

What's New in SSI Prevention 2017?



Disclosures

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Objectives

1. Review current evidence supporting introduction or elimination of SSI prevention products and practices,
2. Discuss cost implications for introducing new SSI prevention products,
3. Provide an overview of current events related to SSI risk in the US,
4. Share highlights from 4 recently updated national SSI Prevention Guidelines.

Pre-op SSI Prevention - What's New

1. Antimicrobial and barbed suture
2. Changing gloves before closure
3. Closure tray - separate
4. Clipper with vacuum
5. Disposable pneumatic tourniquets, B/P cuffs, EKG leads, pulse ox probes
6. Drapes – iodine impregnated (updated evidence)
7. Hybrid head cover - skull cap and bouffant
8. Head covers – colored for visitors and pre-op checklist



What's New continued



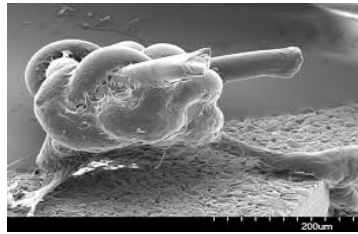
9. Incisional adhesives and antimicrobial post op dressings
10. Nasal decolonization with antiseptic
11. Patient bathing - antimicrobial soap and wipes; how/when to use
12. Space suits Sterile FDA cleared antiseptic surgical irrigation
13. Stopcocks – closed vs. open
14. Topical benzoyl peroxide prior to shoulder surgery
15. UV technology for cleaning surfaces and air
16. Wound protector

Cost Implications

- Costs associated with new products or practices should be considered in the context of the cost of current infection burden.
- Business case for addition of new product to further reduce HAI risk/rate should reflect both the estimated cost of the product, and the estimated cost of treatment for current rate of infection – e.g. cost of disinfection cap for IV ports = $.90/\text{each} \times 3,000 \text{ patients/month} = \$2,700$ compared to 3 CLABSI/month current incidence = $\$45,814 \times 3 = \$137,442$.

Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, Keohane C, Denham CR, Bates DW. “Health Care–Associated Infections Meta-analysis of Costs and Financial Impact on the US Health Care System”. *JAMA Intern Med.* 2013;173(22):2039-2046.

Antimicrobial impregnated sutures, barbed suture



D. J. Leaper, C. E. Edmiston Jr and C. E. Holy. “Meta-analysis of the potential economic impact following introduction of absorbable antimicrobial sutures”. *BJS* 2017; 104: e134–e144. The reviewed literature suggested that **antimicrobial sutures may result in significant savings** across various surgical wound types.

Krishnamoorthy B, Shepherd N, Critchley WR, et al. “A Randomized Study Comparing Traditional Monofilament Knotted Sutures with Barbed Knotless Sutures for Donor Leg Wound Closure In Coronary Artery Bypass Surgery”. *Interact Cardiovasc Thorac Surg.* 2016 ;22(2):161-167. **Surgical knots on the suture line represent a potential source of infection**

Changing gloves prior to closure to prevent contamination of wound



Ban KA, Minei JP, Laronga C, et al. "American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update". J Am Coll Surg. 2017;224(1):59-74.

"Though literature lacks evidence to support the practice of **changing gloves prior to closure** and the use of new instruments, these practices are recommended for colorectal cases **based on expert consensus** and evidence supporting bundles that incorporate these practices."

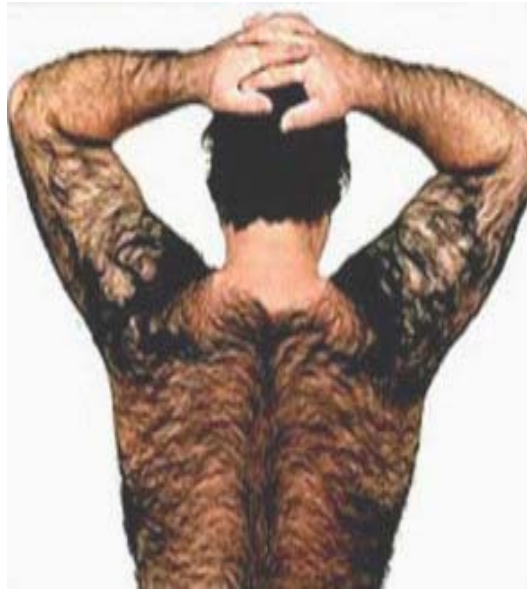
Closure – separate sterile instrument tray for wound closure to prevent contamination



Ban K et al. “American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update” JAMCollSurg 2016 in Press.

“Though literature lacks evidence to support the practice of changing gloves prior to closure and the **use of new separate instruments**, these practices are recommended for colorectal cases **based on expert consensus** and evidence supporting bundles that incorporate these practices.”

Clipper with vacuum (for hair removal)



“Use of **vacuum-assisted hair collection device** resulted in significant ($P < .001$) reduction in total time required to clip and clean up residual hair contaminating the operative field.”

Edmiston CE Jr, Griggs RK, Tanner J, Spencer M, Seabrook GR, Leaper D.

“Perioperative hair removal in the 21st century: Utilizing an innovative vacuum-assisted technology to safely expedite hair removal before surgery.” *Am J Infect Control*. 2016 Dec 1;44(12):1639-1644.

Hair Removal – AORN and Beyond

AORN: Hair removal at the surgical site should be performed only in select clinical situations.

Beyond the Basics:

- ✓ Pre op patient teaching **no leg, pubic hair removal** one week prior to procedure
 - ✓ **Reprocess clipper hand piece** b/w patients
 - ✓ **Razor** vs. clipper for **scalp and scrotum**
-
- 2017 AORN Guideline for Preoperative Patient Skin Antisepsis.
 - Broekman ML. “Neurosurgery and shaving: what's the evidence?” *J Neurosurg.* 2011 Oct;115(4):670-8.
 - Grober ED, Domes T, Fanipour M, Copp JE. “Preoperative hair removal on the male genitalia: clippers vs. razors”. *J Sex Med.* 2013 Feb;10(2):589-94.

Disposable pneumatic tourniquets, B/P cuffs, EKG leads, pulse ox probes



SMY Ahmed, R Ahmad, R Case, and RF Spencer “A Study of Microbial Colonisation of Orthopaedic Tourniquets”. *Ann R Coll Surg Engl.* 2009 Mar; 91(2): 131–134.

Random Germ Question

How many bacteria can be found on one hair follicle?

- 500 bacteria
- 2,500
- 50,000
- 1 million



Double gloves for scrubbed staff to prevent contamination of wound via micro-perforations



Lee SW, Cho MR, Lee HH, Choi WK, Lee JH. "Perforation of Surgical Gloves during Lower Extremity Fracture Surgery and Hip Joint Replacement Surgery". Hip Pelvis. 2015 Mar;27(1):17-22.

Double gloves and Hand hygiene for Anesthesia providers

- Double gloving for Anesthesia, remove one pair after intubation
- Hand hygiene for Anesthesia staff.



Loftus R et al. “**Hand contamination** of anesthesia providers is an important risk factor for intraoperative bacterial transmission”. *Anesth Analg.* 2011 Jan;112(1):98-105.

Birnback DJ et al. “**Double gloves**: a randomized trial to evaluate a simple strategy to reduce contamination in the operating room”. *Anesth Analg* 2015 Apr;120(4):848-52.

Drapes – Iodine impregnated

- ✓ Surgeon preference based on adhesion to skin and theoretical reduction in skin organisms beneath the drape during surgery.
- ✓ 2015 April Cochrane review 7 studies: **No evidence of reduced SSI rate with iodine drape.**
- ✓ 2015 October RCT 808 cardiac surgery patients: **Iodine drape resulted in reduced SSI (6.5 vs. 1.9)**

Webster J, Alghamdi A. "Use of plastic adhesive drapes during surgery for preventing surgical site infection". Cochrane Database Syst Rev. 2015;(4):CD006353.

Bejko J. "Comparison of Efficacy and Cost of Iodine Impregnated Drape vs. Standard Drape in Cardiac Surgery: Study in 5100 Patients". Cardiovasc Transl Res. 2015 Oct;8(7):431-7.

Hybrid head cover (new)



“Compromise” between skull cap and bouffant?

Head cover – red

Version 1: visitors, vendors

Version 2: patient pre-op checklist pending



Incisional adhesive to maintain aseptic wound until skin begins healing or impregnated post op dressing



Grimaldi L, et al. "Octyl-2-cyanoacrylate **adhesive for skin closure**: eight years experience". *In Vivo*. 2015 Jan-Feb;29(1):145-8.

Grosso MJ, Berg A, LaRussa S, Murtaugh T, Trofa DP, Geller JA. "**Silver-Impregnated Occlusive Dressing** Reduces Rates of Acute Periprosthetic Joint Infection After Total Joint Arthroplasty". *J Arthroplasty*. 2017;32(3):929-932.

Nasal decolonization - Antiseptics



Anderson MJ et al. Efficacy of skin and **nasal povidone-iodine** preparation against MRSA and *S. aureus* within the anterior nares. 2015 *Antimicrobial Agents and Chemotherapy* 59 (5), pp. 2765-2773.

Steed LL, Costello J, Lohia S, Spannhake EW, Nguyen S. Reduction of nasal *Staphylococcus aureus* carriage in health care professional by treatment with a non-antibiotic **alcohol-based nasal antiseptic**. 2014 *American Journal of Infection Control* 42 (8), pp 841-846.

Nasal mupirocin resistance and ASP

Widespread usage and over the counter availability of mupirocin has resulted in **resistance among Staphylococcus species**. Increased prevalence of mupirocin resistance among community-acquired staphylococci demands the judicious use of the drug in the community.

Rudresh MS et al. Prevalence of Mupirocin Resistance Among Staphylococci, its Clinical Significance and Relationship to Clinical Use. J Lab Physicians. 2015 Jul-Dec;7(2):103-7.



Random Germ Question

Studies have shown that human influenza viruses generally can survive on surfaces

- between 2 and 8 hours
- 24 hours
- 48 hours
- 1 week



Patient bathing with antimicrobial soap and wipes – how & when to use



Edmiston CE Jr. “Evidence for a Standardized Preadmission Showering Regimen to Achieve Maximal Antiseptic Skin Surface Concentrations of Chlorhexidine Gluconate, 4%, in Surgical Patients”. JAMA Surg. 2015 Nov;150(11):1027-33.

Patient bathing - Text/Electronic reminder

A pre-op process that includes use of an electronic alert system **improves patient compliance** with pre-op antiseptic bathing, while maximizing skin surface concentrations effective against MRSA and other staphylococcal surgical pathogens.

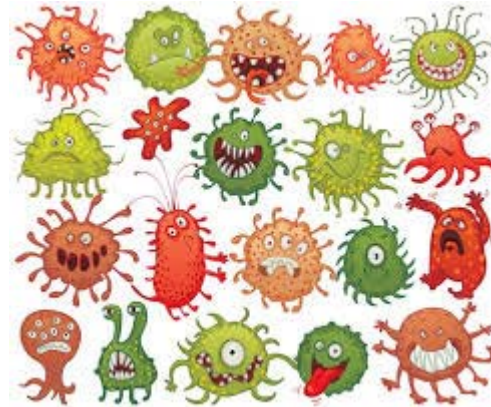


Edmiston CE, Krepel CJ, Spencer MP, et al. "Preadmission Application of 2% Chlorhexidine Gluconate (CHG): Enhancing Patient Compliance While Maximizing Skin Surface Concentrations". *Infect Control Hosp Epidemiol.* 2016;37(3):254-259.

Random germ question:

Within the digestive tract there is an ecosystem of microbes with many purposes including assimilating nutrients, and protecting us from toxins from entering our blood stream. If we were able to gather all of these microbes together, how much would they weigh?

- 2 grams
- 250 grams
- 3 pounds
- 10 pounds?



Space Suites (Laminar Flow and Exhaust Suits)

No data to support reduction in SSIs



- Young SW. “Do 'Surgical Helmet Systems' or 'Body Exhaust Suits' Affect Contamination and Deep Infection Rates in Arthroplasty? A Systematic Review”. J Arthroplasty. 2016 Jan;31(1):225-33.
- Lipsett PA. “Do we really need laminar flow ventilation in the operating room to prevent surgical site infections?” Ann Surg 2008;248:701
- Pasquarella C, Pitzurra O, Herren T, et al. “Lack of influence of body exhaust gowns on aerobic bacterial surface counts in a mixed-ventilation operating theatre. A study of 62 hip arthroplasties”. J Hosp Infect 2003;54:2.

Sterile surgical antiseptic (CHG) irrigation



- Non-antibiotic
- Just prior to closure to eliminate contaminants

“Consider use of **surgical irrigation with aqueous .05% CHG** to reduce SSI risk” Wisconsin DPH SSI Prevention Guidelines 2016

“**Do not use antibiotic incisional wound irrigation** before closure for preventing SSI” – WHO SSI Prevention Guidelines 2016

<http://www.who.int/gpsc/ssi-prevention-guidelines/en/>

Sterile antibiotic impregnated cement and antibiotic resistance

“Antibiotics are often incorporated into bone cement to prevent infection. The increase in the number of microorganisms acquiring or developing **resistance to antibiotics**, such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE), is a major concern.”



- Van Staden AD, Dicks LM. “Calcium orthophosphate-based bone cements (CPCs): Applications, antibiotic release and alternatives to antibiotics.” *J Appl Biomater Funct Mater*. 2012 Jun 26;10(1):2-11.
- Voigt J. Antibiotics and antiseptics for preventing infection in people receiving revision total hip and knee prostheses: a systematic review of randomized controlled trials. *BMC Infect Dis*. 2016 Dec 12;16(1):749.

Stopcocks – Conventional open-lumen stopcock devices (COLDs) vs. closed

“The **swabbable stopcock** with hub disinfection before injection was associated with a significant reduction in the risk of inadvertent bacterial injection as compared to the conventional open-lumen stopcock.”



Loftus RW. “Prevention of intravenous bacterial injection from health care provider hands: the importance of catheter design and handling”. *Anesth Analg* 2012 Nov;115(5):1109-19.

Topical Benzoyl Peroxide prior to shoulder surgery

- *Propionibacterium acnes* infection is a significant problem after shoulder surgery.
- CHG has minimal effect on eradication of *P. acnes*.
- Topical 5% BPO cream 48 hours before surgery plus CHG/alcohol skin prep as usual prior to procedure – shown to reduce *P acnes*.



Sabetta JR. “Efficacy of topical benzoyl peroxide on the reduction of *Propionibacterium acnes* during shoulder surgery”. *J Shoulder Elbow Surg.* 2015 Jul;24(7):995-1004.

UV light: novel technologies and approaches



- **Upper-room UV Germicidal Irradiation:** Linnes JC Eggcrate UV: a whole ceiling upper-room ultraviolet germicidal irradiation system for air disinfection in occupied rooms. *Indoor Air*. 2014 Apr;24(2):116-24
- **Contract service for UV disinfection of environment:** Napolitano N et al. “The effectiveness of UV-C radiation for facility-wide environmental disinfection to reduce health care acquired infections”. *AJIC* 43 (2015) 1342-6.
- **Combined UV/HVAC Systems:** Miller SL. Upper Room Germicidal Ultraviolet Systems for Air Disinfection Are Ready for Wide Implementation. *Am J Respir Crit Care Med*. 2015 Aug 15;192(4):407-9.
- **Continuous violet blue visible light** Maclean M et al. 405 nm light technology for the inactivation of pathogens and its potential role for environmental disinfection and infection control. *J Hosp Infect*. 2014 Sep;88(1):1-11

Wound Edge Protectors to protect wound edges from contamination

- ✓ All open abdominal
- ✓ Single or double ring
- ✓ Surgeon must be familiar with handling the device during placement and removal to avoid wound edge contamination



André L. Mihaljevic et al. “Wound Edge Protectors in Open Abdominal Surgery to Reduce Surgical Site Infections: A Systematic Review and Meta-Analysis”. PLoS One 2015; 10(3).

<http://www.stopwoundinfection.com/clinicalstudies/self-retaining-wound-protector-retractor>

Wound Closure Bundle?

1. Before closing:
 - .05% sterile CHG irrigation
 - Change sterile gloves
 - Separate sterile closure tray
2. Antimicrobial impregnated sutures
3. Incisional adhesive or antimicrobial dressing
4. Post op patient wound care and hygiene



Random Germ Question

How far do sneeze droplets travel?

- One hands length
- 12 inches
- 2 feet
- 3 feet



Post Op SSI Prevention

- “Interventions in the period following an operation are necessary to reduce the incidence of surgical infections.”
- “Introducing chlorhexidine into the daily postoperative bathing solution is safe, requires little additional resources, and has a proven efficacy in reducing infection in a high-risk intensive care population.”
- There is some evidence to suggest that incisional adhesives, negative wound therapy and antimicrobial dressings are helpful in reducing SSI risk.

Walcott B. “Infection Following Operations on the Central Nervous System Deconstructing the Myth of the Sterile Field”. *Neurosurg Focus*. 2012;33(5):e8.

Post operative patient CHG bathing

American College of Surgeons and Surgical Infection Society
2016 SSI Prevention Guidelines:

- **Paucity of informative research** in the area of post hospital interventions for SSI prevention. Substantial number of SSI occur after discharge.
- No evidence that timing of **post op dressing removal** increases SSI risk.
- **Early showering** (12 hours post op) does not increase risk of SSI.



Post operative nasal decolonization with antiseptic

- *Staphylococcus aureus* nasal colonization is a well-known independent risk factor for infection, and decolonization has been proven effective in reducing *S. aureus* infections.
- Using antiseptic instead of antibiotic (mupirocin) would eliminate the risk of antibiotic resistance and transfer of resistance.
- Antiseptics must be applied several times daily – so thinking about post operative nasal decolonization might make sense.



Post op SSI Prevention Discharge Kit?

1. Hand sanitizer
2. Environmental cleaning wipes
3. Nasal antiseptic
4. Liquid CHG soap
5. Instructions for all product use
6. Information on surgical infection symptoms

Ong AY, Tan J, Yeo HL, Goh ML. **Patient-centered hand hygiene** information in orthopaedics units: an evidence-based implementation project. Int J Evid Based Healthc. 2016 Nov 21.

Knox J, et al. Association of **Environmental Contamination in the Home** With the Risk for Recurrent Community-Associated, Methicillin-Resistant Staphylococcus aureus Infection. JAMA Intern Med. 2016 Jun 1;176(6):807-15.

Random Germ Question

England's King Henry IV made a grand move toward cleanliness when he insisted that his knights bathe with what increased frequency?

- Once a day
- Once a week
- Once a month
- Once in their lives



Current Events impacting SSI Risk

Robotic surgical instrument cleaning

- “Our data demonstrated that **complete removal of residual protein from surgical instruments is virtually impossible.**”
- “It might be necessary to **establish a new standard for cleaning** using a novel classification according to the structural complexity of instruments, especially for those for robotic surgery.”
- "By implementing new cleaning procedures using **repeated measurements of the level of contamination** on an instrument more than once, we could potentially save many patients from future infections."

2016 Study in ICHE: Saito Y, Yasuhara H, Murakoshi S, Komatsu T, Fukatsu K, Uetera Y. “Challenging Residual Contamination of Instruments for Robotic Surgery in Japan”. Infect Control Hosp Epidemiol. 2017;38(2):143-146.

Current Events impacting SSI Risk

CRE risk and duodenoscopes

- Recent reports have identified carbapenem-resistant *Enterobacteriaceae* (CRE) transmission associated with persistently contaminated duodenoscopes for which no breaches in reprocessing were identified.
- Contaminated scopes were tied to 35 deaths and many more infections in the U.S.
- Reprocessing guidelines and culturing protocol provided on CDC web page.

CDC information and surveillance protocol:

<https://www.cdc.gov/hai/organisms/cre/cre-duodenoscope-surveillance-protocol.html>

Current Events impacting SSI Risk

Heater cooler units and non TB mycobacterium infections

- Some Sorin heater-cooler devices, used during open heart surgeries, might have been contaminated during manufacturing which could put patients at risk for life-threatening infections.
- CDC recommends following manufacturer instructions, establishing regular cleaning for the devices and directing the heater-cooler's vent away from the patient "to mitigate the risk of aerosolizing heater-cooler tank water into the sterile field".
- Many facilities are notifying patients.

CDC information and patient notification toolkit:

<https://www.cdc.gov/hai/outbreaks/heater-cooler.html>

Current Events impacting SSI Risk

Forced air warming (FAW) devices – safe or unsafe?

- One theoretical concern is that a convective device could disrupt unidirectional downward laminar airflow, which has been suggested could increase the risk of deep surgical site infections.
- This concern is based on theoretical mechanisms, laboratory simulations, and studies showing potentially pathogenic organisms growing in the hoses and filters of forced air warming devices.
- However, multiple well designed studies and commentary pieces (including AORN) recommend patient warming with devices including FAW to reduce SSI risk.

ECRI 2013: Conclusion = Safe!

“Our Review Finds Insufficient Evidence to Support Changes in Current

Practice” [http://www.fawfacts.com/_asset/d2hqh9/Forced-](http://www.fawfacts.com/_asset/d2hqh9/Forced-Air_Warming_and_Surgical_Site_InfectionsHealth_Devices2.pdf)

[Air_Warming_and_Surgical_Site_InfectionsHealth_Devices2.pdf](http://www.fawfacts.com/_asset/d2hqh9/Forced-Air_Warming_and_Surgical_Site_InfectionsHealth_Devices2.pdf)

Wisconsin Public Health Dept SSI Prevention Guidelines: Conclusion = Safe!

<https://www.dhs.wisconsin.gov/hai/ssi-prevention.htm>

Evidence Based Resource: Updated SSI Prevention Guidelines Wisconsin DPH 2016

- For patients targeted by screening before high risk procedures nasal decolonization recommended with mupirocin (5-7 days pre-op) or iodine (1-2 hours pre-op) in addition to CHG bathing for 2 days.
- **Recommend PAB: based on weight** e.g. BMI >30 = 3 vs. 2 gm Ancef.
- For colorectal procedures include pre-op oral antibiotics in combination with mechanical bowel prep.
- **Standardize pre-op shower** (detailed guidelines for CHG shower and CHG bathing cloths included) 2x: night before and morning of procedure 4 oz. liquid or 6 cloths per shower/bath.
- **Recommend text reminder** or phone call to patients for pre-op shower.

2016 SSI Prevention Guidelines Wisconsin DPH continued

- **Use of 2% CHG with 70% alcohol** as preferred skin prep for all surgical procedures including OB GYN.
- Use of wound edge protectors.
- **Sterile glove change** prior to fascia and skin closure.
- **Dedicated wound closure tray** for fascia and skin.
- Consider use of **surgical irrigation with aqueous .05% CHG** to reduce SSI risk.
- Use triclosan coated antimicrobial sutures.

Evidence Based Resource: Updated SSI Prevention Guidelines American College of Surgeons and Surgical Infection Society 2016

- **Use of skull cap supported** if minimal hair exposed (**contradicts AORN**)
- Combination of mechanical and oral antibiotic prep is recommended for elective colectomies.
- Recommend screening and nasal mupirocin for *S aureus* colonized patients before total joint and cardiac procedures.
- Alcohol containing skin prep should be used – no clear superiority b/w CHG and iodine when combined with alcohol. If alcohol cannot be included, CHG should be used instead of iodine.
- Recommend use of impervious plastic wound protector in open abdominal surgery.
- (Intra-operative) topical antibiotics (e.g. paste, powder, drops, irrigation) can reduce SSI for specific cases, including spine, total joint, cataract, but there **is insufficient evidence to recommend routine use.**

2016 SSI Prevention Guidelines American College of Surgeons and Surgical Infection Society continued

- **Use of double gloves** is recommended and changing before closure in colorectal cases.
- Use of new instruments for closure in colorectal cases is recommended.
- Triclosan suture is recommended in clean and clean contaminated abdominal cases.
- **Paucity of informative research** in the area of post hospital interventions for SSI prevention. Substantial number of SSI occur after discharge.
- No evidence that timing of **post op dressing removal** increases SSI risk.
- **Early showering** (12 hours post op) does not increase risk of SSI.
- **Daily wound probing** can decrease SSI in contaminated wounds.
- Use of wound vacuum therapy over stapled skin can reduce SSI in open abdominal and vascular (groin) cases.

Evidence Based Resource: Updated SSI Prevention Guidelines – WHO 2016

- Screening and nasal mupirocin recommended for *S aureus* colonized patients before total joint and cardiac procedures.
- Combination of mechanical and oral antibiotic prep is recommended for elective colorectal surgery.
- **Alcohol based CHG** solutions for skin prep recommended.
- **Antimicrobial sealants should not** be used after skin prep.
- **Plastic adhesive incise drapes** with or without antimicrobial properties should not be used for SSI prevention.
- Use of impervious plastic wound protector can prevent SSI in open abdominal surgery.
- Triclosan suture is recommended in any type of surgical procedure.
- Consider use of **aqueous iodine solution for irrigation** prior to closure.
- **Do not use antibiotic irrigation solution.**
- (Post op) negative pressure wound therapy recommended in high risk wounds.

Evidence Based Resource: Updated SSI Prevention Guidelines OB and GYN Consensus 2017

- "Document is not designed to be prescriptive or to introduce new guidance, but serves to **compile existing guidelines.**" Pre op education process should include specific instructions and education related to including: Not shaving before the procedure.
- Reinforcement of the often ignored periOperative Registered Nurses recommendation that the standard operating room temperature should be maintained between 68°F and 75°F (20–24°C).
- Only recommendation re obese patients: "More aggressive administration and re-dosing of antibiotics is warranted in the obese. And they **may benefit from use of subQ sutures, talc application, wound vacuum.**"

Resources

1. 2016 Wisconsin Public Health Dept SSI Prevention Guidelines <https://www.dhs.wisconsin.gov/publications/p01715.pdf>
2. 2016 WHO SSI Prevention Guidelines <http://www.who.int/gpsc/ssi-prevention-guidelines/en/>
3. 2016 Update SSI Prevention Guidelines American College of Surgeons and Society of Surgical Infections - Minei J et al. “American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update” Journal of the American College of Surgeons January 2017 Volume 224, Issue 1, Pages 59–74.
4. Pellegrini J. et al. “Consensus bundle on prevention of surgical site infections after major gynecologic surgery”. Obstet Gynecol. 2017 Jan;129(1):50-61.
5. SHEA Compendium SSI Prevention 2014 <https://www.shea-online.org/priority-topics/compendium-of-strategies-to-prevent-hais>
6. ASHP (American Society of Health System Pharmacists) Antibiotic prophylaxis guidelines <http://www.ashp.org/surgical-guidelines>