

AORN Guideline for Hand Hygiene  
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
1	Ellingson, K., Haas, J. P., Aiello, A. E., et al. Strategies to prevent healthcare-associated infections through hand hygiene 2014	Guideline	n/a	n/a	n/a	n/a	SHEA Compendium Guideline on hand hygiene.	IVA
2	Tanner, J., Dumville, J. C., Norman, G. and Fortnam, M. Surgical hand antisepsis to reduce surgical site infection. <i>Cochrane Database Syst Review</i> . 2016	Systematic Review	n/a	n/a	n/a	n/a	No one surgical hand antiseptic was more effective than another for preventing SSI. Although the evidence was conflicting, some research indicates that alcohol-based antiseptics may be more effective for reducing bacterial	IB
3	Martins, Tatiana, Nazareth Amante, LÃ¢rcia, Vicente, Camila, et al. Nursing interventions to reduce surgical site infection in potentially contaminated surgeries: an integrative review.	Systematic Review	n/a	n/a	n/a	n/a	Hand hygiene was identified as essential to nursing intervention that is effective in reducing SSIs in potentially contaminated surgeries.	IIIB
4	Loftus, Randy W., Dexter, Franklin and Robinson, Alysha D. M. High-risk Staphylococcus aureus transmission in the operating room: A call for widespread improvements in perioperative hand	Nonexperimental	178 <i>S aureus</i> isolates from 548 surgical procedures, United States	n/a	n/a	Transmission of <i>S aureus</i> isolates	Transmission locations were provider hands, patient skin sites and environmental surfaces. Transmission occurred during procedures.	IIIA
5	Robinson, Alysha D. M., Dexter, Franklin, Renkor, Valerie, Reddy, Sundara and Loftus, Randy W. Operating room PathTrac analysis of current intraoperative <i>Staphylococcus aureus</i>	Nonexperimental	Adult patients undergoing sequential care in same OR, university hospital,	n/a	n/a	Epidemiologically related <i>S aureus</i> transmission events within and between-	<i>Staphylococcus aureus</i> exposure in OR includes patient skin sites and provider hands, so infection control efforts should extend beyond patient decolonization to include strategies to improve intraoperative provider hand	IIIA
6	Ulrich, Nikos, Gastmeier, Petra and Vonberg, Ralf-Peter. Effectiveness of healthcare worker screening in hospital outbreaks with gram-negative pathogens: a systematic review.	Literature Review	n/a	n/a	n/a	n/a	Due to very low quality evidence, rectal screening of health care workers (HCWs) is not recommended during a nosocomial outbreak with gram negative bacteria. However, evaluation of HCW's hand hygiene compliance	VB
7	WHO Guidelines on Hand Hygiene in Health Care. Geneva, Switzerland: World Health Organization; 2009.	Guideline	n/a	n/a	n/a	n/a	WHO guidelines for hand hygiene, including surgical hand scrubs.	IVA
8	Malik A, Qureshi H, Abdul-Razakq H, et al. 'I decided not to go into surgery due to dress code': A cross-sectional study within the UK investigating experiences of female muslim medicalfemale	Qualitative	Female Muslim health care professionals, medical conference, United Kingdom	n/a	n/a	Views on bare below the elbows (BBE) policy	56.3% felt religious requirement to cover their arms was not respected and 74.1% were not happy with their BBE uniform policy alternative. Some respondents felt the dress code issue was enough to not specialize in surgery	IIIB
9	Abdelwahab, R, Aden, A, Bearden B, et al. Surgical scrubbing and attire in the operating room and ICU: a multicultural guide. 2021. <i>J Am Coll Surg</i> ; 233:321-327.	Consensus	n/a	n/a	n/a	n/a	Guide to assist health care facilities in developing PPE and surgical hand antisepsis protocols inclusive of religious and cultural practices.	IVC
10	Guideline for Transmission-Based Precautions.In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2021	Guideline	n/a	n/a	n/a	n/a	The activities of health care personnel with dermatitis, infections, exudative lesions, and nonintact skin should be restricted when these activities pose a risk of transmission of infection to patients and other health	IVA
11	Boyce, J. M., Pittet, D. and Healthcare Infection Control Practices Advisory Committee. Society for Healthcare Epidemiology of America. Association for Professionals in Infection Control. Infectious	Guideline	n/a	n/a	n/a	n/a	CDC Guidelines for Hand Hygiene.	IVA

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12	AST Standards of Practice for Surgical Attire, Surgical Scrub, Hand Hygiene and Hand Washing. April 13, 2008.	Guideline	n/a	n/a	n/a	n/a	AST Standards for surgical scrubs and hand hygiene.	IVC
13	American Association of Nurse Anesthetists. Infection Prevention and Control Guidelines for Anesthesia Care, 2015.	Consensus	n/a	n/a	n/a	n/a	AANA Infection control guide.	IVB
14	Hautemaniere A, Cunat L, Diguio N et al.. Factors determining poor practice in alcoholic gel hand rub technique in hospital workers. <i>J Infect Public Health</i> . 2010;3(1):25–34	Quasi-experimental	Hospital personnel, France	Educational intervention (30-minute session to teach best practices for	n/a	Hand hygiene effectiveness (validated technique to observe rubbing	Having long nails was associated with ineffective hand rub use by the evaluation criteria. However, the researchers did not describe the nail length that was used to classify nails as long in this study.	IIB
15	McNeil SA, Nordstrom-Lerner L, Malani PN, Zervos M, Kauffman CA. Outbreak of sternal surgical site infections due to <i>Pseudomonas aeruginosa</i> traced to a scrub nurse with onychomycosis. <i>Clin</i>	Case Report	n/a	n/a	n/a	n/a	In VA hospital over 9-month time period, 16 median sternotomy patients developed <i>Pseudomonas aeruginosa</i> SSI which was traced to scrub nurse with severe onycholysis of right thumb nail.	VA
16	Fagernes M, Lingaas E. Factors interfering with the microflora on hands: a regression analysis of samples from 465 healthcare workers. <i>J Adv Nurs</i> . 2011;67(2):297–307	Nonexperimental	465 Norwegian health care personnel	n/a	n/a	Hand cultures	Fingernails longer than 2 mm were significantly associated with the prevalence of <i>Staphylococcus aureus</i> . There was no effect of nail polish status on the bacterial count for the whole hand. Using hand lotion within 5	IIIB
17	Rupp ME, Fitzgerald T, Puumala S et al.. Prospective, controlled, cross-over trial of alcohol-based hand gel in critical care units. <i>Infect Control Hosp Epidemiol</i> . 2008;29(1):8–15	Quasi-experimental	Health care workers, 2 medical-surgical intensive care units at a tertiary care teaching	Alcohol-based hand rub introduced to unit	No alcohol-based hand rub in unit	Hand hygiene compliance, patient outcomes, microbial hand flora of health	Fingernail length longer than 2 mm (0.08 inches) was significantly associated with a higher number of microorganisms compared with fingernail lengths shorter than 2 mm.	IIB
18	Hardy J.M., Owen T.J., Martinez S.A., Jones L.P. and Davis M.A. The effect of nail characteristics on surface bacterial counts of surgical personnel before and after scrubbing. <i>Veterinary Surgery</i> .	RCT	Veterinary students, small animal surgery personnel, veterinary teaching hospital,	Nail polish (P) on nails for 1 week (n=21)	Nonpolished (NP) fingernails (n=21)	Bacterial counts of fingernails before and after surgical scrub	Bacterial counts and types of isolates were not influenced by presence of nail polish, but nail length was risk factor for increased counts. Researchers recommend the length of nails to be under 2 mm.	IB
19	NICE. Surgical site infections: prevention and treatment. NICE guideline [NG125] April 2019	Guideline	n/a	n/a	n/a	n/a	NICE (UK) Guideline for surgical site infection prevention.	IVA
20	Hewlett, Angela L., Hohenberger, Heather, Murphy, Caitlin N., et al. Evaluation of the bacterial burden of gel nails, standard nail polish, and natural nails on the hands of health care	Quasi-experimental	Direct patient care providers, 3 university hospitals, United States	1 nail: ultraviolet-cured (gel) nail polish 1 nail: standard nail polish	3 nails: natural	Bacterial colony forming units (CFUs) of fingernail, cuticle bed, and	No significant difference in CFUs found for any of the products after hand hygiene, leading researchers to conclude gel nails were not associated with increased CFUs. However, reduction in CFUs was seen over time for	IIB
21	Arrowsmith, V. A., Taylor, R. Removal of nail polish and finger rings to prevent surgical infection. <i>Cochrane database of systematic reviews</i> . 2014;8:CD003325.	Systematic Review	n/a	n/a	n/a	n/a	One small trial investigated the number of bacteria on the skin of personnel with and without nail polish and did not identify any clear differences between bacterial counts. No studies were found on the effect of	IC
22	Blackburn, L, Acree, K, Bartley, J., et al. Microbial growth on the nails of direct patient care nurses wearing nail polish. <i>Oncology Nursing Forum</i> 2020;47(2):1-10.	Quasi-experimental	Nurses providing direct patient care, cancer center, United States	(1)Nail polish at one-day (2) Nail polish at four-days	No nail polish	Colony-forming units (CFUs) of nail and subungual area on dominant hand after	Nail polish had similar bacterial counts as natural nails for first 24-hours, but once chipping occurred bacterial burden increased.	IIB

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23	van der Meer, E. W., Boot, C. R., van der Gulden, J. W., et al. Hands4U: the effects of a multifaceted implementation strategy on hand eczema prevalence in a healthcare setting. Results of a	RCT	1,649 hospital personnel, Netherlands	Educational intervention to prevent hand eczema	No education	Self-reported hand eczema and preventive behavior	Researchers found that 12 months after the baseline report, the intervention group was significantly more likely to report hand eczema, less hand washing, more frequent moisturizer use, and more use of cotton	IB
24	Harnoss JC, Brune L, Ansorg J, Heidecke C-D, Assadian O, Kramer A. Practice of skin protection and skin care among German surgeons and influence on the efficacy of surgical hand	RCT	Healthy adult volunteers, university hospital, Germany	Using skin care products three times daily for 8 days (n = 13)	Did not use any skin care products (n = 13)	Effect of skin protection and skin care products on surgical hand	Survey: Sent to 16,000 German surgeons, 1,433 responses (response rate 11%). 50% reported skin irritation or discomfort, only 5% reported that they used skin care products. 10% refused to use skin care products	IB
25	<i>Drainage systems. Electronic edition ed.</i> Facilities Guideline Institute, US Department of Health and Human Services, American Society for Healthcare Engineering. Guidelines for design and	Guideline	n/a	n/a	n/a	n/a	FGI guidelines for design and construction of hospitals, including hand hygiene stations and surgical hand scrub facilities.	IVC
26	Oosterhuis T, Piebenga WPP, Jungbauer FHW, et al. Guideline.contact eczema: Prevention, treatment and guidance by the company doctor. NVAB, the Netherlands Society of Occupational	Guideline	n/a	n/a	n/a	n/a	Evidence-based recommendations for preventing hand eczema in an occupational setting.	IVB
27	Bolyard, E. A., Tablan, O. C., Williams, W. W., Pearson, M. L., Shapiro, C. N. and Deitchmann, S. D. Guideline for infection control in healthcare personnel, 1998. Hospital Infection Control	Guideline	n/a	n/a	n/a	n/a	State, federal, and professional guidelines and strategies should be followed to determine the need for work restrictions for health care personnel with bloodborne infections.	IVA
28	Jepson AP, McDougall C, Clark A, Bateman A, Williamson G, Kaufmann ME. Finger rings should be removed prior to scrubbing. <i>J Hosp Infect</i> . 2006;64: 197–8.	Case Report	n/a	n/a	n/a	n/a	Six postoperative <i>Serratia marcescens</i> traced to surgeon who wore 2 rings on right hand.	VA
29	Anderson, D. J., Podgorny, K., Berrios-Torres, S. I., et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update 2014	Guideline	n/a	n/a	n/a	n/a	SHEA Compendium Guideline on surgical site infection prevention.	IVA
30	Biddle C, Shah J. Quantification of anesthesia providers' hand hygiene in a busy metropolitan operating room: What would Semmelweis think?. <i>Am J Infect Control</i> . 2012;40(8): 756-759	Nonexperimental	Academic medical center, United States	n/a	n/a	Hand hygiene compliance	Hand hygiene opportunities averaged 34 to 41/hour and peaked several times at 54/hour. Aggregate failure rate was 82% with a range of 64% to 93% by provider group, and was very poor among anesthesia providers. The task	IIIB
31	Krediet AC, Kalkman CJ, Bonten MJ, Gigengack ACM, Barach P. Hand-hygiene practices in the operating theatre: an observational study. <i>Br J Anaesth</i> . 2011;107(4):553–558.	Nonexperimental	Operating room, academic hospital, Netherlands	n/a	n/a	Hand hygiene compliance	Frequent interactions between patient, staff, and environment were observed. Adherence to hand-hygiene guidelines by OR staff was extremely low.	IIIB
32	Andersson AE, Bergh I, Karlsson J, Eriksson BI, Nilsson K. The application of evidence-based measures to reduce surgical site infections during orthopedic surgery - report of a single-center	Nonexperimental	Sweden, Orthopedic teaching hospital, fracture procedures and total joint	n/a	n/a	Adherence to hand disinfection guidelines	Observed hand hygiene in orthopedic surgical procedures and found poor adherence to hand disinfection guidelines, including during aseptic insertion technique procedures.	IIIB
33	Megeus V, Nilsson K, Karlsson J, Eriksson BI, Andersson AE. Hand hygiene and aseptic techniques during routine anesthetic care—observations in the operating room.	Nonexperimental	Operating rooms, general hospital, Sweden	n/a	n/a	Hand hygiene compliance	Overall hand hygiene adherence was 8.1%. Lowest adherence was observed during induction phase before an aseptic task (2.2%) and highest during full-length surgeries after body fluid exposure (15.9%). Hand	IIIB

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34	Rowlands J, Yeager MP, Beach M, Patel HM, Huysman BC, Loftus RW. Video observation to map hand contact and bacterial transmission in operating rooms. <i>Am J Infect Contr</i> ol. 2014;42(7):	Nonexperimental	Anesthesia providers, United States	n/a	n/a	Hand hygiene compliance	Used video observations of anesthesia professionals to evaluate hand hygiene compliance with WHO criteria. Three perioperative team members (ie, an anesthesiologist, an anesthesiology resident, and a	IIIA
35	Loftus RW, Brown JR, Koff MD, et al. Multiple reservoirs contribute to intraoperative bacterial transmission. <i>Anesth Analg</i> . 2012;114(6): 1236-1248	Nonexperimental	3 medical centers, United States	n/a	n/a	Cultures: provider hand, patient, environment, peripheral IV tubing 3	Bacterial contamination of patients, provider hands, and the environment contributes to stopcock transmission events, but the surrounding patient environment is the most likely source. Stopcock contamination is associated	IIIA
36	Heid, Florian, Bender, Carolin, Gervais, Hendrik, Schmeck, Joachim, Kohnen, Wolfgang and Noppens, Rudiger. Microbial contamination of anesthetic syringes in relation to different	Quasi-experimental	Syringes used during general anesthesia in urological surgeries, university hospital,	(1) Syringes capped with sterile cap (n=102) (2) Syringes not capped or covered (n= 116)	Syringes with no patient contact (n=90)	Bacterial contamination of first medication drop, syringe hub, syringe	Overall contamination rate was 21%, whereas control group rate was 4.4%. Skin contact was main source of contamination (ie, coagulase-negative staphylococci), reiterating importance of hand hygiene.	IIA
37	Allen G. Hand hygiene and the surgical team. <i>Perioperative Nursing Clinics</i> . 2010;5(4): 411-418.	Expert Opinion	n/a	n/a	n/a	n/a	Review of hand hygiene in the perioperative setting. Describes perioperative challenges and hand hygiene moments for RN circulator, anesthesia professionals, surgeon and surgical assistants, and scrub persons.	VA
38	Guideline for sterilization packaging systems. In: <i>Guidelines for Perioperative Practice</i> . Denver, CO: AORN, Inc; 2021:571-590.	Guideline	n/a	n/a	n/a	n/a	Evidence-based guideline providing recommendations for sterilization packaging systems used in the health care organization	IVA
39	Munoz-Price, L. S., Bowdle, A., Johnston, B. L., et al. Infection prevention in the operating room anesthesia work area 2018	Consensus	n/a	n/a	n/a	n/a	Provides recommendations for anesthesia work area infection prevention that include hand hygiene, environmental disinfection and implementing effective improvement efforts.	IVA
40	Bellaard-Smith ER, Gillespie EE. Implementing hand hygiene strategies in the operating suite. <i>Healthcare Infection</i> . 2012;17(1): 33-37.	Organizational Experience	Australia	Education (WHO five moments of hand hygiene specific to the perioperative setting,	Compliance before intervention	Hand hygiene compliance	Significant improvement in hand hygiene compliance after implementing multiple hand hygiene strategies in the operating suite, including education about the WHO five moments of hand hygiene specific to the	VA
41	Guideline for Environmental Cleaning. In: <i>Guidelines for Perioperative Practice</i> . Denver, CO: AORN, Inc; 2021	Guideline	n/a	n/a	n/a	n/a	Floors in the perioperative setting should be considered contaminated at all times. Items that contact the floor for any amount of time should be considered contaminated.	IVA
42	Smith, Fiona, Lee, Karen, Binnie-McLeod, Eleanor, et al. Identifying the World Health Organization's fifth moment for hand hygiene: Infection prevention in the operating room. <i>Journal of</i>	Organizational Experience	11 surgical procedures in children's and adult operating rooms, teaching hospital,	n/a	n/a	n/a	Equipment in direct contact with patient and touched by non-scrubbed personnel were identified as part of patient zone, photographed, and placed in a poster that was used for education and sustainment of hand hygiene	VA
43	Allegranzi B., Memish ZA, Donaldson, L., Pittet, D. Religion and culture: Potential undercurrents influencing hand hygiene promotion in health care. 2009, <i>AJIC</i> ; 37(1):28-34.	Literature Review	n/a	n/a	n/a	n/a	Religious faith and cultural specificities can impact the promotion of hand hygiene globally and should be taken into consideration when implementing strategies to increase compliance.	VA
44	Association for Professionals in Infection Control and Epidemiology. APIC guide to hand hygiene programs for infection prevention. 2015. Washington, DC. 1-66.	Consensus	n/a	n/a	n/a	n/a	Synthesis of evidence-based strategies to implement hand hygiene into everyday practices and improve patient outcomes.	IVA

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45	Jeanes,A.; Dick,J.; Coen,P.; Drey,N.; Gould,D.J.Hand hygiene compliance monitoring in anaesthetics: Feasibility and validity.2018. <i>J.Infect.Prev.</i> ; 19(8). 116-122.	Organizational Experience	Anesthesiologist, operating rooms, university hospital, United Kingdom	n/a	n/a	n/a	Invalid and unreliable hand hygiene compliance monitoring resulted from direct observation of anesthesiologist, leading authors to conclude it should not be used in this specialty. Interventions to reduce	VB
46	Birnbach DJ, Rosen LF, Fitzpatrick M, Carling P, Arheart KL, Munoz-Price LS. Double gloves: A randomized trial to evaluate a simple strategy to reduce contamination in the operating room.	RCT	USA, simulated laryngoscopy and intubation in OR	Wore two pairs of gloves and removed the outer pair of gloves after intubation (n =	Wore a single pair of gloves (n = 11)	Contamination of surfaces measured with fluorescent marking gel	Researchers found that the group wearing two pairs of gloves during intubation and removing the outer gloves immediately after intubation contaminated significantly fewer surfaces, as measured by fluorescent marking gel.	IB
47	Birnbach DJ, Rosen LF, Fitzpatrick M, Carling P, Arheart KL, Munoz-Price LS. A new approach to pathogen containment in the operating room: Sheathing the laryngoscope after intubation.	RCT	USA, simulated laryngoscopy and intubation in OR	(1) Wore two pairs of gloves and removed the outer pair of gloves after intubation (n =	Wore a single pair of gloves (n = 15)	Contamination of surfaces measured with fluorescent marking gel	Researchers found that both double-gloving techniques were associated with significantly less contamination than single gloving. Use of the outer pair as a sheath for the laryngoscope immediately after intubation was	IB
48	McDonald, L. C., Gerding, Dale N., Johnson, Stuart, et al. Clinical Practice Guidelines for <i>Clostridium difficile</i> Infection in Adults and Children: 2017 Update by the Infectious Diseases Society of	Guideline	n/a	n/a	n/a	n/a	Provides guidance for management and treatment of <i>Clostridium difficile</i> infection.	IVA
49	Guideline for Sterile Technique.In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2021	Guideline	n/a	n/a	n/a	n/a	Surgical hand antisepsis should be performed before donning a surgical gown and gloves.	IVA
50	Gaspar, Gilberto G., Meneguetti, Mayra G., Lopes, Ana E. R., et al. Alcohol-based surgical hand preparation: translating scientific evidence into clinical practice. <i>Antimicrobial Resistance and</i>	Quasi-experimental	Cardiac and orthopedic surgical teams, university hospital, Brazil	Education, availability, and feedback on use of alcohol-based surgical hand rub	Surgical hand scrub with antimicrobial soap	Quality and duration of surgical hand rub; SSI probability	Alcohol-based surgical rub improved quality and duration of procedure and was equally as effective in preventing SSIs as surgical hand scrub.	IIB
51	Lopez Martin, M. B., Erice Calvo-Sotelo, Alejo. Comparative study of presurgical hand hygiene with hydroalcoholic solution versus traditional presurgical hand hygiene. <i>Enferm Clin</i> .	Quasi-experimental	Surgical nurses and surgeons, orthopedic hospital, Spain	Surgical hand scrub with hydroalcoholic solution for 3 min	Traditional surgical hand scrub	Bacterial count (CFUs) from imprints of first and second fingers of both	Significant difference in CFUs and time for completion of surgical hand scrub was found with hydroalcoholic solution compared to other solutions and methods. The cost for hydroalcoholic solution was half of other	IIB
52	Ban, Kristen A., Minei, Joseph P., Laronga, Christine, et al. Executive Summary of the American College of Surgeons/Surgical Infection Society Surgical Site Infection Guidelines-2016	Guideline	n/a	n/a	n/a	n/a	Summary of literature supporting preoperative, intraoperative and postoperative SSI guidelines.	IIB
53	Berrios-Torres, Sandra I., Umscheid, Craig A. M. S. C. E., Bratzler, Dale W. D. O., et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017.	Guideline	n/a	n/a	n/a	n/a	Re-emphasis of select 1999 CDC and HICPAC recommendations for prevention of SSIs.	IVA
54	World Health Organization (WHO). Global Guidelines for the Prevention of Surgical Site Infection 2016	Guideline	n/a	n/a	n/a	n/a	A comprehensive range of evidence-based recommendations for pre-, intra- and postoperative periods for prevention of SSI.	IIB
55	Kashkoush A., Agarwal N., Ayres A., Novak V., Chang Y.-F. and Friedlander R.M. Scrubbing technique and surgical site infections: An analysis of 14,200 neurosurgical cases. <i>J Neurosurg.</i>	Nonexperimental	Neurosurgeons, university hospital, United States	n/a	n/a	Scrubbing technique; gloving; 90-day SSIs	Personal scrubbing or gloving preference was not associated with neurosurgical SSIs.	IIIB

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56	Kampf,G.; Ostermeyer,C. Small volumes of n-propanol (60%) applied for 3 minutes may be ineffective for surgical hand disinfection, 2014. <i>Antimicrob.Resist Infect.Control .;3(15):</i> 1-5.	Nonexperimental	Healthy volunteers with different hand sizes, Germany	n/a	n/a	Microbial log reduction on fingers after disinfection and glove wearing for 3	The amount of disinfectant applied is a factor in optimal efficacy of surgical hand disinfection.	IIB
57	Siddiqui, N., Friedman, Z., McGeer, A., Yousefzadeh, A., Carvalho, J. C. and Davies, S. Optimal hand washing technique to minimize bacterial contamination before neuraxial	RCT	Anesthesiologists performing labor epidurals, hospital, Canada	(1) alcohol gel (2) antimicrobial soap, dry sterile towel, alcohol gel	(4) antimicrobial soap, dry non-sterile towel (5) antimicrobial soap, dry sterile towel	Bacterial colonization of forearm measured in colony forming units (CFUs)	Reduction of colonization incidence occurred most frequently with alcohol-based antiseptic solutions and use of sterile towel	IA
58	Abdelatif, DA., El-Haiyk, K., Ghobashi, N. H., El-Qudaa, R. and El-Sabouni, R. Comparing of using sterile brush during surgical scrubbing versus brushless for surgical team in operating room.	RCT	Health science female students, hospital, Egypt	Brushless hand scrub (n=25)	Hand scrub with brush (n=25)	Bacterial cultures of hands	Brushes for surgical hand scrubs are not necessary. Findings not statistically significant, but did show an increase in Staphylococcus one hour after scrub and glove removal in the group that used the brush. However,	IC
59	da Cunha ER, Matos FGOA, da Silva AM, de Araújo EAC, Ferreira KASL, Graziano KU. The efficacy of three hand asepsis techniques using chlorhexidine gluconate (CHG 2%). <i>Revista da Escola de</i>	Quasi-experimental	32 health care workers, Brazil	CHG 2% application methods: (1) Hand scrubbing with brush	n/a	Hand cultures using glove juice method	Statistical analyses showed there were no significant differences regarding the number of colony-forming units when comparing hand rubbing, hand scrubbing with sponge, and hand scrubbing with brush techniques	IIB
60	Okgun Alcan, Aliye, Demir Korkmaz, Fatma. Comparison of the efficiency of nail pick and brush used for nail cleaning during surgical scrub on reducing bacterial counts. <i>AJIC.</i> 2012;40:826-	RCT	60 circulating nurses, university hospital, Turkey	(1) Use nail pick during surgical scrub (n = 20) (2) Use brush during surgical scrub (n = 20)	Use surgical scrub alone (n = 20)	Hand bacterial counts	Using nail picks and brushes during the surgical scrub does not provide additional hand decontamination.	IB
61	Parlak, E A, Iyigun, E, Albay, A, Bedir, O. Impact of methods and duration of surgical hand scrub on bacterial count: A randomized controlled trial. 2021. <i>AJIC</i> ;49(11):1376-1383.	RCT	Surgical nurses and surgeons, university hospital, Turkey	I: One-minute scrub with nail brush II: Two-minute scrub with nail brush	III: One-minute scrub with no nail brush IV: Two-minute scrub with no nail brush	Bacterial counts on hands using glove juice method, before and after scrub, and	Nail brush is not necessary when performing surgical hand scrub. No difference in bacterial count was found between a one-minute or two-minute scrub.	IB
62	<i>Hand-washing station sinks. Electronic edition ed.</i> Facilities Guideline Institute, US Department of Health and Human Services, American Society for Healthcare Engineering. Guidelines for design and	Guideline	n/a	n/a	n/a	n/a	FGI guidelines for design and construction of outpatient facilities, including hand hygiene stations and surgical hand scrub facilities.	IVC
63	Guideline for processing flexible endoscopes. In: <i>Guidelines for Perioperative Practice.</i> Denver, CO; AORN,Inc; 2021:183-272.	Guideline	n/a	n/a	n/a	n/a	Evidence-based guideline providing recommendations for processing of flexible endoscopes used in the health care organization	IVA
64	Guideline for design and maintenance of the surgical suite. In: <i>Guidelines for Perioperative Practice.</i> Denver, CO; AORN,Inc; 2021:51-82.	Guideline	n/a	n/a	n/a	n/a	Evidence-based guideline providing recommendations for processing of flexible endoscopes used in the health care organization	IVA
65	American Society of Health Care Engineering (ASHE). Using the health care physical environment to prevent and control infection. 2018	Consensus	n/a	n/a	n/a	n/a	Guidance on providing a safe, environment in health care that includes hand hygiene infrastructure and water-related environmental infection control.	IVB
66	Charron, D, Bedard E, Lalancette, C. et al. Impact of electronic faucets and water quality on occurrence of <i>Pseudomonas aeruginosa</i> in water: A multi-hospital study. 2015. <i>Infection Control &amp;</i>	Nonexperimental	First flush cold water from electronic and manual faucets, 4 hospitals, Canada	n/a	n/a	<i>P aeruginosa</i> presence in water using culture and enzymatic detection	Electronic faucets with simple designs and smaller mixing chambers are not any more susceptible to <i>P aeruginosa</i> contamination than manual faucets	IIIA

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Evidence Table

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67	Yapicioglu, Hacer, Gokmen, Tulin G., Yildizdas, Dincer, et al. <i>Pseudomonas aeruginosa</i> infections due to electronic faucets in a neonatal intensive care unit. <i>Journal of Paediatrics and Child Health</i> .	Case Report	n/a	n/a	n/a	n/a	<i>Pseudomonas aeruginosa</i> infections in a Turkish neonatal intensive care unit (NICU) decreased after removal of electronic faucets and installation of elbow-operated faucets. Authors recommend if electronic	VA
68	Sydnor, E. R., Bova, G., Gimburg, A., Cosgrove, S. E., Perl, T. M. and Maragakis, L. L. Electronic-eye faucets: Legionella species contamination in healthcare settings. <i>Infection Control and</i>	Nonexperimental	Tap water from new electronic faucets (n=20) and existing manual faucets (n=20),	n/a	n/a	Heterotrophic plate counts (HPCs) and <i>Legionella</i> species growth	<i>Legionella</i> species and other bacteria were found most often in electronic faucets. Remediation with chlorine dioxide was less likely to disinfect these faucets, as their components may provide concentrated bacterial growth	IIIB
69	Walker J, Jhutti, A, Parks, S, et al. Investigation of healthcare-acquired infections associated with <i>Pseudomonas aeruginosa</i> biofilms in taps in neonatal units in Northern Ireland. 2014. <i>Journal</i>	Nonexperimental	Sensor and nonsensor taps in neonatal intensive care units, Ireland	n/a	n/a	<i>P aeruginosa</i> and biofilm presence using culture and fluorescence	Electronic faucets had a significantly higher odds of having at least one internal component positive for <i>P aeruginosa</i> and biofilm formation	IIIA
70	Bedard, E., Prevost, M. and Deziel, E. <i>Pseudomonas aeruginosa</i> in premise plumbing of large buildings. <i>Microbiology Open</i> . 5: 937-956. 2016	Literature Review	n/a	n/a	n/a	n/a	Summarizes factors contributing to <i>P. aeruginosa</i> growth in plumbing, as well as proactive control measures.	VA
71	Centers for Medicare & Medicaid Services. Requirement to reduce <i>Legionella</i> risk in healthcare facility water systems to prevent cases and outbreaks of Legionnaires' Disease. 2017	Regulatory	n/a	n/a	n/a	n/a	Clarification of facility requirement to develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce growth and spread of opportunistic water pathogens.	n/a
72	Centers for Disease Control and Prevention. Developing a water management program to reduce <i>Legionella</i> growth & spread in buildings: A practical guide to implementing industry	Consensus	n/a	n/a	n/a	n/a	Toolkit to help develop, implement, and evaluate a water management program that meets ASHRAE Standard 188-2015	IVB
73	Hajar Z, Mana TSC, Cadnum JL, Donskey CJ. Dispersal of gram-negative bacilli from contaminated sink drains to cover gowns and hands during hand washing. <i>Infect Control Hosp</i>	Nonexperimental	Volunteers, 20 sinks in 7 units of university hospital, United States	n/a	n/a	Number of gram-negative bacilli colonies on hands and cover gowns	Hand washing resulted in frequent dispersal of gram-negative bacilli from colonized sink drains to cover gowns and hands. A plastic drain cover reduced but did not eliminate the risk for contamination.	IIIA
74	Stjärne Aspelund A, Sjöström K, Olsson Liljequist B, Mörgelin M, Melander E, Pählman LI. Acetic acid as a decontamination method for sink drains in a nosocomial outbreak of metallo-β-lactamase-	Case Report	n/a	n/a	n/a	n/a	A nosocomial outbreak of Pae-MBL associated with hospital sink drains was investigated and to evaluate acetic acid as a decontamination method. Antibacterial and antibiofilm properties of acetic acid were evaluated	VA
75	Kotay SM, Donlan RM, Ganim C, Barry K, Christensen BE, Mathers AJ. Droplet- Rather than Aerosol-Mediated Dispersion Is the Primary Mechanism of Bacterial Transmission from	Nonexperimental	3 replicate handwashing sinks with mannequin hands, laboratory, United	n/a	n/a	Settle plate growth of green fluorescent protein (GFP)-expressing	When mannequin hands were used there was 10-fold-lower dispersion on settle plates and none on air samples. No dispersal was captured without or in between faucet event suggesting organisms are larger	IIIB
76	Sehulster L, Chinn RY, Arduino MJ, et al. Guidelines for Environmental Infection Control in Health-Care Facilities. Recommendations of CDC and the Healthcare Infection Control Practices	Guideline	n/a	n/a	n/a	n/a	Provides guidance for environmental infection control in health care facilities.	IVA
77	Ta C, Wong G, Cole W, Medvedev G. Scrub sink contamination and transmission to operating room personnel. <i>New Microbes New Infect</i> . 2020;37:100754. Published 2020 Sep 1.	Nonexperimental	OR personnel, two hospitals, United States	n/a	n/a	Bacterial counts on scrub sink and personnel hands	Significant contamination on the faucets of OR scrub sinks with virulent gram-negative bacilli, but similar bacteria were not found on hands of OR personnel who performed surgical scrub at these sinks. Routine hygienic	IIIA

AORN Guideline for Hand Hygiene  
Evidence Table

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78	Smolders D, Hendriks B, Rogiers P, Mul M, Gordts B. Acetic acid as a decontamination method for ICU sink drains colonized by carbapenemase-producing Enterobacteriaceae and its effect on	Nonexperimental	Sink drains in a single ICU department, Belgium	n/a	n/a	In-vitro growth of OXA-48; Carbapenemase-producing	A variety of CPE strains, all carrying the OXA-48 resistance gene, were isolated from almost all sinks in patient rooms in the ICU. Decontamination of the sinks with 250 mL 25% acetic acid three times weekly was	IIIA
79	Decraene, V., Phan, H. T. T., George, R., et al. A Large, Refractory Nosocomial Outbreak of <i>Klebsiella pneumoniae</i> Carbapenemase-Producing <i>Escherichia coli</i> Demonstrates	Case Report	n/a	n/a	n/a	n/a	All carbapenem-resistant <i>Enterobacteriaceae</i> (CRE) positive sites were from wastewater or plumbing-associated sites. Plumbing was replaced, but when unit reopened strains were again detected suggesting	VB
80	Porteous, Grete H., Bean, Helen A., Woodward, Crystal M., et al. A Simulation Study to Evaluate Improvements in Anesthesia Work Environment Contamination After Implementation of an	Quasi-experimental	25 anesthesia personnel, simulated OR with manikin, United States	Bundle of double gloving, confining airway equipment, and increased hand hygiene	No bundle	Anesthesia work area contamination using UV fluorescent gel	Implementation of evidence-based bundle decreased anesthesia work area contamination by 27% during general anesthesia scenarios	IIB
81	Paul, Elizabeth T., Kuszajewski, Michele, Davenport, Ashley, Thompson, Julie A. and Morgan, Brett. Sleep safe in clean hands: Improving hand hygiene compliance in the	Organizational Experience	Anesthesia providers in main OR, university hospital United States	n/a	n/a	n/a	Significant increase in HH compliance from preimplementation to postimplementation, which was sustained 60 days postimplementation.	VB
82	Loftus RW, Dexter F, Goodheart MJ, McDonald M, Keech J, Noisoux N, Pugely A, Sharp W, Sharafuddin M, Lawrence WT, Fisher M, McGonagill P, Shanklin J, Skeete D, Tracy C,	RCT	Patients undergoing plastic, orthopedic, general abdominal procedures, academic	Enhanced hand hygiene, vascular care, environmental cleaning, and patient	Basic hand hygiene, vascular care, environmental cleaning and patient	<i>S aureus</i> transmission; SSIs	Enhanced bundle significantly reduced number of transmitted <i>S aureus</i> isolates and SSIs.	IA
83	Wilcox M.H., Dyche A. Service evaluation of alcohol-release door plates: an addition to hand hygiene. <i>Journal of Hospital Infection.</i> 2019;103:e97-e100.	Quasi-experimental	Healthcare professionals, 2 individual operating rooms, university	Surfaceskins doorplates, education session, poster	No doorplates, education or poster	Opportunities for hand hygiene and activations of alcohol gel-based dispensers	The addition of alcohol-release doorplates, coupled with education on device use and purpose did not reduce conventional hand hygiene compliance. In fact, when doorplates were in place, there was an 80.7% increase in	IIB
84	Centers for Medicare & Medicaid Services. State Operations Manual Appendix A--Survey Protocol, Regulations and Interpretive Guidelines for Hospitals. 2020	Regulatory	n/a	n/a	n/a	n/a	§482.41(d)(2) states that "facilities, supplies, and equipment must be maintained to ensure an acceptable level of safety and quality," including storage in compliance with fire codes. §482.41(b)(7) states alcohol-	n/a
85	Guideline for a Safe Environment of Care. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2021	Guideline	n/a	n/a	n/a	n/a	Dispenser placement and storage of flammable alcohol-based hand hygiene products must be in compliance with local, state, and federal regulations.	IVA
87	Koff MD, Brown JR, Marshall EJ, O'Malley AJ, Jensen JT, Heard SO, Longtine K, O'Neill M, Longtine J, Houston D, Robison C, Moulton E, Patel HM, Loftus, R.W. Frequency of Hand	RCT	Operating rooms, 2 medical centers, United States	Personalized, body-worn HH system (n=1636)	Intraoperative HH dispensers (n=1620)	Hand decontamination event (HDE) rate; 30-day postoperative	Personalized HH system significantly increased HDE rate (4.3 to 0.54 events per hour), but did not reduce 30-day HAIs.	IA
87	NFPA 101: Life Safety Cod. Quincy, MA: National Fire Protection Association, 2021	Regulatory	n/a	n/a	n/a	n/a	NFPA recommendations for storage of flammable solutions and placement of alcohol-based hand hygiene product dispensers.	IVC
88	Parks, C.L.; Schroeder, K.M.; Galgon, R.E. Personal hand gel for improved hand hygiene compliance on the regional anesthesia team., 2015. <i>J. Anesth.</i> ;29(6): 899-	Quasi-experimental	Health care personnel in Acute Pain Service, Post Anesthesia Care Unit and Block Room,	Wearable personal hand hygiene gel worn (n=161)	No personal hand hygiene gel (n=146)	Hand hygiene compliance	Significant improvement in HCP's hand hygiene compliance occurred following distribution of personal hand hygiene gel dispensers (34% to 63%). Greatest improvement was found among nursing personnel and	IIB



AORN Guideline for Hand Hygiene  
Evidence Table

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89	Centers for Medicare & Medicare Services. State Operations Manual Appendix L - Guidance for Surveyors: Ambulatory Surgical Centers. 2020	Regulatory	n/a	n/a	n/a	n/a	§416.44(b)(4) states alcohol-based hand rub dispensers may be installed in a facility "if the dispensers are installed in a manner that adequately protects against inappropriate access."	n/a
90	Guideline for medical device and product selection. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2016:177-184.	Guideline	n/a	n/a	n/a	n/a	The interdisciplinary team should develop a mechanism for product evaluation and selection of hand hygiene products.	IVB
91	US Food and Drug Administration. Safety and Effectiveness of Health Care Antiseptics; Topical Antimicrobial Drug Products for Over-the-Counter Human Use. 21 CFR Part 310 2017	Regulatory	n/a	n/a	n/a	n/a	Provides new safety and effectiveness data on active ingredients in OTC antiseptic products intended for use in healthcare situations.	n/a
92	US Food and Drug Administration. Q&A for Consumers: Health Care Antiseptics. <a href="http://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm445063.htm">http://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm445063.htm</a>	Regulatory	n/a	n/a	n/a	n/a	While the FDA gathers scientific evidence from the manufacturers, they recommend that health care personnel continue to use health care antiseptics to maintain a standard of care to prevent patient infection.	n/a
93	Shen N-J, Pan S-C, Sheng W-H, et al. Comparative antimicrobial efficacy of alcohol-based hand rub and conventional surgical scrub in a medical center. <i>Journal of Microbiology, Immunology and</i>	Nonexperimental	Healthcare workers, academic medical center, Taiwan	n/a	n/a	Hand cultures by plating swabs	The alcohol-based hand rub was more efficacious for surgical antisepsis and had sustained efficacy, compared to conventional surgical scrub.	IIIB
94	Lai KW, Foo TL, Low W, Naidu G. Surgical hand antiseptics-a pilot study comparing povidone iodine hand scrub and alcohol-based chlorhexidine gluconate hand rub. <i>Annals of the</i>	Quasi-experimental	Volunteers, suture practice workshop, Singapore	Avagard hand rub followed by 1 hour of suture practice	Traditional povidone-iodine scrub followed by 1 hour of suture practice	Hand cultures	Results suggest that the Avagard was more efficacious than aqueous povidone-iodine scrub at reducing baseline colony counts and sustaining this antiseptics.	IIC
95	Hamed Mahmoud M, Morad Asaad A, Ansar Qureshi M. Hand rubbing and scrubbing in relation to microbial count among surgical team members in a Saudi hospital. <i>Life Science Journal</i> 1.	Quasi-experimental	Volunteer surgical team members, 300-bed general hospital, Saudi	(A) Traditional povidone-iodine scrub (B) Ethyl alcohol 70% rub	n/a	Hand cultures on agar plates	Surgical hand rub using avagard was significantly more effective in reducing skin colony counts compared to ethyl alcohol 70% and povidone iodine 7.5%.	IIB
96	Chen S-H, Chou C-Y, Huang J-C, Tang Y-F, Kuo Y-R, Chien L-Y. Antibacterial effects on dry-fast and traditional water-based surgical scrubbing methods: A two-time points experimental study.	Quasi-experimental	OR staff, medical center, Taiwan	Ethyl alcohol (61%) with 1% CHG	Povidone-iodine 7.5%	Hand cultures using immersion in broth, cognitive scale for surgical technique	Use of dry-fast antiseptics has a better persistent effect (P = 0.001), more nurses chose dry-fast antiseptics than surgeons (P = 0.012), and the post-operation number of colonies for nurses was significantly higher than that for	IIB
97	Ghorbani A, Shahrokhi A, Soltani Z, Molapour A, Shafikhani M. Comparison of surgical hand scrub and alcohol surgical hand rub on reducing hand microbial burden. <i>Journal of perioperative</i>	RCT	Surgeons and nurses, 4 teaching hospitals, Iran	Wash hands with non-antibacterial soap and water for 30 seconds, then rub with 70%	Wash hands with counted brush stroke method for 6 minutes with povidone-iodine	Hand bacterial counts	Both methods were effective in reducing microbial burden on the hands.	IC
98	Howard JD, Jowett C, Faoagali J, McKenzie B. New method for assessing hand disinfection shows that pre-operative alcohol/chlorhexidine rub is as effective as a traditional surgical scrub. <i>J Hosp</i>	Quasi-experimental	Anesthetists, Australia	Isopropyl alcohol (70%) with 0.5% CHG	4% CHG scrub	Hand cultures by glove juice method	An alcohol/chlorhexidine hand rub was found to be as efficacious as a traditional scrub after 30 minutes.	IIB
99	Ho Y.-H., Wang Y.-C., Loh E.-W. and Tam K.-W. Antiseptic efficacies of waterless hand rub, chlorhexidine scrub, and povidone-iodine scrub in surgical settings: a meta-analysis of randomized	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Waterless hand rub (WHR) and CHG had greater reduction of CFUs than PI. More studies with consistent outcome measures and grouping are needed for comprehensive result. Preference, compliance and cost	IA

AORN Guideline for Hand Hygiene  
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
100	Jarral OA, McCormack DJ, Ibrahim S, Shipolini AR. Should surgeons scrub with chlorhexidine or iodine prior to surgery?. <i>Interactive Cardiovascular and Thoracic Surgery</i> . 2011;12(6):	Systematic Review	n/a	n/a	n/a	n/a	CHG scrubs may reduce bacterial counts on hands more effectively than aqueous povidone-iodine.	IIB
101	De Bengoa Vallejo R.B., Fernandez D.S., Cervera L.A., et al. Effectiveness of surgical hand antiseptics using chlorhexidine digluconate and parachlorometaxyleneol hand scrub Cross-over	RCT	Health science students, university hospital, Spain	Chlorhexidine digluconate 4% (CHG) (n=20)	Parachlorometaxyleneol 3%(PCMX) (n=20)	Bacterial colony forming units (CFUs)on fingertips and fingernails using	CHG and PCMX have similar bactericidal efficacy. A particular focus should occur on fingernails when using either antiseptic.	IB
102	Olson LKM, Morse DJ, Duley C, Savell BK. Prospective, randomized in vivo comparison of a dual-active waterless antiseptic versus two alcohol-only waterless antiseptics for surgical	Quasi-experimental	Healthy volunteers, United States	(1) Ethyl alcohol (80%) (2) Ethyl alcohol (70%)	Alcohol (ethyl 61%) plus CHG (1%)	Bacterial cultures (log counts), safety evaluation	The alcohol plus CHG product showed noninferiority to the alcohol-only products at all sampling points and, based on significantly lower bacterial regrowth (p=.026), superior persistence to the alcohol-only products after 6	IIA
103	Macinga, David R., Edmonds, Sarah L., Campbell, Esther and McCormack, Robert R. Comparative Efficacy of Alcohol-Based Surgical Scrubs: The Importance of Formulation. <i>AORN J</i> .	RCT	USA, healthy volunteers	(1) Alcohol rub A (70% ethanol gel) (2) Alcohol rub B (90%	Alcohol control (leave on liquid) 4% CHG (rinse off	FDA performance requirements in the 1994 TFM, for 5 days	Alcohol-based antiseptics were equally or more effective than the alcohol and CHG combination surgical hand antiseptics. The most important criteria for choosing a surgical scrub are a demonstrated ability to meet efficacy	IB
104	Cargill DI, Roche ED, Van Der Kar CA, et al. Development of a health care personnel handwash with 6-hour persistence. <i>Am J Infect Control</i> . 2011;39(3): 226-234.	Quasi-experimental	Healthy volunteers, United States	(A) Ethyl alcohol 62% surgical scrub (B) Ethyl alcohol 61% and 1% CHG	Viacydin-Containing Alcohol Sanitizer (VCAS)	In vitro: Minimum inhibitory concentration (MIC), time kill, resistance	Viacydin-Containing Alcohol Sanitizer (VCAS) was superior to or at parity with on-market products, exhibited substantial residual effects and persistence up to 6 hours, and was safe and well tolerated.	IIA
105	Hennig,T.J.; Werner,S.; Naujox,K.; Arndt,A.Chlorhexidine is not an essential component in alcohol-based surgical hand preparation: a comparative study of two handrubs	Quasi-experimental	Healthy volunteers, Switzerland	Surgical hand rub with alcohol-only (45% ethanol, 18% n-propanol, emollients)	Surgical hand rub with 1% chlorhexidine gluconate, 61% ethanol, emollients	Microbial log reduction post application and at 6 hours under gloves	alcohol-only surgical hand rub compared to CHG-alcohol hand rub, leading researchers to conclude that CHG is not a necessary for surgical antiseptics, particularly because CHG has greater potential for skin irritation.	IIB
106	Kampf G, Reichel M, Hollingsworth A, Bashir M. Efficacy of surgical hand scrub products based on chlorhexidine is largely overestimated without neutralizing agents in the sampling fluid. <i>Am J</i>	Quasi-experimental	Healthy volunteers, Germany	(1) Adding neutralizing agents to sampling and dilution fluid	(3) Neutralizing agents were added to the dilution fluid only, and Cetaphil	Efficacy of Avagard and Hibiclens	Lack of neutralizing agents in the sampling fluid resulted in overestimation of efficacy by a factor of between 0.3 and 1.1 log <sub>10</sub> . Studies assessing the efficacy of CHG without using neutralizing agents in the culture sampling	IIB
107	Birnbach, David J., McKenty, Nathan T., Rosen, Lisa F., Arheart, Kristopher L., Everett-Thomas, Ruth and Lindsey, Scott F. Does Adherence to World Health Organization Hand Hygiene	RCT	Volunteers, medical school, United States	ABHR without moisturizer applied every 15 minutes for 8 hours for 5 days (n=9)	ABHR with moisturizer applied every 15 minutes for 8 hours for 5 days (n=8)	Hand Eczema Severity Index dermatitis scale; participant view of	Repetitive use of ABHR may be associated with a change in skin health. Future studies that include evaluation of repeated HH in real OR are needed.	IB
108	Lopes Ricci AE , Gonc M, Menegueti A, et al. Comparing surgeons' skin tolerance and acceptability to alcohol based surgical hand preparation versus traditional surgical scrub: a	Quasi-experimental	Orthopedic and cardiac surgeons, university hospital, Brazil	Surgical hand scrub with antimicrobial soap and water (N =33)	Surgical hand rub with alcohol-based rub (N =33)	Tolerance; acceptability	Minimal variation in redness, scaliness, or fissures with either method, but hand rub with alcohol-based product was preferred method.	IIB
109	van Resburg SJ, Franken A, Du Plessis JL. Measurement of transepidermal water loss, stratum corneum hydration and skin surface pH in occupational settings: A review. <i>Skin Res Technol</i> .	Literature Review	n/a	n/a	n/a	n/a	Transdermal water loss can be used as a predictive tool for occupational skin disease.	VA
110	Girard R, Carre E, Mermet, V, et al. Factors influencing field testing of alcohol-based hand rubs. <i>Infect Control Hosp Epidemiol</i> . 2015;36(3): 302-310. doi:10.1017/ice.2014.51.	Nonexperimental	European field study	n/a	n/a	Factors influencing testing of hand rubs	Investigated factors that influenced the testing of alcohol-based hand rubs and found that test periods during colder seasons were significantly associated with skin reactions.	IIB

AORN Guideline for Hand Hygiene  
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
111	Eiref SD, Leitman IM, Riley W. Hand sanitizer dispensers and associated hospital-acquired infections: Friend or fomite?. <i>Surgical Infections</i> . 2012;13(3): 137-140.	Nonexperimental	17 manual hand sanitizer dispensers, ICU, urban teaching hospital, United states	n/a	n/a	Bacterial cultures of the dispenser lever, rear underside, and area around	Each dispenser contaminated with bacteria, both from common skin flora and gram-negative bacteria. Greatest contamination at lever.	IIIB
112	Abdollahi L, Tabrizi JS, Jodati A, et al. Quality of surgical scrub in a heart hospital: Do not take it for granted. <i>J Cardiovasc Thorac Res</i> . 2017, 9(3):164-169.	Quasi-experimental	Perioperative team members, heart operating rooms, Iran	Education, ergonomic adjustments	No education or ergonomic adjustments	Compliance with 57 outlined steps for surgical hand scrub.	Compliance with standards for surgical hand scrub was improved from 47% to 70% after education and ergonomic adjustments. Periodic audits and observations, along with feedback is recommended.	IIB
113	Forrester J.A., Koritsanszky L.A., Amenu D., et al. Developing Process Maps as a Tool for a Surgical Infection Prevention Quality Improvement Initiative in Resource-Constrained Settings. <i>J Am</i>	Quasi-experimental	Operating rooms, university hospital, Ethiopia	Six perioperative infection prevention standards (Clean Cut) and process mapping	No standard list or process map	Observed adherence to standards	Process mapping led to significant improvement in hand decontamination standard (24.1% to 67.6%). Process maps could be powerful strategy for improving safe care of surgical patients.	IIB
114	Haessler S, Connelly NR, Kanter G et al.. A surgical site infection cluster: the process and outcome of an investigation—the impact of an alcohol-based surgical antiseptic product and	Organizational Experience	Operating rooms, academic, Level 1 trauma, tertiary care medical center, United	n/a	n/a	n/a	Investigation of an SSI cluster. Direct observations of surgical hand antiseptic, including scrub and alcohol rub products, were performed. Observers noted inadequate pre-washing when required (eg, for soiled hands), lack of	VB
115	Fichtner A, Haupt E, Karwath T, Wullenk K, Pöhlmann C, Jatzwauk L. A single standardized practical training for surgical scrubbing according to EN1500: effect quantification, value of the	RCT	Fourth year medical students, skills lab, Germany	45-minute standardized peer training session on surgical hand scrubbing	Received training after testing for hand coverage (n = 81)	Hand coverage with a fluorescent surgical hand scrub antiseptic	In this pilot study, the researchers found that the intervention group had significantly better hand coverage than the control group, which received training after the test.	IC
116	Santos LX, Souza Dias MB, Borrasca VL, et al. Improving hand hygiene adherence in an endoscopy unit.. <i>Endoscopy</i> . 2013;45(6): 421-425	Organizational Experience	Brazil, endoscopy unit	Hand hygiene education (task oriented training, live demonstrations)	Compliance before intervention	Hand hygiene compliance	Significant improvement in hand hygiene rates in an endoscopy unit after a hand hygiene education intervention that included task-oriented training and live demonstrations.	VA
117	Jericho BG, Kalin AM, Schwartz DE. Improving hand hygiene compliance by incorporating it into the verification process in the operating room. <i>Internet J Anesthesiol</i> . 2013;32(3):2	Organizational Experience	Perioperative areas, tertiary care institution, United States	n/a	n/a	n/a	Investigated two interventions to improve hand hygiene compliance in the perioperative setting: use of <b>educational posters</b> and including hand hygiene in the time-out process. The researchers found that compliance	VA
118	Fernandez PG, Loftus RW, Dodds TM et al.. Hand hygiene knowledge and perceptions among anesthesia providers. <i>Anesth Analg</i> . 2015;120(4):837–843	Nonexperimental	3 major academic medical centers and national survey of ASA members, United	n/a	n/a	Anesthesia provider hand hygiene knowledge	Anesthesia provider knowledge deficits around hand hygiene guidelines occur frequently and are often due to failure to recognize opportunities for hand hygiene after prior contact with contaminated patient and	IIIA
119	Elkaradawy SA, Helaly GF, Abdel Wahab MM. Effect of an infection control educational programme on anaesthetists' attitude and anaesthetic field bacterial contamination.	Quasi-experimental	Operating room, Egypt	Develop policy, educate, quiz	n/a	Bacterial contamination on the anesthesia machine and hands of health	Researchers found a significant reduction in bacterial contamination of the anesthesia machine and the hands of personnel after the intervention.	IIA
120	Swenne CL, Alexandrén K. Surgical team members' compliance with and knowledge of basic hand hygiene guidelines and intraoperative hygiene. <i>J Infect Prev</i> . 2012;13(4):114–119	Nonexperimental	Operating rooms, university hospital, Sweden	n/a	n/a	Hand hygiene compliance	Hand disinfection before and after direct patient contact was incomplete, team members used gloves in an incorrect way, and scrub nurses did not always change sterile gloves after intraoperative skin disinfection before	IIIB
121	Pimentel M.P.T., Feng A.Y., Piszcz R., Urman R.D., Lekowski R.W. and Nascimben L. Resident-Driven Quality Improvement Project in Perioperative Hand Hygiene. <i>J Patient Saf</i> . 2019;15(4):e44-e47.	Organizational Experience	Anesthesiologists and nurses in preanesthesia and postanesthesia areas, women's	n/a	n/a	n/a	An anesthesia resident driven multifaceted approach significantly improved overall hand hygiene compliance. (68% to 79%)	VA

AORN Guideline for Hand Hygiene  
Evidence Table

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122	Plemmons, Molly M., Marcenaro, Janina, Oermann, Marilyn H., Thompson, Julie and Vacchiano, Charles A. Improving infection control practices of nurse anesthetists in the anesthesia	Organizational Experience	35 nurse anesthetists, main OR of university hospital, United States	n/a	n/a	n/a	A 26% increase in hand hygiene practices after intubation was seen after intervention. (P = .029)	VB
123	Erichsen Andersson, A., Frodin, M., Dellenborg, L., et al. Iterative co-creation for improved hand hygiene and aseptic techniques in the operating room: experiences from the safe hands study.	Nonexperimental	12 health care personnel, orthopedic operating rooms, Sweden	n/a	n/a	Perception, interaction, and response to knowledge	Interprofessional dialogue and safe-spaces for learning about hand hygiene provided motivation and engagement of HCP.	IIIB
124	Pan S-C, Chen E, Tien K-L et al.. Assessing the thoroughness of hand hygiene: "Seeing is believing." <i>Am J Infect Contr</i> ol. 2014;42(7):799–801	Quasi-experimental	Health care workers, hospital, Taiwan	Hand hygiene with soap and water to remove fluorescent substance	n/a	Removal of fluorescent substance from hands	Researchers found that the most missed areas of the hand were the nails. The researchers recommended using fluorescent products as part of a "seeing is believing" hand hygiene campaign to encourage active	IIA
125	World Health Organization (WHO). A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Geneva, Switzerland;WHO Press; 2009: 1-47.	Consensus					Guide to assist health care facilities in implementing improvements in hand hygiene according to WHO Guideline on Hand Hygiene.	IVA
126	Pedersen L., Elgin K., Peace B., et al. Barriers, perceptions, and adherence: Hand hygiene in the operating room and endoscopy suite. <i>AJIC</i> . 2017;45:695-697.	Qualitative	Students, nurses, surgeons, anesthesia providers, university hospital, United States	n/a	n/a	Perceptions and barriers to hand hygiene	Poor role modeling, inconvenience of dispensers, and simply forgetting to perform were identified as perception and barriers to HH completion .	IIIB
127	Munoz-Price LS, Riley B, Banks S, et al. Frequency of interactions and hand disinfections among anesthesiologists while providing anesthesia care in the operating room: Induction versus	Nonexperimental	Anesthesia providers, teaching hospital, United States	n/a	n/a	Number of contacts with the environment, hand hygiene	There were a high number of contacts of anesthesiologists with the anesthesia work environment and patients' body surfaces during both the induction and maintenance of anesthesia. Contacts with surfaces	IIIB
128	Segal, Scott, Harris, Hannah M., Gunawan, Antonius and Schumann, Roman. A Simple Method for Estimating Hand Hygiene Use Among Anesthesia Personnel: Development, Validation,	Organizational Experience	Anesthesia professionals, operating room, medical center, United	n/a	n/a	n/a	Anesthesia provider's intraoperative hand hygiene performance was accurately measured using a container weight-based system.	VA
129	Rodriguez-Aldrete D, Sivanesan E, Banks S, Mavarez A, Arheart K, Eber S, Munoz-Price,L.S. Recurrent Visual Electronic Hand Hygiene Reminders in the Anesthesia Work Area. <i>Infection</i>	Quasi-experimental	Anesthesia residents during elective upper and lower extremity surgeries, urban	Simple, periodic, visual reminder for 60 seconds every 15 minutes for total of 4	No visual reminder	Number of hand hygiene events per hour	Electronic reminder increased the hand hygiene rate.	IIIB
130	Beyfus, TA, Dawson, NL, Danner, CH, et al. The use of passive visual stimuli to enhance compliance with handwashing in a perioperative setting. <i>AJIC</i> . 2016;44:496-499.	Quasi-experimental	Perioperative holding area, academic hospital, United States	Picture of eyes from known hospital leader placed above two automatic hand	No picture on automatic hand hygiene dispenser	Product volume dispensed	Passive visual stimuli may enhance hand hygiene compliance.	IIIB
131	Ottum A, Sethi AK, Jacobs EA, Zerbel S, Gaines ME, Safdar N. Do patients feel comfortable asking healthcare workers to wash their hands?. <i>Infection Control and Hospital Epidemiol ogy</i> .	Qualitative	Patient survey, United States	n/a	n/a	Comfort in reminding health care personnel to perform hand hygiene.	Surveyed 200 patient respondents (response rate 94.78%) about their comfort in reminding health care personnel to perform hand hygiene. 99.5% of patients surveyed believed that personnel were supposed to wash	IIIB
132	Sande-Meijide, M., Lorenzo-González, M., Mori-Gamarra, F., et al. Perceptions and attitudes of patients and health care workers toward patient empowerment in promoting hand hygiene. <i>AJIC</i> .	Qualitative	Patients, patient families and health care workers (HCW), university hospital,	n/a	n/a	Importance of hand hygiene (HH); intention to request HCW to perform HH;	Significant difference found in patient, patient's families, and HCW's support for hand hygiene promotion by patients.	IIIA