To Bathe or Not to Bathe With Chlorhexidine Gluconate: Is It Time to Take a Stand for Preadmission Bathing and Cleansing?

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Many health care facilities have incorporated an antiseptic skin cleansing protocol, often referred to as preoperative bathing and cleansing, to reduce the endogenous microbial burden on the skin of patients undergoing elective surgery, with the aim of reducing the risk of surgical site infections (SSIs). According to a recent study by Injean et al,[1] 91% of all facilities that perform coronary artery bypass surgery in California have a standardized preoperative bathing and cleansing protocol for patients. Historically, this practice has been endorsed by national and international organizations, such as the Hospital Infection Control Practice Advisory Committee and the Centers for Disease Control and Prevention,[2] the Association for Professionals in Infection Control and Epidemiology (APIC),[3] AORN,[4] the Institute for Healthcare Improvement (IHI),[5] and the National Institute for Health and Care Excellence (NICE),[6] which recommend bathing and/or cleansing with an antiseptic agent before surgery as a component of a broader strategy to reduce SSIs. The 2008 Society for Healthcare Epidemiology of America (SHEA)/Infectious Diseases Society of America (IDSA)/Surgical Infection Society (SIS) strategies to prevent SSIs in acute care hospitals declined to recommend a specific application policy regarding selection of an antiseptic agent for preoperative bathing but acknowledged that the (maximal) antiseptic benefits of chlorhexidine gluconate (CHG) are dependent on achieving adequate skin surface concentrations.[7]

Findings in reports published in the past 10 years have identified SSIs to be the most common health care–associated infection (HAI) and the most expensive in terms of resource utilization.[8,9] This provides a strong business case for health care institutions to invest in targeted, evidence-based, interventional strategies that reduce the risk of postoperative complications. In addition, because the microbial flora of the skin, especially staphylococci, provides a prominent reservoir of pathogens that cause SSIs,[7,10] focused interventions aimed at mitigating this reservoir in preoperative patients represent a logical and effective risk reduction strategy.

THE YIN AND YANG OF PREADMISSION BATHING: A RATIONAL CONSIDERATION OF BENEFIT

Despite the prevalent clinical practice of preoperative bathing with CHG, clinicians are now confronted with a possible shift in both CDC and AORN recommendations. The current proposed draft recommendations for preoperative showering or cleansing are summarized in Table 1. The 2015 AORN "Guideline for preoperative patient skin antisepsis"[11] and the CDC draft guideline[12] both have expanded their recommendations for perioperative skin antisepsis from using CHG products to also using other cleansing products (eg, antimicrobial or nonantimicrobial soap, other unspecified skin antiseptics). These expanded recommendations marginalize the practice of

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Table 1. Professional Organizations' Current and Draft Recommendations

Source	Previous Recommendations	Draft Recommendations	New Recommendations
AORN	**Cleanse 2 times with CHG** "Patients undergoing open Class I surgical procedures below the chin should have two preoperative showers with chlorhexidine gluconate (CHG) before surgery, when appropriate."[1(p73)]	Not applicable	**Cleanse 1 time with soap or an antiseptic** "The patient should be instructed to bathe or shower before surgery with either soap or a skin antiseptic on at least the night before or the day of surgery."[2(p45)]
Hospital Infection Control Practice Advisory Committee—Centers for Disease Control and Prevention	**Cleanse at least 1 time with an antiseptic** "Require patients to shower or bathe with an antiseptic agent on at least the night before the operative day."[3(p267)]	**Cleanse at least 1 time with soap or an antiseptic** "Advise patients to shower or bathe (full body) with either soap (antimicrobial or nonantimicrobial) or an antiseptic agent on at least the night before the operative day."[4(p49)]	Not applicable
Institute for Healthcare Improvement—Project JOINTS	**Cleanse 3 times with CHG** "Instruct patients to bathe or shower with [CHG] soap for at least three days before surgery."[5(p6)]	Not applicable	Not applicable

1. *Recommended practices for preoperative patient skin antisepsis. In:* Perioperative Standards and Recommended Practices. *Denver, CO: AORN, Inc; 2014:73-87.*
2. *Guideline for preoperative patient skin antisepsis. In:* Guidelines for Perioperative Practice. *Denver, CO: AORN, Inc; 2015:43-66.*
3. *Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR; Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection.* Infect Control Hosp Epidemiol. *1999;20(4):250-278.*
4. *Centers for Disease Control and Prevention. Draft guideline for the prevention of surgical site infections.* Fed Regist. *2014;79(67):19339. http://www.regulations.gov/#!docketDetail;D=CDC-2014-0003. Accessed January 9, 2015.*
5. *How-to guide: prevent surgical site infection for hip and knee arthroplasty. Project JOINTS. Institute for Healthcare Improvement. http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventSSIforHipKneeArthroplasty.aspx. Accessed January 2, 2015.*

using CHG for the prevention of SSIs by suggesting that soap or an unspecified antiseptic agent provides benefits that are equivalent to those of CHG.

It is important to note that six of the seven studies cited in the CDC draft document were also cited in the Webster and Osborne[13] 2007 Cochrane Review, which evaluated a total of six clinical studies involving 10,157 patients that analyzed preoperative bathing with 4% CHG compared with placebo, bar soap, or no preoperative bathing before hospital admission. These cited clinical studies were conducted more than 20 years ago (ie, between 1983 and 1992). The conclusions reached by Webster and Osborne[13] suggested that preoperative bathing with CHG does not result in a significant reduction in SSIs involving clean surgical procedures; however, these authors clearly pointed out that one of the limitations they faced in conducting a systematic review was the quality of some of the studies.[13] This observation should not be viewed as trivial but instead as an honest expression of the limitations that Webster and Osborne encountered in developing their manuscript. Unfortunately, the CDC draft guideline[12] has chosen to cite the studies reviewed by Webster and Osborne as evidence that the preadmission shower with 4% CHG has no (or limited) risk reduction benefit, despite the reported limitations of these studies.

The characteristics of the seven studies[14-20] cited in the recent CDC draft guideline document are presented in Table 2. Collectively, the seven studies suggested that there is a high level of surgical heterogeneity (ie, surgical classes 1, 2, and 3). In four of the studies, the patients showered once[16,17,19,20]; in two studies, the patients showered or bathed twice[15,18]; and in one study, the patients showered a total of three times.[14] Inadequate postoperative SSI surveillance was noted in five of the seven cited studies.[15-18,20] No written showering instructions or inadequate showering instructions were noted in five of the seven studies.[15-17,19,20] There was no evidence in any of the

Table 2. Summary of Chlorhexidine Gluconate (CHG) Preadmission Shower and Cleansing Studies

Author (year)	Study Design	Number of Subjects	Follow-up	Compliance	Comment
Byrne et al (1992)[1]	• Randomized controlled trial (RCT) • Patients took 3 showers using 50 mL CHG per shower	• Patients: 3,733 • Class 3 surgical procedures	• 6-week post-discharge surveillance • Infection defined by wound purulence only	• Written instructions to patient • No compliance measured	• 4% CHG vs placebo • Significant heterogeneity of surgical cases
Earnshaw et al (1989)[2]	• RCT • Patients took 2 baths (no shower)	• Patients: 66 • Class variable • Vascular surgery	• No postdischarge surveillance • Infection defined by wound purulence only	• Variable instructions given to patients • No compliance measured	• 4% CHG vs soap • No standardized instruction between groups • Possible group selection bias
Hayek et al (1987)[3]	• Cluster RCT • Patients took 1 shower or bath the day before surgery	• Patients: 2,015 • Class variable • General surgery	• No postdischarge surveillance • Nonstandard SSI definitions used	• Instructions provided to 4% CHG and placebo group only • No compliance measured	• 4% CHG vs placebo vs bar soap • Possible group selection bias • No baseline patient data presented in text
Randall et al (1983)[4]	• RCT • Patients took 1 preadmission shower	• Patients: 94 • Class 2 • Vasectomy procedures	• 7-day postdischarge surveillance • Nonstandard SSI definitions used	• No evidence of instructions provided to patients • No compliance measured	• 4% CHG vs soap vs no intervention • Possible selection bias
Rotter et al (1988)[5]	• Cluster RCT • Patients took 2 showers using 50 mL 4% CHG per shower	• Patients: 2,593 • Class 1 • Thyroidectomy, inguinal herniorrhaphy, hip or knee procedures, mastectomy, laminectomy, and other clean surgical procedures	• 21-day postdischarge surveillance • Nonstandard SSI definitions used	• Instructions provided to all participants • No compliance measured	• 4% CHG vs placebo group

(continued)

Table 2. *(continued)*

Author (year)	Study Design	Number of Subjects	Follow-up	Compliance	Comment
Veiga et al (2009)[6]	• RCT • Patients took 1 shower	• Patients: 150 • Class 1 • Plastic surgery procedures involving the trunk	• 30-day postdischarge surveillance • Used standard CDC definitions for SSIs	• No evidence that instructions were given to patients • No compliance measured	• 4% CHG vs placebo vs no intervention
Wihlborg (1987)[7]	• RCT • Patients took 1 shower	• Patients: 1,530 • Class 1 and 2 • General surgical procedures	• No postdischarge surveillance • Infection defined by presence of wound purulence only	• No indication that instructions were given to patients • No compliance measured	• 4% CHG total body shower vs 4% CHG partial body wash vs no CHG shower • Study was conducted over 6 years (from 1978 to 1984) • Possible outcome bias

1. *Byrne DJ, Napier A, Cuschieri A. The value of whole body disinfection in the prevention of postoperative wound infections in clean and potentially contaminated surgery. A prospective, randomized, double-blind placebo-controlled clinical trial.* Surg Res Comm. *1992;12(1):43-52.*
2. *Earnshaw JJ, Berridge DC, Slack RC, Makin GS, Hopkinson BR. Do preoperative chlorhexidine baths reduce the risk of infection after vascular reconstruction?* Eur J Vasc Surg. *1989;3(4):323-326.*
3. *Hayek LJ, Emerson JM, Gardner AM. A placebo-controlled trial of the effect of two preoperative baths or showers with chlorhexidine detergent on postoperative wound infection rates.* J Hosp Infect. *1987;10(2):165-172.*
4. *Randall PE, Ganguli L, Marcuson RW. Wound infection following vasectomy.* Br J Urol. *1983;55(5):564-567.*
5. *Rotter ML, Larsen SO, Cooke EM, et al. A comparison of the effects of preoperative whole-body bathing with detergent alone and with detergent containing chlorhexidine gluconate on the frequency of wound infections after clean surgery. The European Working Party on Control of Hospital Infections.* J Hosp Infect. *1988;11(4):310-320.*
6. *Veiga DF, Damasceno CA, Veiga-Filho J, et al. Randomized controlled trial of the effectiveness of chlorhexidine showers before elective plastic surgical procedures.* Infect Control Hosp Epidemiol. *2009;30(1):77-79.*
7. *Wihlborg O. The effect of washing with chlorhexidine soap on wound infection rate in general surgery. A controlled clinical study.* Ann Chir Gynaecol. *1987;76(5):263-265.*

seven studies that an effort was made to measure patient compliance. Only two studies used a standardized method for assessing postoperative wound infection.[18,19] Selective elements of operational bias were noted in four of the seven studies.[15-17,20] Finally, one study was conducted over an extended six-year period (ie, from 1978 to 1984), which may have affected the continuity of patient selection and enrollment.[20] Although these seven studies may be characterized as randomized controlled clinical trials and, therefore, existing at the top of the evidence-based pyramid of research, they all exhibit significant design and methodological flaws and cannot be viewed as robust representatives of evidence-based medicine. Although AORN rejected the Webster and Osborne study as well as five of the seven studies cited by the CDC, the 2015 AORN "Guideline for preoperative patient skin antisepsis"[11] considered two of the seven studies (Rotter et al, Veiga et al) cited by the CDC.

A series of single studies[21-26] and bundled interventional studies[27-33] published since 2009 that address SSI risk reduction in class 1 and class 2 surgical procedures are presented in Tables 3 and 4. These studies were not considered in the CDC draft guideline. Although the studies presented in Table 3 were considered in the AORN guideline, the studies in Table 4 were not. This series of evidence-based research comprised case-control studies, cohort analyses, prospective interventional analyses, prospective observational analyses, randomized controlled trials, retrospective cohort studies, or sequential

Table 3. Chlorhexidine Gluconate (CHG) Preadmission Shower Studies—Single Intervention

Author (Year)	Outcome	Type of Study
Eiselt (2009)[1]	• In the three quarters before implementation of the protocol, the surgical site infection (SSI) rate was 3.19%. • In the three quarters after use of the 2% CHG cloth was implemented, the SSI rate decreased to 1.59%, representing a 50.16% reduction in SSIs.	Sequential cohort
Dizer et al (2009)[2]	• In the group for whom a CHG bath was not applied, the researchers found the infection risk to be 4.76 times greater (95% confidence interval, 1.20-18.83) even after corrections for age and sex had been made. • The difference between the control group and the study group with respect to SSIs also was significant ($P < .05$).	Retrospective cohort
Johnson et al (2010)[3]	• Of the 1,134 patients who underwent hip arthroplasty, 157 patients completely complied with the preoperative CHG preparation protocol. • Fourteen infections occurred in the group that was not compliant (1.6% infection rate). • No infections occurred in the compliant patient population.	Cohort
Graling (2013)[4]	• There was a significant ($P = .01$) overall reduction of infection in the group that received a 2% CHG cloth bath before surgery.	Cohort
Johnson et al (2013)[5]	• A lower incidence of SSI was found in patients using the CHG cloths (0.6%) compared with patients undergoing in-hospital perioperative skin preparation only (2.2%). • Based on the results of this study, a preadmission CHG protocol was considered an effective method to prevent SSIs after total knee arthroplasty procedures.	Cohort
Kapadia et al (2013)[6]	• A lower incidence of infections occurred in patients who used the CHG cloths (0.5%) compared with patients undergoing in-hospital perioperative skin preparation only (1.7%). • These results confirm prior studies suggesting that this is an effective method to prevent periprosthetic hip arthroplasty infections.	Cohort

1. *Eiselt D. Presurgical skin preparation with a novel 2% chlorhexidine gluconate cloth reduces rates of surgical site infection in orthopaedic surgical patients.* Orthop Nurs. *2009;28(3):141-145.*
2. *Dizer B, Hatipoglu S, Kaymakcioglu N, Tufan T, Yava A, Iyigun E, Senses Z. The effect of nurse-performed preoperative skin preparation on postoperative surgical site infections in abdominal surgery.* J Clin Nurs. *2009;18(23):3325-3332.*
3. *Johnson AJ, Daley JA, Zywiel MG, Delanois RE, Mont MA. Preoperative chlorhexidine preparation and the incidence of surgical site Infections after hip arthroplasty.* J Arthroplasty *2010;25(6 Suppl):S98-S102.*
4. *Graling PR. Effectiveness of 2% CHG cloth bathing for reducing surgical site infections.* AORN J. *2013;97(5):547-551.*
5. *Johnson AJ, Kapadia BH, Daley JA, Molina CB, Mont MA. Chlorhexidine reduces infections in knee arthroplasty.* J Knee Surg. *2013;26(3):213-218.*
6. *Kapadia BH, Johnson AJ, Daley JA, Issa K, Mont MA. Pre-admission cutaneous chlorhexidine preparation reduces surgical site infections in total hip arthroplasty.* J Arthroplasty. *2013;28(3):490-493.*

Table 4. Bundled Interventional Studies Including Chlorhexidine Gluconate (CHG) Preadmission Showering Strategy

Author (Year)	Outcome	Type of Study
Bode et al (2010)[1]	• 6,771 patients were screened prospectively. • The rate of *Staphylococcus aureus* (*S aureus*) infection was 3.4% in the mupirocin/CHG group compared with 7.7% in the placebo group (relative risk [RR], 0.42; 95% confidence interval [CI], 0.23-0.75). • The greatest benefit for intervention was seen with deep incisional surgical site infections (SSIs) (RR, 0.21; 95% CI, 0.07-0.62).	Randomized control trial
Kim et al (2010)[2]	• 7,019 patients underwent polymerase chain reaction (PCR) staphylococcal screening, of which 22.6% were identified as *S aureus* carriers and 4.4% were identified as methicillin-resistant *S aureus* (MRSA) carriers. • Compared with nonscreened historical control patients (5,283), the infection rate was significantly reduced (0.19%, $P < .0093$) in the mupirocin/CHG group.	Prospective observational
Lipke et al (2010)[3]	• In a quality improvement study, SSIs were reduced by 67% and MRSA SSIs decreased by 78% after active surveillance (ie, nasal mupirocin and CHG preadmission screening).	Prospective interventional
Rao et al (2011)[4]	• The overall SSI rate decreased from 2.7% (20/741) in the preintervention control patient group to 1.2% (17/1,440) in the interventional total joint patient group ($P < .009$).	Cohort
Thompson et al (2013)[5]	• The rate of MRSA SSIs significantly decreased in patients who underwent cardiac, orthopedic, vascular, and neurosurgical procedures ($N = 9,818$, $P < .0003$) after implementation of a care bundle (ie, mupirocin/CHG intervention).	Case control
Chen et al (2013)[6]	• Nasal mupirocin and CHG preadmission showers were effective at reducing methicillin-sensitive *S aureus* (MSSA) colonization ($P < .001$); MRSA colonization approached significance ($P < .063$).	Prospective interventional
Chien et al (2014)[7]	• After implementation of a cardiac care bundle that included CHG preadmission showers, the sternal wound SSI rate decreased from 3.5% to 1.4% ($P < .03$). • The care bundle was highly protective against MRSA infection (0.5% vs 2.3%, $P < .02$).	Sequential cohort

1. *Bode LG, Kluytmans JA, Weertheim HF, et al. Preventing surgical site infection in nasal carriers of* Staphylococcus aureus. N Engl J Med. *2010;362(1):9-17.*
2. *Kim DH, Spencer M, Davidson SM, et al. Institutional prescreening for detection and eradication of methicillin-resistant* Staphylococcus aureus *in patients undergoing elective orthopedic surgery.* J Bone Joint Surg Am. *2010;92(9):1820-1826.*
3. *Lipke VL, Hyott AS. Reducing surgical site infections by bundling multiple risk-reduction strategies and active surveillance.* AORN J. *2010;92(3):288-296.*
4. *Rao N, Cannella BA, Crossett LS, Yates AJ, McGough RL, Hamilton CW. Preoperative screen/decolonization for* Staphylococcus aureus *to prevent orthopedic surgical site infection: prospective cohort study with 2-year follow-up.* J Arthroplasty. *2011;26(8):1501-1507.*
5. *Thompson P, Houston S. Decreasing methicillin resistant* Staphylococcus aureus *surgical site infections with chlorhexidine and mupirocin.* Am J Infect Control. *2013;41(7):629-633.*
6. *Chen AF, Heyl AE, Xu PZ, Rao N, Klatt BA. Preoperative decolonization effective at reducing staphylococcal colonization in total joint arthroplasty patients.* J Arthroplasty. *2013;28(8):S18-S20.*
7. *Chien CY, Lin CH, Hsu RB. Care bundle to prevent methicillin-resistant Staphylococcus aureus sternal wound infection after off-pump coronary artery bypass.* Am J Infect Control. *2014;42(5):562-564.*

cohort studies. Furthermore, these studies were conducted by respected clinical professionals, vetted by peer review, and published in highly respected medical, nursing, infection control, and surgical journals. Clinicians should view these newer studies as more timely and representative of sound evidence-based analysis. As presented in Table 3, many of these studies demonstrated a reduction of SSIs for patients undergoing general, vascular, or orthopedic surgery when using CHG to clean the skin preoperatively in a standardized and controlled manner. Unfortunately, in evaluating the evidence to support the new draft recommendations and guidelines, neither the CDC nor AORN, respectively, took into consideration the limitations of the earlier body of research or considered findings from newer studies.

In addition to the studies identified in Table 3, seven clinical studies with findings that suggest a "care bundle" approach is effective for reducing the risk of SSIs in general, orthopedic, and cardiothoracic surgical procedures are presented in Table 4. A bundled approach often includes three separate elements:

1. Real-time, proximate nasal screening of patients for colonization with *Staphylococcus aureus* (methicillin-sensitive and/or -resistant strains).
2. Use of nasal mupirocin.
3. Preadmission bathing and/or cleaning using either 2% or 4% CHG.

The risk of a *Staphylococcus aureus* SSI in nasal carriers is 5.8 times greater than in non-nasal carriers,[34] which relates to the need for achieving adequate skin surface concentrations on the skin to combat the microbial flora of the patient's skin.

Although it is difficult in the current evidence-based literature to sort out the hierarchical benefit of each individual component, the adjunctive nature of the combined interventions has a rational, mechanistic quality that together serves to lower the microbial burden of those pathogens most problematic to the surgical patient population. Interestingly, more than 25 years ago, Kaiser et al[35] and Garibaldi et al[36] demonstrated in two separate randomized, prospective clinical trials of surgical patients that bathing with a 4% aqueous solution of CHG was more effective at reducing staphylococcal skin colonization than using povidone-iodine or antiseptic bar soap. Although neither study was sufficiently powered to evaluate SSI reduction, both studies did clearly document that repeat application of 4% CHG was superior to a single shower ($P < .05$) in reducing the concentration of the staphylococcal skin microbiota.

STANDARDIZATION AS A PATHWAY FOR IMPROVING PATIENT OUTCOMES

Recent studies,[37-39] as presented in Table 4, have documented that CHG-containing products require a minimum of two applications to attain maximum antimicrobial benefit, so usually repeated antiseptic showers are indicated. Furthermore, findings from research recently completed in the first author's laboratory in the Department of Surgery at the Medical College of Wisconsin showed that skin surface concentrations of CHG were maximized after two showers if a standard regimen was followed that included using 4 oz of CHG per shower and using a 60-second time out before rinsing. The investigators found no additional benefit to adding a third shower to the regimen to boost skin surface concentrations of CHG (written communication; January 2015; unpublished findings). A recent meta-analysis conducted by Chlebicki[40] failed to find a significant difference in SSI reduction in patients taking multiple CHG baths or cleansing. The authors of this study found the results to be surprising given that CHG has been shown in practice to have a demonstrable cumulative effect on the skin with repeated application and is highly efficacious at reducing the microbial burden on the surface of the skin.[41] The current pragmatic perspective suggests that antiseptic bathing, specifically with CHG, before a surgical procedure reduces endogenous flora, thus reducing the risk of SSIs caused by the patient's resident (ie, endogenous) microbial populations.

Most new research, as shown in Table 4, has generally focused on two standardized methods of using CHG preoperatively:

- Method 1: one hour after a regular bath or shower, apply the CHG to the surface of the skin by cleansing with cloths impregnated with 500 mg of CHG.
- Method 2: apply liquid CHG (4%) directly to the skin surface during a shower and then rinse with water.

A potential problem with interpretation of findings from studies conducted before 2009 that used the 4% CHG liquid formulation is a lack of a standardized process. This limitation is significant because researchers and investigators have only recently appreciated the importance of process standardization that includes a consistent application of CHG to the surface of the skin (eg, leaving lather on the skin for one to two minutes before rinsing).[38,39] Given that most patients would be unfamiliar with the preoperative shower or cleansing strategy, their receiving recommendations for a minimum of two preoperative showers with detailed instructions on effective application may be considered prudent skin antisepsis practice. In addition, to maximize the effectiveness of the CHG shower or cleansing process, careful consideration should be given to the development of an effective patient education tool to enhance process compliance.

HOW CAN CLINICIANS IMPROVE PATIENT COMPLIANCE?

Patient compliance with CHG skin cleansing instructions is a common concern. When patients cleanse at home, they lack supervision of skilled health care providers, which makes it difficult to verify whether they cleansed correctly or even cleansed at all. In a recently published study,[38] researchers queried 100 general surgical and orthopedic patients about their preadmission shower compliance (ie, completion):

- 71 patients indicated that they took two showers as prescribed,
- 19 patients indicated that they took only one shower, and
- 10 patients indicated that they skipped the protocol entirely.

The reasons cited for lack of compliance included apathy, lack of interest, or that the patient did not fully realize the importance of completing the task.[38] Because of the potential

risk of noncompliance, the full benefit of this intervention is likely truncated and, as a result, may explain why health care institutions (and practitioners) that have invested in the CHG shower or cleansing process may fail to see the full benefit of this interventional strategy.

Addressing this challenge requires an understanding of the barriers to patient compliance. Patients have a lot on their minds before surgery; often fear and uncertainty cloud their thought processes, and even the best-intentioned patients may not follow their surgical team's instructions correctly. According to Gignon et al,[42] factors associated with patient noncompliance with emergency department discharge instructions may include

- failure to understand administrative instructions,
- physical limitations to thorough cleansing (eg, underlying pain/restricted range of motion caused by osteoarthritis),
- use of unfamiliar medical terminology,
- social isolation,
- language barriers,
- low educational level or illiteracy, and
- socioeconomic status.

Effective patient education is an essential driver of both compliance and improved patient outcome. When patients receive skin cleansing instructions, they need to understand the importance of this process and how these products should be used. A recent study has documented the benefit of using SMS text messaging as a reminder prompt to the patient to complete the preadmission showering process at a designated time.[38] An effective educational process empowers the patient, making the individual an intimate partner in the health care experience while addressing the root causes of patient noncompliance.

In addition to implementing educational programs with patients, product choice can also help enhance the skin cleansing process. Typically, CHG skin cleansing products come in two categories:

1. Bottles of CHG liquid.
2. CHG-impregnated polyester cloths.

Both products are highly effective in reducing the number of bacteria on the surface of the skin. Some of the 4% CHG manufacturers include applicator devices and other materials with their product to assist in the shower/cleansing process. These CHG cleansing kits provide everything in one place and are convenient for patients and health care personnel and may make it easier for patients to comply with institutional protocols and instructions. To date, most manufacturers also provide a digital, web-based alert system (ie, SMS text messaging, e-mail, voice mail) that is designed to enhance patient compliance. This innovative approach to improving patient outcomes has been used successfully in other patient care venues, such as enhancing patient compliance to prescription medication use[43] or resulting in increasing influenza vaccination rates within a low-income pediatric and adolescent patient population.[44]

STAYING THE COURSE

Despite the new CDC draft recommendations and AORN guidelines that marginalize the importance of CHG antiseptic preadmission showering and cleansing protocols for SSI reduction, clinical evidence (see Tables 3 and 4) supports a minimum of two preadmission 4% CHG showers or no-rinse 2% CHG cloth applications as a critical component of a broader interventional strategy for reducing the risk of SSIs. Clinicians face ongoing challenges with HAIs, including SSIs, and now is not the time to scale back efforts in that arena. A recent letter to the editor by Rauber and colleagues states, "Analyzing the types of surgeries covered in the studies reveals a remarkable diversity of surgical sites, which could affect infection risk based on timing and complexity of surgical procedures and disease severity."[45(p1301)]

Following is our recommendation that is based on a thoughtful analysis of current contemporary studies reviewed in this paper: preadmission showering or cleaning with CHG should be implemented as a standard of practice for all patients undergoing elective surgery. Furthermore, efforts to implement this practice within the ambulatory surgical environment would provide an additional benefit as more and more surgical procedures transition from inpatient facilities to the outpatient settings. As previously stated, our evaluation of the CDC draft recommendations and the AORN guideline does not provide a compelling reason for expanding skin antisepsis practices to include nonspecific antiseptic agents or soap, thereby marginalizing the practice of preadmission bathing and/or cleansing with CHG products. Evidence-based medicine is a moving target, and the wealth of current peer-review clinical studies clearly suggest that a standardized protocol that embraces CHG preadmission showering and cleansing is an effective risk reduction strategy.

Disclaimer: *The statements and commentary expressed in this document are the opinions of the cited authors and theirs alone. No monetary consideration was provided to the authors for the development of this document.*

References

1. Injean P, McKinnell JA, Hsiue PP, et al. Survey of preoperative infection prevention for coronary artery bypass graft procedures. *Infect Control Hosp Epidemiol.* 2014;35(6):736-737.
2. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR; Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection. *Infect Control Hosp Epidemiol.* 1999;20(4):250-278.

3. Greene LR, Mills R, Moss R, et al. *Guide to the Elimination of Orthopedic Surgical Site Infections*. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2010:39.
4. Recommended practices for preoperative patient skin antisepsis. In: *Perioperative Standards and Recommended Practices*. Denver, CO: AORN, Inc; 2014:73-87.
5. How-to guide: prevent surgical site infection for hip and knee arthroplasty. Project JOINTS. Institute for Healthcare Improvement. http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventSSIforHipKneeArthroplasty.aspx. Accessed January 2, 2015.
6. Surgical site infection: prevention and treatment of surgical site infections. National Institute for Health and Care Excellence. October 2008. http://www.nice.org.uk/guidance/cg74/chapter/Introduction. Accessed January 2, 2015.
7. Anderson DJ, Podgorny K, Berríos-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(6):605-627.
8. Magill SS, Edwards JR, Bamberg W; Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team. Multistate point-prevalence survey of health care—associated infections. *N Engl J Med.* 2014;370(13):1198-1208.
9. Zimlichman E, Henderson D, Tamir O, et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. *JAMA Intern Med.* 2013;173(22):2039-2046.
10. Weigelt JA, Lipsky BA, Tabak YP, Derby KG, Kim M, Gupta V. Surgical site infections: causative pathogens and associated outcomes. *Am J Infect Control.* 2010;38(2):112-120.
11. Guideline for preoperative patient skin antisepsis. In: *Guidelines for Perioperative Practice*. Denver, CO: AORN, Inc; 2015:43-66.
12. Centers for Disease Control and Prevention. Draft guideline for the prevention of surgical site infections. *Fed Regist.* 2014;79(67):19339. http://www.regulations.gov/#!docketDetail;D=CDC-2014-0003. Accessed January 9, 2015.
13. Webster J, Osborne S. Cochrane Collaboration: preoperative bathing or showering with skin antiseptics to prevent surgical site infection. *Cochrane Database Syst Rev.* 2007;18(2):CD004985.
14. Byrne DJ, Napier A, Cuschieri A. The value of whole body disinfection in the prevention of postoperative wound infections in clean and potentially contaminated surgery. A prospective, randomized, double-blind placebo-controlled clinical trial. *Surg Res Comm.* 1992;12(1):43-52.
15. Earnshaw JJ, Berridge DC, Slack RC, Makin GS, Hopkinson BR. Do preoperative chlorhexidine baths reduce the risk of infection after vascular reconstruction? *Eur J Vasc Surg.* 1989;3(4):323-326.
16. Hayek LJ, Emerson JM, Gardner AM. A placebo-controlled trial of the effect of two preoperative baths or showers with chlorhexidine detergent on postoperative wound infection rates. *J Hosp Infect.* 1987;10(2):165-172.
17. Randall PE, Ganguli L, Marcuson RW. Wound infection following vasectomy. *Br J Urol.* 1983;55(5):564-567.
18. Rotter ML, Larsen SO, Cooke EM, et al. A comparison of the effects of preoperative whole-body bathing with detergent alone and with detergent containing chlorhexidine gluconate on the frequency of wound infections after clean surgery. The European Working Party on Control of Hospital Infections. *J Hosp Infect.* 1988;11(4):310-320.
19. Veiga DF, Damasceno CA, Veiga-Filho J, et al. Randomized controlled trial of the effectiveness of chlorhexidine showers before elective plastic surgical procedures. *Infect Control Hosp Epidemiol.* 2009;30(1):77-79.
20. Wihlborg O. The effect of washing with chlorhexidine soap on wound infection rate in general surgery. A controlled clinical study. *Ann Chir Gynaecol.* 1987;76(5):263-265.
21. Johnson AJ, Daley JA, Zywiel MG, Delanois RE, Mont MA. Preoperative chlorhexidine preparation and the incidence of surgical site Infections after hip arthroplasty. *J Arthroplasty.* 2010;25(6 Suppl):S98-S102.
22. Graling PR. Effectiveness of 2% CHG cloth bathing for reducing surgical site infections. *AORN J.* 2013;97(5):547-551.
23. Johnson AJ, Kapadia BH, Daley JA, Molina CB, Mont MA. Chlorhexidine reduces infections in knee arthroplasty. *J Knee Surg.* 2013;26(3):213-218.
24. Kapadia BH, Johnson AJ, Daley JA, Issa K, Mont MA. Pre-admission cutaneous chlorhexidine preparation reduces surgical site infections in total hip arthroplasty. *J Arthroplasty.* 2013;28(3):490-493.
25. Eiselt D. Presurgical skin preparation with a novel 2% chlorhexidine gluconate cloth reduces rates of surgical site infection in orthopaedic surgical patients. *Orthop Nurs.* 2009;28(3):141-145.
26. Dizer B, Hatipoglu S, Kaymakcioglu N, et al. The effect of nurse-performed preoperative skin preparation on postoperative surgical site infections in abdominal surgery. *J Clin Nurs.* 2009;18(23):3325-3332.
27. Bode LG, Kluytmans JA, Weertheim HF, et al. Preventing surgical site infection in nasal carriers of *Staphylococcus aureus*. *N Engl J Med.* 2010;362(1):9-17.
28. Kim DH, Spencer M, Davidson SM, et al. Institutional prescreening for detection and eradication of methicillin-resistant *Staphylococcus aureus* in patients undergoing elective orthopedic surgery. *J Bone Joint Surg Am.* 2010;92(9):1820-1826.
29. Lipke VL, Hyott AS. Reducing surgical site infections by bundling multiple risk-reduction strategies and active surveillance. *AORN J.* 2010;92(3):288-296.
30. Rao N, Cannella BA, Crossett LS, Yates AJ, McGough RL, Hamilton CW. Preoperative screen/decolonization for *Staphylococcus aureus* to prevent orthopedic surgical site infection: prospective cohort study with 2-year follow-up. *J Arthroplasty.* 2011;26(8):1501-1507.
31. Thompson P, Houston S. Decreasing methicillin resistant *Staphylococcus aureus* surgical site infections with chlorhexidine and mupirocin. *Am J Infect Control.* 2013;41(7):629-633.
32. Chen AF, Heyl AE, Xu PZ, Rao N, Klatt BA. Preoperative decolonization effective at reducing staphylococcal colonization in total joint arthroplasty patients. *J Arthroplasty.* 2013;28(8):S18-S20.
33. Chien CY, Lin CH, Hsu RB. Care bundle to prevent methicillin-resistant *Staphylococcus aureus* sternal wound infection after off-pump coronary artery bypass. *Am J Infect Control.* 2014;42(5):562-564.
34. Skråmm I, Fossum Moen AE, Arøen A, Bukholm G. Surgical site infections in orthopaedic surgery demonstrate clones similar to those in orthopaedic *Staphylococcus aureus* nasal carriers. *J Bone Joint Surg Am.* 2014;96(11):882-888.
35. Kaiser AB, Kernodle DS, Barg NL, Petracek MR. Influence of preoperative showers on staphylococcal skin colonization: a comparative trial of antiseptic skin cleansers. *Ann Thorac Surg.* 1988;45(1):35-38.
36. Garibaldi RA, Skolnick D, Lerer T, et al. The impact of preoperative skin disinfection on preventing intraoperative wound contamination. *Infect Control Hosp Epidemiol.* 1988;9(3):109-113.

37. Edmiston CE, Okoli O, Graham MB, Sinski S, Seabrook GR. Evidence for using chlorhexidine gluconate preoperative cleansing to reduce the risk of surgical site infection. *AORN J.* 2010;92(5):509-518.
38. Edmiston CE, Krepel CJ, Edmiston SE, et al. Empowering the surgical patient: a randomized, prospective analysis of an innovative strategy for improving patient compliance to the preadmission showering protocol. *J Am Coll Surg.* 2014;219(2):256-264.
39. Edmiston CE, Krepel CJ, Seabrook GR, Lewis BD, Brown KR, Towne JB. Preoperative shower revisited: can high topical antiseptic levels be achieved on the skin surface before surgical admission? *J Am Coll Surg.* 2008;207(2):233-239.
40. Chlebicki MP. Preoperative chlorhexidine shower or bath for prevention of surgical site infection: a meta-analysis. *Am J Infect Control.* 2013;41(2):167-173.
41. Edmiston CE, Seabrook GR, Johnson CP, Paulson DS, Beausoleil CM. Comparative of a new and innovative 2% chlorhexidine gluconate-impregnated cloth with 4% chlorhexidine gluconate as topical antiseptic for preparation of the skin prior to surgery. *Am J Infect Control.* 2007;35(2):89-96.
42. Gignon M, Ammirati C, Mercier R, Detave M. Compliance with emergency department discharge instructions. *J Emerg Nurs.* 2014;40(1):51-55.
43. Fenerty SD, West C, Davis SA, Kaplan SG, Feldman SR. The effect of reminder systems on patient's adherence to treatment. *Pt Prefer Adherence.* 2012;6:127-135.
44. Stockwell MS, Karbanda EO, Martinez RA, et al. Effect of a text messaging intervention on influenza vaccination in an urban, low-income pediatric and adolescent population: A randomized controlled trial. *JAMA.* 2012;307(16):1702-1708.
45. Rauber JM, Carneiro M, Krummenauer EC, Machado JA, Valim AR. Preoperative chlorhexidine baths/showers: for or against [letter]? *Am J Infect Control.* 2011;41(12):1301.

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