom of the door way and in at the top. Researchers concluded that this is most likely due to the fact that vertical LAF causes unidirectional air from ceiling down and causes the air by the walls and door areas to flow upward. The air volume is higher on the side of the door where the person walks closure to the door frame upon entering. The researchers concluded that this means that personnel should walk in the middle and not close to either door frame when entering an OR to minimize air volumes entering the OR.	IIIA
214	Esser JMN, Shrinski K, Cady R, Belew J. Reducing OR traffic using education, policy development, and communication technology. AORN J. 2016;103(1):82-88.	Nonexperimental	474 SSI patients and 803 control subject	n/a	n/a	SSI	This large, single-center, retrospective, case control study found that OR traffic was significantly correlated to SSI rates, in cases classified as clean. They did find that SSIs were significantly linked to a history of diabetes mellitus and operative duration, in cases classified as clean.	IIIB
215	Pulido RW, Kester BS, Ran. Effects of intervention and team culture on operating room traffic. Qual Manag Health Care. 2017;26(2):103-107.	Organizational Experience	10 general surgery procedures were observed	n/a	n/a	n/a	Once data was evaluated, nursing targeted interventions were used resulting in an initial decrease in nursing traffic but an increase in door openings.	VB
216	Eskildsen SM, Moskal PT, Laux J, Del Gaizo DJ. The effect of a door alarm on operating room traffic during total joint arthroplasty. Orthopedics. 2017;40(6):e1081-e1085.	Organizational Experience	102 total hip and knee arthroplasty procedures	n/a	n/a	n/a	The interventions and process changes decreased door openings by 50%. The door openings in both phases two and three of the project were significantly decreased from the door openings in phase 1. Reductions in door openings was not fully maintained after six months when the door openings were only found to be 38% reduced from phase 1. The top reasons for traffic were supply gathering, vendors, gathering of warmed solutions and blankets, breaks and communication.	VB
217	Hamilton WG, Balkam CB, Purcell RL, Parks NL, Holdsworth JE. Operating room traffic in total joint arthroplasty: identifying patterns and training the team to keep the door shut. Am J Infect Control. 2018;46(6):633-636.	Organizational Experience	171 pre-intervention data compared against 134 post-intervention data during complex procedures	n/a	n/a	n/a	There was a statistically significant 13% decrease in door openings post intervention (education and process changes).	VA

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218	Liu Z, Dumville JC, Norman G, et al. Intraoperative interventions for preventing surgical site infection: an overview of Cochrane Reviews. <i>Cochrane Database Syst Rev.</i> 2018;2:CD012653.	Nonexperimental	207 cases 50 were total hip and knee arthroplasties and 157 cases were orthopedic but non-arthroplasty	n/a	n/a	Door opening rates	Simple verbal commands by surgeons are shown to have a statistically significant reduction of OR door openings.	IIIB
219	Ahn DK, Park HS, Kim TW, et al. The degree of bacterial contamination while performing spine surgery. <i>Asian Spine J.</i> 2013;7(1):8-13.	Nonexperimental	100 door openings during primary hip and knee cases by a single surgeon	n/a	n/a	Door opening rates and how long the door was open	The first 50 cases only counted door openings and time the door was ajar. In the next 50 cases an alarm was placed on the door to indicate when it was open. The alarm decreased door openings significantly but the result did decrease over time, presumably as the staff got used to the alarm. The amount of time the door was left open also was significantly decreased with the application of the alarm.	IIIA
220	Chauveaux D. Preventing surgical-site infections: measures other than antibiotics. <i>Orthop Traumatol Surg Res.</i> 2015;101(Suppl 1):S77-S83.	Nonexperimental	264 hip and knee total arthroplasty procedures	n/a	n/a	Door opening rates	Found that installing door opening counters was not enough to decrease door openings. Found reduction in door openings after education was provided.	IIIB
221	Howard JL, Hanssen AD. Principles of a clean operating room environment. <i>J Arthroplasty.</i> 2007;22(7 Suppl 3):6-11.	Systematic Review	n/a	n/a	n/a	n/a	Cochrane Systematic Review that included only other Cochrane Systematic Reviews and RCTs. Guidance included limiting OR traffic and use of a laminar airflow system.	IB
222	Castella A, Charrier L, Di Legami V, et al. Surgical site infection surveillance: analysis of adherence to recommendations for routine infection control practices. <i>Infect Control Hosp Epidemiol.</i> 2006;27(8):835-840.	Nonexperimental	5 cases with 180 plates total	n/a	n/a	Bacterial contamination	All the plates collected grew gram positive bacteria. The surgical field and the surgical suite traffic area by the door were the most highly contaminated. There was a significant difference in growth between the 1 hour and 3 hours plates, showing that increases surgical times is likely to have increased contamination. With increasing resistance to bacteria it is crucial that factors that contribute to contamination of the surgical suite be mitigated.	IIIB
223	Quality improvement/quality assessment: quality improvement. In: <i>Procedural Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 3.1 ed.</i> Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2018:65.	Expert Opinion	n/a	n/a	n/a	n/a	This article discusses many areas that may influence operating room particulate and bacterial contamination that subsequently may contribute to SSIs. Discussed unidirectional airflow, air exchanges, positive pressure, preoperative patient antisepsis, hand hygiene, sterile glove use, surgical attire, draping, sterile field set up, surgical light positioning, and limiting personnel.	VB
224	06: Clinical records and health information. In: <i>2017 Accreditation Handbook for Ambulatory Health Care.</i> Skokie, IL: Accreditation Association for Ambulatory Health Care; 2017:51-53.	Expert Opinion	n/a	n/a	n/a	n/a	Discussed factors that may contribute to OR contamination including unidirectional ultra clean air, ultraviolet light, sterile field set up, surgical hand antisepsis, placement of surgical sterile tables in the curtain of the unidirectional ultra clean air system, surgical masks, surgical helmet systems, and sterile gowns and drapes.	VB

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225	Medical records: general. In: Regular Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 14.5 ed. Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2017:57-59.	Nonexperimental	856 patient observations from 49 hospitals in Italy	n/a	n/a	Data collected about surgical infection control practices	The data collected on a wide range of surgical infection prevention parameters indicates a wide variation in practice supporting the idea that standardization and increased compliance to certain infection control practices may reduce the risk of SSIs in patients. Also found average number of people in an OR was 6-7 but that this was sometimes higher in academic medical centers and in hospitals with complex cases.	IIIB
226	Medical records: pre-operative medical record. In: Regular Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 14.5 ed. Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2017:58-59.	Accreditation	n/a	n/a	n/a	n/a	QI and QA in ASCs.	n/a
227	Medical records: operating room records. In: Regular Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 14.5 ed. Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2017:60-63.	Accreditation	n/a	n/a	n/a	n/a	Provides accreditation information from AAAHC on what to include in health information and clinical records	n/a
228	State Operations Manual Appendix A—Survey Pro-tocol, Regulations and Interpretive Guidelines for Hospitals. Rev 176; 2017. Centers for Medicare & Medicaid Services. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/som107ap_a_hospitals.pdf . Accessed September 12, 2018.	Accreditation	n/a	n/a	n/a	n/a	Required general requirements for documentation.	n/a
229	State Operations Manual Appendix L—Guidance for Surveyors: Ambulatory Surgical Centers. Rev 137; 2015. Centers for Medicare & Medicaid Services. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Downloads/som107ap_l_ambulatory.pdf . Accessed September 12, 2018.	Accreditation	n/a	n/a	n/a	n/a	Accreditation information from AAAASF on preoperative medical record requirements.	n/a
230	Medical records: general. In: Procedural Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 3.1 ed. Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2018:58-59.	Accreditation	n/a	n/a	n/a	n/a	Accreditation information from AAAASF on the necessary documentation for the operative record.	n/a

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231	Medical records: procedure room records. In: Procedural Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 3.1 ed. Gurnee, IL: American Association for Accreditation of Ambulatory Surgery Facilities; 2018:63-65.	Regulatory	n/a	n/a	n/a	n/a	Guidance on what may be included during surveys.	n/a
232	Department of Health & Human Services (DHHS), Centers for Medicare & Medicaid Services. State Operations Manual Appendix L: Guidance for Surveyors: Ambulatory Surgical Centers. Rev. 137, 04-01-15. 2015.	Regulatory	n/a	n/a	n/a	n/a	Guidance on what may be included during a survey for ASCs.	n/a
233	American Association for Accreditation of Ambulatory Surgery Facilities. Medical records: general. Procedural Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 3.1. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance on what to include in medical records for accreditation of ASCs by AAAASF.	n/a
234	American Association for Accreditation of Ambulatory Surgery Facilities. Medical records: procedure room records. Procedural Standards and Checklist for Accreditation of Ambulatory Surgery Facilities. Version 3.1. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance on what to include in procedure room records for ASC accreditation by AAAASF.	n/a
235	Program: Critical Access Hospital, Chapter: Record of Care, Treatment, and Services. RC.01.01.01: The critical access hospital maintains complete and accurate medical records for each individual patient. Comprehensive Accreditation Manual. The Joint Commission. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance for records of treatment and services at critical access hospitals for Joint Commission accreditation.	n/a
236	Program: Hospital, Chapter: Record of Care, Treatment, and Services. RC.01.01.01: The hospital has policies and procedures that guide and support patient care, treatment, and services. Comprehensive Accreditation Manual. The Joint Commission. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance for records of treatment and services at hospitals for Joint Commission accreditation.	n/a
237	Program: Ambulatory, Chapter: Record of Care, Treatment, and Services. RC.01.01.01: The organization maintains complete and accurate clinical records. Comprehensive Accreditation Manual. The Joint Commission. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance for records of treatment and services at ambulatory facilities for Joint Commission accreditation.	n/a
238	Program: Office Based Surgery, Chapter: Record of Care, Treatment, and Services. RC.01.01.01: The practice maintains complete and accurate clinical records. Comprehensive Accreditation Manual. The Joint Commission. 2018.	Accreditation	n/a	n/a	n/a	n/a	Guidance for records of treatment and services at office-based surgery facilities for Joint Commission accreditation.	n/a

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239	Surgical Site Infection (SSI) Event. Chapter 9. National Healthcare Safety Network (NHSN) Patient Safety Component Manual. CDC. 2018.	Regulatory	n/a	n/a	n/a	n/a	Description of CDC Wound Class.	n/a