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SPS PREVENTION BUNDLES

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SPS PREVENTION BUNDLE

Catheter – Associated Urinary Tract Infections (CAUTI)

Table of Contents

I. Background & Team

CAUTI (Catheter – Associated Urinary Tract Infections) is the 6th largest contributor to harm caused across the SPS network. In 2011, approximately 19 children were harmed each month as a result of CAUTI across the Phase I SPS hospitals (n=33). The CAUTI team formed in May of 2012 to develop strategies consistent with high reliability concepts to reduce harm caused by CAUTI, and released the first recommended bundle to the network. In 2013, Phase II hospitals (n=55) joined the network and the number of children harmed per month increased to 38.

The network strategy has been successful with a 25% CAUTI reduction across the network as of May 2014. Using data obtained from the SPS network as well as external evidence in the medical literature, the CAUTI team has identified those bundle elements within the first recommended CAUTI bundle that when reliably implemented are highly likely to result in decreased harm to hospitalized children.

As a result, SPS is stratifying bundle elements based on their level of evidence to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for CAUTI and the other aviator HACs:

- *Standard Element:* Strong evidence suggests that implementation of this element is associated with significant decrease in patient harm; all SPS hospitals should implement and measure reliability of this element.
- *Recommended Element*: Preliminary data and clinical expert opinion support the implementation of this element; SPS hospitals should strongly consider implementing this element.

CAUTI Co-Leaders
Linda Chappell, Cook Children's
Vera Hupertz, Cleveland Clinic

CAUTI Subject Matter Experts
Rachel Bowes, Cook Children's
Lisa Schlaefli, Cook Children's
Joann Sanders, Cook Children's
Kathy Ackerman, Cleveland Clinic
Charles Foster, Cleveland Clinic

SPS Staff
Shari Wooton, QIC
Matt Short, Project Specialist
Erin Goodman, Project Coordinator
Ursula Bradshaw, Data Analyst

II. Prevention Bundle Elements – Overview

Insertion

SPS Standard Elements

- Use aseptic technique for insertion
- Avoid unnecessary catheterization

SPS Recommended Elements

- Not applicable

Maintenance

SPS Standard Elements

- Maintain a closed drainage system
- Maintain hygiene
- Keep bag below level of bladder
- Maintain Unobstructed flow
- Remove catheter when no longer needed

SPS Recommended Elements

- Secure catheter

III. Prevention Bundle Elements – Evidence Reviewed

Prevention Bundle Element - Insertion	Level of Evidence CDC*/SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Use aseptic technique for insertion	*IB/**Scenario 4	2, 3, 4
Avoid unnecessary catheterization	*IB/**Scenario 4	2, 3, 4

Prevention Bundle Element - Maintenance	Level of Evidence SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Maintain a closed drainage system	*IB/**Scenario 2	2, 3, 4
Maintain Hygiene	*IB /**Scenario 2	2, 3, 4
Keep bag below level of bladder	*IB/**Scenario 4	2, 3, 4
Maintain Unobstructed flow of urine	*IB/**Scenario 4	2, 3, 4
Remove catheter when no longer needed	*IB/**Scenario 4	2, 3, 4
Recommended Elements		
Secure catheter	*IB//N/A	2, 3, 4

*CDC Modified Recommendation Category

- IA - A strong recommendation supported by high to moderate quality† evidence suggesting net clinical benefits or harms
- IB - A strong recommendation supported by low quality evidence suggesting net clinical benefits or harms or an accepted practice (e.g., aseptic technique) supported by low to very low quality evidence
- IC - A strong recommendation required by state or federal regulation.
- II - A weak recommendation supported by any quality evidence suggesting a trade off between clinical benefits and harms

**SPS Evidence

- Scenario 1: Reliably implementing element is associated with statistically significant improvement
- Scenario 2: Failing to implement element is associated with statistically significant failure to improve along with the system,
- Scenario 3: In cases where all hospitals implement, implementing an element without measuring reliability of the element is associated with statistically significant failure to improve along with the system,

- Scenario 4: Reliably implementing element is not associated with statistically significant improvement; however, literature supports adoption of element as an SPS Standard

IV. Prevention Bundle Elements Care Descriptions

Prevention Bundle Element - Insertion	Care Descriptions
Standard Elements	
Use Aseptic Technique for Insertion	• Perform hand hygiene immediately before and after insertion or any manipulation of the catheter device or site [CDC Reference] • Use sterile gloves, drape, sponges, and appropriate antiseptic or sterile solution for per urethral cleaning, and a single packet of lubricant jelly for insertion [CDC Reference]
Avoid unnecessary catheterization	• Consider having written clinical indications[CDC Reference]

Prevention Bundle Element - Maintenance	Care Descriptions
Standard Elements	
Maintain closed drainage system	• If breaks in aseptic technique, disconnection, or leakage occur, replace the catheter and collecting system using aseptic technique and sterile equipment
Maintain Hygiene	• Perform perineal hygiene at minimum daily.
Keep bag below level of bladder	• Do not rest bag on floor [CDC Reference]
Maintain Unobstructed flow of urine	• Keep the catheter and collecting tube free from kinking
Remove catheter when no longer needed	• Review necessity daily • Document indication daily
Recommended Elements	
Secure catheter	

V. Measurement – Prevention Bundle Reliability

Measurement	Formula	Standards	Reporting Period
CAUTI Prevention Bundle Insertion and Maintenance to be measured separately.	Number of audits totally compliant with SPS Prevention Bundle Elements/ Number of audits completed* x 100	• Your bundle reliability data should include **all** the SPS Prevention Bundle Standard elements • SPS strongly encourages hospitals to also include the SPS Recommended Elements. • Hospitals can choose to include additional elements. Please note that including too many (>5) elements may confuse and overwhelm care providers so proceed with caution. • Measure your bundle as ALL or None. See Reference 5 for IHI description of All on None. [5] • Minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.	Monthly

VI. Spotlight Tools

We have asked hospitals to share their spotlight tools, and have highlighted a few in this SharePoint folder (note: this folder is password protected and can only be accessed by SPS network member hospitals). The highlighted categories are: Bundle Measure Methodology, PDSAs and Interventions, Risk Assessment, Training, Patient & Family Engagement and Failure Analysis.

VII. Spotlight Hospitals

Please click here to view the Sharing Hospitals' Innovation for Network Engagement (SHINE) report.

VIII. References

1. Muir Gray JA, 1997 Evidence-Based Health Care: How to Make Health Policy and Management Decisions. London, UK: Churchill Livingstone;
2. Gould, CA, et al, 2009[4,] Guideline for Prevention of Catheter-Associated Urinary Tract Infections. HICPAC
3. 2014 A Special. On the CUSP: Stop CAUTI, APIC
4. 2014 Update Author(s): Evelyn Lo, MD; Lindsay E. Nicolle, MD; Susan E. Coffin, MD, MPH; Carolyn Gould, MD, MS; Lisa L. Maragakis, MD, MPH; Jennifer Meddings, MD, MSc; David A. Pegues, MD; Ann Marie Pettis, RN, BSN, CIC; Sanjay Saint, MD, MPH; Deborah S. Yokoe, MD, MPH. (May 2014), Strategies to Prevent Catheter-Associated Urinary Tract Infections in Acute Care Hospitals: Source: Infection Control and Hospital Epidemiology, Vol. 35, No. 5, pp. 464-479
5. Resar R, Griffin FA, Haraden C, Nolan TW. 2012 Using Care Bundles to Improve Health Care Quality. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement (Available on www.IHI.org)

IX. Revision History

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Sharyl Wooton & Rachel Bowes	Initial Draft	October 2, 2012
Version 2	Erin Goodman &Sharyl Wooton (on behalf of HAC Co-Leader Team)	Format & Release of new SPS Prevention Bundle content	June 10, 2014
Version 3			
Version 4			

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SPS PREVENTION BUNDLE

Central Line-Associated Blood Stream Infections (CLABSI)

Table of Contents

I. Background & Team

CLABSI (Central Line-Associated Blood Stream Infections) is the largest contributor to harm caused across the SPS network. In 2011, approximately 97 children were harmed each month as a result of CLABSI across the Phase I SPS hospitals (n=33). The CLABSI team formed in May of 2012 to develop strategies consistent with high reliability concepts to reduce harm caused by CLABSI, and released the first recommended bundle to the network. In 2013, Phase II hospitals (n=55) joined the network and the number of children harmed per month increased to 159.

The network strategy has been successful with a 11% CLABSI reduction across the network as of May 2014. Using data obtained from the SPS network as well as external evidence in the medical literature, the CLABSI team has identified those bundle elements within the first recommended CLABSI bundle that when reliably implemented are highly likely to result in decreased harm to hospitalized children.

As a result, SPS is stratifying bundle elements based on their level of evidence to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for CLABSI and the other aviator HACs:

- *Standard Element:* Strong evidence suggests that implementation of this element is associated with significant decrease in patient harm; all SPS hospitals should implement and measure reliability of this element.
- *Recommended Element*: Preliminary data and clinical expert opinion support the implementation of this element; SPS hospitals should strongly consider implementing this element.

CLABSI Co-Leaders
Mike Gutzeit, Wisconsin
Holly O'Brien, Wisconsin
Margie McCaskey, Riley
Michele Saysana, Riley

CLABSI Subject Matter Experts
Holly O'Brien, Wisconsin
Margie McCaskey, Riley

SPS Staff
Shari Wooton, Quality Improvement Consultant
Matt Short, Project Specialist
Erin Goodman, Project Coordinator
Ursula Bradshaw, Data Analyst

II. Prevention Bundle Elements – Overview

Insertion

SPS Standard Elements

- Hand Hygiene
- CHG Scrub
- No iodine ointment
- Prepackaged or filled insertion cart, tray or box
- Insertion checklist with staff empowerment to stop non-emergent procedure
- Full sterile barrier for providers and patients
- Insertion training for all providers

SPS Recommended Elements

- Not applicable

Maintenance

SPS Standard Elements

- Daily discussion of line necessity, functionality and utilization including bedside and medical care team members
- Regular assessment of dressing to assure clean/dry/occlusive
- Standardized access procedure
- Standardized dressing, cap and tubing change procedures/timing

SPS Recommended Elements

- An in-depth review of all identified CLABSI with multidisciplinary involvement AND the intent to change the process if needed.
- Daily CHG bathing and linen changes

III. Prevention Bundle Elements – Evidence Reviewed

Prevention Bundle Element - Insertion	Level of Evidence CDC*/SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Hand Hygiene	*IB/**Scenario 4	3,4,5
CHG Scrub	*IA(/**Scenario 4	3,4,5
No iodine ointment	*IB/**Scenario 4	3,4,5
Prepackaged or filled insertion cart, tray or box	NA/**Scenario 4	3,4,5
Insertion checklist with staff empowerment to stop non-emergent procedure	NA/**Scenario 4	3,4,5
Full sterile barrier for providers and patients	*IB/**Scenario 4	3,4,5
Insertion training for all providers	*IA/**Scenario 4	3,4,5

Prevention Bundle Element - Maintenance	Level of Evidence CDC*/SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Daily discussion of line necessity, functionality and utilization including bedside and medical care team members	*IB/**Scenario 4	3,4,5
Regular assessment of dressing to assure clean/dry/ occlusive	*IB /**Scenario 4	3,4,5
Standardized	*IB/**Scenario 4	3,4,5

Prevention Bundle Element - Maintenance	Level of Evidence CDC*/SPS**	Evidence Cited (Numbers refer to Reference Section)
access procedure		
Standardized dressing, cap and tubing change procedures/timing	*IB/**Scenario 4 & 2	3,4,5
Recommended Elements		
An in-depth review of all identified CLABSI with multidisciplinary involvement AND the intent to change the process if needed.	N/A/N/A	5
Daily CHG bathing and linen changes		6

*CDC Modified Recommendation Category

- IA - A strong recommendation supported by high to moderate quality† evidence suggesting net clinical benefits or harms
- IB - A strong recommendation supported by low quality evidence suggesting net clinical benefits or harms or an accepted practice (e.g., aseptic technique) supported by low to very low quality evidence
- IC - A strong recommendation required by state or federal regulation.
- II - A weak recommendation supported by any quality evidence suggesting a trade off between clinical benefits and harms

**SPS Evidence

- Scenario 1: Reliably implementing element is associated with statistically significant improvement
- Scenario 2: Failing to implement element is associated with statistically significant failure to improve along with the system,
- Scenario 3: In cases where all hospitals implement, implementing an element without measuring reliability of the element is associated with statistically significant failure to improve along with the system,
- Scenario 4: Reliably implementing element is not associated with statistically significant improvement; however, literature supports adoption of element as an SPS Standard

IV. Prevention Bundle Elements Care Descriptions

Prevention Bundle Element - Insertion	Care Descriptions
Standard Elements	
Hand Hygiene	• Perform hand hygiene procedures, either by washing hands with conventional soap and water or with alcohol-based hand rubs (ABHR). Hand hygiene should be performed before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained [CDC Reference]
CHG Scrub	• Prepare clean skin with an antiseptic (70% alcohol, tincture of iodine, an iodophor or chlorhexidine gluconate) before peripheral venous catheter insertion [CDC Reference] • Prepare clean skin with a .0.5% chlorhexidine preparation with alcohol before central venous catheter andperipheral arterial catheter insertion and during dressing changes. If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives [CDC Reference]
No iodine ointment	• Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance [CDC reference]
Prepackaged or filled insertion cart, tray or box	• Catheter cart that contains all the necessary supplies (CDC reference]
Insertion checklist with staff empowerment to stop non-emergent procedure	• Include a checklist to ensure adherence to proper practices; [CDC Reference] • Stoppage of procedures in non-emergent situations, if evidence-based practices were not being followed [CDC Reference]
Full sterile barrier for providers and patients	• Use maximal sterile barrier precautions, including the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape, for the insertion of CVCs, PICCs, or guidewire exchange 2. Use a sterile sleeve to protect pulmonary artery catheters during insertion [CDC reference]
Insertion training for all providers	• Refer to CDC reference on education & training details (page e169)

Prevention Bundle Element - Maintenance	Care Descriptions
Standard Elements	
Daily discussion of line necessity, functionality and utilization including bedside and medical care team members	• Discuss with the medical team continued necessity of line • Discuss with the medical team the function of the line and any problems • Discuss with the medical team the frequency of access and utilization of line. Consider bundling labs and line entries. • Consider best practice is documentation that the discussion occurred in the medical record.
Regular assessment of dressing to assure clean/dry/ occlusive	• Replace catheter site dressing if the dressing becomes damp, loosened, or visibly soiled (CDC Reference) • Replace dressings used on short-term central venous catheters sites every 2 days for gauze dressings and at least every 7 days for transparent dressings [CDC Reference)]
Standardized access procedure	• Refer to Hand Hygiene details in CLABSI insertion Bundle • Disinfect cap before all line entries by scrubbing with an appropriate antiseptic and accessing the port only with sterile devices [CDC Reference] • Alcohol (15 second scrub + 15 second dry) or CHG (30 second scrub + 30 second dry) [CDC Reference]
Standardized dressing, cap and tubing change procedures/timing	• Scrub skin around site with CHG for 30 seconds (2 minute for femoral site), followed by complete drying. (Note: institutional preference for CHG use for infant < 2 months of age) [CDC Reference] • Change crystalloid tubing no more frequently than every 72 hours [CDC Reference] • Change tubing used to administer blood products every 24 hours or more frequently per institutional standard [CDC Reference] • Change tubing used for lipid infusions every 24 hours [CDC Reference] • Document date dressing/cap/tubing was changed or is due for change [CDC Reference & SPS Data] • Consider when hub of catheter or insertion site are exposed, wear a mask (all providers and assistants)—shield patient's face, ETT or trach with mask or drape
Recommended Elements	
An in-depth review of all identified CLABSI with multidisciplinary involvement AND the intent to change the process if needed.	• Utilize a systematic approach to review all hospital acquired CLABSIs

Daily CHG bathing and linen changes	• Follow manufacturer recommendations for usage

V. Measurement – Prevention Bundle Reliability

Measurement	Formula	Standards	Reporting Period
CLABSI Prevention Bundle Insertion and Maintenance to be measured separately.	Number of audits totally compliant with SPS Prevention Bundle Elements/ Number of audits completed* x 100	• Your bundle reliability data should include **all** the SPS Standard elements • SPS strongly encourages hospitals to also include the SPS Recommended Elements. • Hospitals can choose to include additional elements. Please note that including too many (>5) elements may confuse and overwhelm care providers so proceed with CLABSIon. • Measure your bundle as ALL or None. See Reference 7 for IHI description of All on None. • Minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.	Monthly

VI. Spotlight Tools

We have asked hospitals to share their spotlight tools, and have highlighted a few in this SharePoint folder (note: this folder is password protected and can only be accessed by SPS network member hospitals). The highlighted categories are: Bundle Measure Methodology, PDSAs and Interventions, Risk Assessment, Training, Patient & Family Engagement, and Failure Analysis.

VII. Spotlight Hospitals

Please click here to view the Sharing Hospitals' Innovation for Network Engagement (SHINE) report.

VIII. References

1. Centers for Disease Control and Prevention. Guidelines for Hand Hygiene in Healthcare Settings. MMWR 2002:51 No. RR-16): 1-56
2. Centers for Disease Control and Prevention/ Guidelines for the Prevention of Intravascular Catheter-Related Infections. MMWR 2002;51 (No. RR-10): 1-29.
3. 2011 CDC Guidelines for Prevention of Catheter –related Infections. Clinical Infectious Diseases.
4. Pediatrics (2010), Quality Transformation Efforts Decreasing PICU Catheter-Associated Bloodstream Infections
5. Pediatrics; (2011), A Hospital-wide Quality-Improvement Collaborative to Reduce Catheter-Associated Bloodstream Infections
6. Aaron M Milstone, Alexis Elward, Xiaoyan Song, Danielle M Zerr, Rachel Orscheln, Kathleen Speck, Daniel Obeng, Nicholas G Reich, Susan E Coffin,Trish M Perl, Published online January 28, 2013 *for the Pediatric SCRUB Trial Study Group;* www.thelancet.com http://dx.doi.org/10.1016/S0140-6736(12)61687-0
   Daily chlorhexidine bathing to reduce bacteraemia in critically ill children: a multicentre, cluster-randomised, crossover trial
7. Resar R, Griffin FA, Haraden C, Nolan TW (2012). Using Care Bundles to Improve Health Care Quality. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement. (Available on www.IHI.org)

IX. Revision History

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Sharyl Wooton	Initial Draft	October 2, 2012
Version 2	Erin Goodman & Sharyl Wooton	Format & Release of new SPS Prevention Bundle content	June 10, 2014
Version 3			
Version 4			

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SPS PREVENTION BUNDLE

Falls

Table of Contents

I. Background & Team

Falls is the 9th largest contributor to harm caused across the SPS network. In 2011, approximately 20 children were harmed each month as a result of Falls across the Phase I SPS hospitals (n=33). The Falls team formed in May of 2012 to develop strategies consistent with high reliability concepts to reduce harm caused by Falls, and released the first recommended bundle to the network. In 2013, Phase II hospitals (n=55) joined the network and the number of children harmed per month decrease to 12.

The network strategy has been successful with an 81% Falls reduction across the network as of May 2014. Using data obtained from the SPS network as well as external evidence in the medical literature, the Falls team has identified those bundle elements within the first recommended Falls bundle that when reliably implemented are highly likely to result in decreased harm to hospitalized children.

As a result, SPS is stratifying bundle elements based on their level of evidence to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for Falls and the other aviator HACs:

- *Standard Element:* Strong evidence suggests that implementation of this element is associated with significant decrease in patient harm; <u>all SPS hospitals should implement and measure reliability of this element.</u>
- *Recommended Element*: Preliminary data and clinical expert opinion support the implementation of this element; <u>SPS hospitals should strongly consider implementing this element.</u>

Falls Co-Leaders

Gary LaBlance, St. Louis Children's
Hila Collins, Dayton Children's
Angela Green, Arkansas Children's

Falls Subject Matter Experts

Heidi Fields, St. Louis Children's
Stephanie Benning, Arkansas Children's

SPS Staff

Shari Wooton, Quality Improvement Coordinator
Matt Short, Project Specialist
Erin Goodman, Project Coordinator
Ursula Bradshaw, Data Analyst

II. Prevention Bundle Elements – Overview

SPS Standard Elements

- Screen patients for risk of fall
- Identify and communicate patients at risk for falls & injury
- Ensure a safe environment
- Review of safety protocols with parents/guardians/family

SPS Recommended Elements

- Implement specific mitigation strategies for patients at risk of falls with injury.

III. Prevention Bundle Elements – Evidence Reviewed

Prevention Bundle Element	Level of Evidence SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Screen patients for risk of fall	*Level 3/**Scenario 4	2, 3, 4, 5, 9
Identify and communicate patients at risk for falls & injury	*Level 3/**Scenario 2/4	1, 4, 10
Ensure a safe environment	*Level 4/**Scenario 4	6, 9
Review of safety protocols with parents/guardians/ family	*Level 3/Scenario 2	1, 7, 9, 10, 11
Recommended Elements		
Implement specific mitigation strategies for patients at risk of falls with injury.	*Level 5/N/A	6, 8, 9

*Muir Gray Classification Levels

- Level 1 – meta-analysis of a series of randomized controlled trials
- Level 2 – at least one well designed randomized controlled trial
- Level 3 – at least one controlled study without randomization
- Level 4 – non-experimental descriptive studies
- Level 5 – reports or opinions from respected authorities

**SPS Evidence

- Scenario 1: Reliably implementing element is associated with statistically significant improvement
- Scenario 2: Failing to implement element is associated with statistically significant failure to improve along with the system,

- Scenario 3: In cases where all hospitals implement, implementing an element without measuring reliability of the element is associated with statistically significant failure to improve along with the system,
- Scenario 4: Reliably implementing element is not associated with statistically significant improvement; however, literature supports adoption of element as an SPS Standard

IV. Prevention Bundle Elements Care Descriptions

Prevention Bundle Element - Maintenance	Care Descriptions
Standard Elements	
Screen patients for risk of fall	• Screen on admission and at interval(s) defined by the selected fall risk assessment tool. • Consider using a fall risk assessment tool that includes variables specific to the pediatric population.
Identify and communicate patients at risk for falls & injury	• Identify patients are risk for falls by signage, armbands , or other identifiers • Communicate fall risk at handoff: o At shift change (nurse to nurse) o At time of transfer in care (unit to unit) o Nurse to other (Child Life specialist, Radiology Technician, etc.)
Ensure a safe environment	• Ensure unused equipment is removed and pathways to door and bathroom are clear • Clutter in room is minimized • Non-skid footwear for ambulating patients • Call light is within reach; orient to use periodically • Use of appropriate sized clothing to prevent tripping • Bed in low position with brakes on • Appropriate sized bed is used (no co-bedding) • Evaluate for gaps in the bed railings that may allow the child to slip between the rails • Wheelchair and commode brakes are locked during transfers
Review of safety protocols with parents/guardians/family	• Parents/guardian/family members have an integral role in a falls risk prevention program • Parent/guardian/family education regarding fall risks of hospitalized children is important. • Educate parents/guardians/family on safe environment

Recommended Elements	
Implement specific mitigation strategies for patients at risk of falls with injury.	• Hourly rounds that include risk identification and prioritizing individualized risk reduction strategies helps to keep patients safe and comfortable by proactively meeting their needs. • Assisting when up and out of bed • 1:1 observation (only when appropriate)

V. Measurement – Prevention Bundle Reliability

Measurement	Formula	Standards	Reporting Period
Falls Prevention Bundle	Number of audits totally compliant with SPS Prevention Bundle Elements/ Number of audits completed* x 100	• Your bundle reliability data should include **all** the SPS Standard elements • SPS strongly encourages hospitals to also include the SPS Recommended Elements. • Hospitals can choose to include additional elements. Please note that including too many (>5) elements may confuse and overwhelm care providers so proceed with caution. • Measure your bundle as ALL or None. See Reference 12 for IHI description of All on None. • Minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.	Monthly

VI. Spotlight Tools

We have asked hospitals to share their spotlight tools, and have highlighted a few in this SharePoint folder (note: this folder is password protected and can only be accessed by SPS network member hospitals). The highlighted categories are: Bundle Measure

Methodology, PDSAs and Interventions, Risk Assessment, Training, Patient & Family Engagement and Failure Analysis.

VII. Spotlight Hospitals

Please click here to view the Sharing Hospitals' Innovation for Network Engagement (SHINE) report.

VIII. References

1. Cooper, C. L. & Nolt, J. D. (2007). Development of an evidence-based pediatric falls prevention program. Journal of Nursing Care Quality, 22, 107-112.
2. Graf, E. (2005a, November). Pediatric hospital falls: Development of a predictor model to guide clinical practice. Paper presented at the 38th STTI Biennial Convention, Indianapolis, IN.
3. Harvey, K., Kramlich, D., Chapman, J., Parker, J., & Blades, E. (2010). Exploring and evaluating five pediatric falls assessment instruments and injury risk indicators: An ambispective study in a tertiary care setting. Journal of Nursing Management, 18, 531-541.
4. Hill-Rodriguez, P. Messmer, P. Williams, R. Zeller, A. Williams, M. Wood & M. Henry. (2008). The humpty dumpty falls scale: A case control study. Journal for Specialists in Pediatric Nursing, 14(1), 22-32.
5. Kissinger, E. & Marin, A. (2010). Pediatric Falls Risk Assessment in the Hospitalized Child. Submitted in partial satisfaction of the requirements for the degrees of Master of Science in Nursing at California State University.
6. Neiman, J., Rannie, M., Thrasher, J., Terry, K. &. Kahn, M. (2011). Development, implementation, and evaluation of a comprehensive fall risk program. Journal for Specialists in Pediatric Nursing, 16, 130-139.
7. Razmus, I. & Davis, D. (2012). The epidemiology of falls in hospitalized children. Pediatric Nursing, 38(1), 31-35.
8. Razmus, I., Wilson, D., Smith, R. & Newman, E. (2006). Falls in the hospitalized child. Pediatric Nursing, 32, 568-572.
9. Child Health Corporation of America Nursing Falls Study Task Force, 2009
10. Krauss, Tutlam, Costantinou, Johnson, Jackson, Fraser, 2008
11. Ryu, Roche, Brunton, 2009
12. Resar R, Griffin FA, Haraden C, Nolan TW. (2012) Using Care Bundles to Improve Health Care Quality. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement;. (Available on www.IHI.org)

IX. Revision History

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Katie Hilbert	Initial Draft	Oct 2012
Version 2	Heidi Fields, Amy Hester	Addition of evidence levels, reliability, and references	Jan 2013
Version 3	Erin Goodman & Sharyl Wooton (on behalf of HAC Co-Leader team)	Format & Release of new SPS Prevention Bundle content	June 10, 2014

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SPS PREVENTION BUNDLE

Pressure Ulcers (PU)

Table of Contents

I. Background & Team

PU (Pressure Ulcers) is the 2nd largest contributor to harm caused across the SPS network. In 2011, approximately 43 children were harmed each month as a result of PU across the Phase I SPS hospitals (n=33). The PU team formed in May of 2012 to develop strategies consistent with high reliability concepts to reduce harm caused by PU, and released the first recommended bundle to the network. In 2013, Phase II hospitals (n=55) joined the network and the number of children harmed per month increased to 65.

The network strategy has been successful with a 30% PU increase across the network as of May 2014. Using data obtained from the SPS network as well as external evidence in the medical literature, the PU team has identified those bundle elements within the first recommended PU bundle that when reliably implemented are highly likely to result in decreased harm to hospitalized children.

As a result, SPS is stratifying bundle elements based on their level of evidence to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for PU and the other aviator HACs:

- *Standard Element:* Strong evidence suggests that implementation of this element is associated with significant decrease in patient harm; all SPS hospitals should implement and measure reliability of this element.
- *Recommended Element*: Preliminary data and clinical expert opinion support the implementation of this element; SPS hospitals should strongly consider implementing this element.

PU Co-Leaders
Gary Frank, Atlanta
Rich Brilli, Nationwide

PU Subject Matter Experts
Marcia Bryant, Atlanta
Maggie Killgore, Atlanta
Trish Burdett, Atlanta
Leah Keller, Nationwide
Brenda Ruth, Nationwide

SPS Staff
Shari Wooton, Quality Improvement Consultant
Matt Short, Project Specialist
Erin Goodman, Project Coordinator
Karen Zieker, Data Analyst

II. Prevention Bundle Elements* – Overview

SPS Standard Elements

- Skin Assessment
- Device Rotation
- Patient Positioning
- Appropriate Bed Surface
- Moisture Management

SPS Recommended Elements

- Not applicable

* Bundle applied to patients who score as a high risk for Pressure Ulcers

III. Prevention Bundle Elements – Evidence Reviewed

Prevention Bundle Element	Level of Evidence SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Skin Assessment	*Level 2/**Scenario 1	3
Device Rotation	*Level 5 /**Scenario 1	1, 4, 9
Patient Positioning	*Level 5/**Scenario 1	4
Appropriate Bed Surface	*Level 1/**Scenario 1	4, 7
Moisture Management	*Level 5/**Scenario 1	8

*Muir Gray Classification Levels

- Level 1 – meta-analysis of a series of randomized controlled trials
- Level 2 – at least one well designed randomized controlled trial
- Level 3 – at least one controlled study without randomization
- Level 4 – non-experimental descriptive studies
- Level 5 – reports or opinions from respected authorities

**SPS Evidence

- Scenario 1: Reliably implementing element is associated with statistically significant improvement
- Scenario 2: Failing to implement element is associated with statistically significant failure to improve along with the system,
- Scenario 3: In cases where all hospitals implement, implementing an element without measuring reliability of the element is associated with statistically significant failure to improve along with the system,
- Scenario 4: Reliably implementing element is not associated with statistically significant improvement; however, literature supports adoption of element as an SPS Standard

IV. Prevention Bundle Elements Care Descriptions

Prevention Bundle Element - Maintenance	Care Descriptions
Standard Elements	
Skin Assessment	• At least every 24 hours but consensus best practice - recommend every shift change (Q4H in perfusion compromised patients), Operating Room (OR) at end of cases lasting 4 hours or more and/or on arrival PACU/ICU's
Device Rotation	• Assess skin in contact with medical devices each shift or more frequently with other care, Rotate pulse-ox probe at least every 8 hours or more often if able
Patient Positioning	• Turn all immobile patients at least every 2 hours or timed with care in NICU (e.g. standardized turning schedule, clock at bedside); • Maintain HOB less than or equal 30 degrees (unless medically contraindicated) Note: Patients who are mobile and/or able to get out of bed may sit in a chair or upright in bed if physically able to do so. Patient position must still be shifted regularly to reduce pressure.
Appropriate Bed Surface	• Evaluate need for specialty bed based on Skin Risk Assessment. • Use gel pads, pillows and/or pressure reduction device to cushion bony prominences.
Moisture Management	• Barrier cream applied to create a moisture barrier for all diapered patients; • Keep skin clean and dry

V. Measurement – Prevention Bundle Reliability

Measurement	Formula	Standards	Reporting Period
PU Prevention Bundle	Number of audits totally compliant with SPS Prevention Bundle Elements/ Number of audits completed* x 100	• Your bundle reliability data should include **all** the SPS Standard elements • SPS strongly encourages hospitals to also include the SPS Recommended Elements. • Hospitals can choose to include additional elements. Please note that including too many (>5) elements may confuse and overwhelm care providers so proceed with caution. • Measure your bundle as ALL or None. See Reference 10 for IHI description of All on None. • Minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.	Monthly

VI. Spotlight Tools

We have asked hospitals to share their spotlight tools, and have highlighted a few in this SharePoint folder (note: this folder is password protected and can only be accessed by SPS network member hospitals). The highlighted categories are: Bundle Measure Methodology, PDSAs and Interventions, Risk Assessment, Training,Patient & Family Engagement and Failure Analysis.

VII. Spotlight Hospitals

Please click here to view the Sharing Hospitals' Innovation for Network Engagement (SHINE) report.

VIII. References

1. Institute for Clinical Systems Improvement, (2007). Skin Safety Protocol: Risk Assessment and Prevention of Pressure Ulcers. Second Edition, Marc: 1-18.
2. Jankowski, I.M., Morris Nadzam, D. (2011). Identifying gaps, barriers and solutions in implementing pressure ulcer prevention programs. The Joint Commission Journal on Quality and Patient Safety, 37, 253-264.
3. Kemp, M. Keithley, J., Smith, D., Morreale, B. (1990) Factor that contribute to pressure sores in surgical patients. Res Nurs Health. 13:293-301.
4. National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel (NPAUP/EPUAP) (2009). Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline. Washington D.C.: National Pressure Advisory Panel.
5. Nellcor Retrieved on 10/1/2012 from http://www.nellcor.com/_Catalog/PDF/Product/CliniciansSensorGuide.pdfNeed to reference Nelcor
6. Pasek, T.A., Geyser, A., Sidoni, M., Harris, P., Warner, J.A., Spence, A., Trent, A., Lazzaro, L., Balach, J., Bakota, A., & Weicheck, S. (2008). Skin care team in the pediatric intensive care unit: A model for excellence. Critical Care Nurse, 28, 125-135.
7. Reddy, M., Gill, S.S., Rochon, P.A. (2006) " Preventing Pressure Ulcers: A Systematic Review". JAMA, 296:974-984.
8. Wound Ostomy and Continence Nurses Society. (2003) WOCN Clinical Practice Guideline Series: Guideline for Prevention and management of Pressure Ulcers. Glenview, IL.
9. Manufacturing Recommendations → Nellcor recommends inspection of the pulse oximeter probe site every 8 hours.
10. Resar R, Griffin FA, Haraden C, Nolan TW. (2012) Using Care Bundles to Improve Health Care Quality. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement. (Available on www.IHI.org)

IX. Revision History

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Katie Hilbert	Initial Draft	Nov 9, 2012
Version 2	Leah Keller, Maggie Killgore	Addition of Standards of Care, Levels of Evidence, and Measuring Reliability	Jan 29, 2013
Version 3	Erin Goodman &Sharyl Wooton (on behalf of HAC Co-Leader Team)	Format & Release of new SPS Prevention Bundle content	June 10, 2014
Version 4			

Children's Hospitals' Solutions for Patient Safety
Every patient. Every day.

SPS PREVENTION BUNDLE

Surgical Site Infections (SSI)

Table of Contents

I. Background & Team

SSI (surgical site infection) is the 4th largest contributor to harm caused across the SPS network. In 2011, approximately 33 children were harmed each month as a result of SSI across the Phase I SPS hospitals (n=33). The SSI team formed in May of 2012 to develop strategies consistent with high reliability concepts to reduce harm caused by SSI, and released the first recommended bundle to the network. In 2013, Phase II hospitals (n=55) joined the network and the number of children harmed per month increased to 46.

The network strategy has been successful with a 19% SSI reduction across the network as of May 2014. Using data obtained from the SPS network as well as external evidence in the medical literature, the SSI team has identified those bundle elements within the first recommended SSI bundle that when reliably implemented are highly likely to result in decreased harm to hospitalized children.

As a result, SPS is stratifying bundle elements based on their level of evidence to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for SSI and the other aviator HACs:

- *Standard Element:* Strong evidence suggests that implementation of this element is associated with significant decrease in patient harm; all SPS hospitals should implement and measure reliability of this element.
- *Recommended Element*: Preliminary data and clinical expert opinion support the implementation of this element; SPS hospitals should strongly consider implementing this element.

SSI Co-Leaders

Jason Newland, Children's Mercy, Kansas City
Lory Harte, Children's Mercy, Kansas City
Scott Marquette, Mott Children's
Josh Schaffzin, Cincinnati Children's Hospital Medical Center

SSI Subject Matter Experts

Suanne Davies, Vanderbilt

SPS Staff

Shari Wooton, QIC
Matt Short, Project Specialist
Erin Goodman, Project Coordinator
Ursula Bradshaw, Data Analyst

II. Prevention Bundle Elements – Overview

SPS Standard Elements

- Preoperative Bath
- No razor
- Appropriate antibiotic timing

SPS Recommended Elements

- Appropriate skin antisepsis ('Skin Prep'IntraOp')

- Appropriate antibiotic redosing

III. Prevention Bundle Elements – Evidence Reviewed

Prevention Bundle Element	Level of Evidence *GRADE/SPS**	Evidence Cited (Numbers refer to Reference Section)
Standard Elements		
Preoperative Bath	GRADE/Scenario 1	3, Plus GRADE*
No Razor	GRADE/Scenario 1	4, 7, Plus GRADE*
Appropriate antibiotic timing	GRADE/Scenario 1	1, 5, 6, 10, 11 Plus GRADE*
Recommended Elements		
Appropriate skin antisepsis	GRADE/N/A	7, Plus GRADE*
Appropriate antibiotic redosing	GRADE/N/A	7, 12,13 Plus GRADE*

*GRADE

- See Appendix A for GRADED Evidence.

**SPS Evidence

- Scenario 1: Reliably implementing element is associated with statistically significant improvement
- Scenario 2: Failing to implement element is associated with statistically significant failure to improve along with the system,
- Scenario 3: In cases where all hospitals implement, implementing an element without measuring reliability of the element is associated with statistically significant failure to improve along with the system,
- Scenario 4: Reliably implementing element is not associated with statistically significant improvement; however, literature supports adoption of element as an SPS Standard

IV. Prevention Bundle Elements Care Descriptions

Prevention Bundle Element	Care Descriptions
Standard Elements	
Preoperative Bath	• Preoperative bath should take place. Options include; bathing with soap and water, bathing with chlorhexidine-containing solution, or wiping with a chlorhexidine-impregnated cloth, the night before and/or the morning of surgery.
No Razor	• Do not use razor for hair removal, use clipper or other non-traumatic method
Appropriate antibiotic timing	• All antibiotics except vancomycin and fluoroquinolones 0-60 minutes prior to incision • Vancomycin and fluoroquinolones 0-120 minutes prior to incision
Recommended Elements	
Appropriate skin antisepsis	• Use of alcohol containing agent if no contraindication
Appropriate antibiotic redosing	Redosing intervals: • Cefazolin- every 3 or 4 hours* • Clindamycin- every 4 or 6 hours* • Vancomycin- no redosing or every 6 hours
*The ASHP national guideline recommends cefazolin to be given every 4 hours, clindamycin every 6 hours and recommends no redosing for vancomycin. These national guidelines do have pediatric recommendations and the authors state these guidelines are mainly extrapolated data from adults and are largely expert opinion based.	

V. Measurement – Prevention Bundle Reliability

Measurement	Formula	Standards	Reporting Period
SSI Prevention Bundle	Number of audits totally compliant with SPS Prevention Bundle Elements/ Number of audits completed* x 100	• Your bundle reliability data should include **all** the SPS Standard elements • SPS strongly encourages hospitals to also include the SPS Recommended Elements. • Hospitals can choose to include additional elements. Please note that including too many (>5) elements may confuse and overwhelm care providers so proceed with caution. • Measure your bundle as ALL or None. See Reference 8 for IHI description of All on None. • Minimum of 20 audits per month. If procedures are fewer than 20, then include all procedures.	Monthly

VI. Spotlight Tools

We have asked hospitals to share their spotlight tools, and have highlighted a few in this SharePoint folder (note: this folder is password protected and can only be accessed by SPS network member hospitals). The highlighted categories are: Bundle Measure Methodology, PDSAs and Interventions, Risk Assessment, Training, Patient & Family Engagement, and Failure Analysis.

VII. Spotlight Hospitals

Please click here to view the Sharing Hospitals' Innovation for Network Engagement (SHINE) report.

VIII. References

1. Haessler, S., N. R. Connelly, et al. (2010). "A surgical site infection cluster: The process and outcome of an investigation-the impact of an alcohol-based surgical antisepsis product and human behavior." Anesthesia and Analgesia 110(4): 1044-1048.
2. Holzmann-Pazgal, G., D. Hopkins-Broyles, et al. (2008). "Case-control study of pediatric cardiothoracic surgical site infections." Infection Control and Hospital Epidemiology 29(1): 76-79.
3. Lonneke, G.M., Bode, M.D., et al. Preventing Surgical-Site Infections in Nasal Carriers. New Englande Journal of Medicine, 2010:362(1) 10-17.
4. Tanner J, Woodings D, Moncaster K. Preoperative hair removal to reduce surgical site infection. Cochrane Database of Systematic Reviews 2006, Issue 3. Art. No.: CD004122. DOI: 10.1002/14651858.CD004122.pub3
5. Darouiche R, Wall M, Itani K, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. New England Journal of Medicine. 2010;362(1):18-26.
6. Swenson B, Hedrick T, Metzger R, Bonatti H, Pruett TL, Sawyer R. Effects of preoperative skin preparation on postoperative wound infection rates: A prospective study of 3 skin preparation protocols. Infection Control and Hospital Epidemiology.2009;30(10):964-971.
7. Stulberg JJ, Delaney CP, Neuhauser DV, Aron DC, Fu P, Koroukian SM. Adherence to surgical care improvement project measures and the association with postoperative infections. JAMA. 2010;303(24):2479-2485
8. Resar R, Griffin FA, Haraden C, Nolan TW. (2012) "Using Care Bundles to Improve Health Care Quality. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement." (Available on www.IHI.org)
9. CDC Guideline for prevention of Surgical site infection. (1999) Infection Control and Hospital Epidemiology.
10. Bratzler DW, et al. (2013) "Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Sys Pharm 70:195-283..
11. Milstone AM et al. (2008) "Timing of preoperative antibiotic prophylaxis: a modifiable risk factor for deep surgical site infections after pediatric spinal fusion". Pediatr Infect Dis J 27:704-708.
12. Stulberg JJ, Delaney CP, Neuhauser DV, Aron DC, Fu P, Koroukian SM. (2012) "Adherence to surgical care improvement project measures and the association with postoperative infections." JAMA.;303(24):2479-2485
13. Bratzler DW1, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, Fish DN, Napolitano LM, Sawyer RG, Slain D, Steinberg JP, Weinstein RA; American Society of Health-System Pharmacists; Infectious Disease Society of America; Surgical Infection Society; Society for Healthcare Epidemiology of America. Clinical practice guidelines for antimicrobial prophylaxis in surgery. American Journal of Health-System Pharmacy February 1, 2013 vol. 70 no. 3 195-283

IX. Revision History

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Katie Hilbert	Initial Draft	9- Nov - 2012
Version 2	Jason Newland, Kathy Ball, Lory Harte	Updating evidence, recommended approaches, measuring reliability, and references.	4- Feb -2013
Version 3	Sharyl Wooton, Erin Goodman on behalf of HAC Team	SPS Prevention Bundles – Standards and Recommendations	15-June -2014
Version 4	Sharyl Wooton, Erin Goodman on behalf of HAC Team	Updating redosing element with changes and evidence to support.	28-August -2014

APPENDIX A

Office of Evidence Based Practice – Specific Care Questions related to Surgical Site Infections (SSI)

Specific Care Question :

This document answers the following questions related to surgical site infections:

Pre-op bathing

1. In children undergoing surgical procedure a pre-operative bath versus none prevents surgical site infections.
2. In children undergoing a surgical procedure chlorhexidine preop bath versus soap and water prevents surgical site infections.

Intra-op

3. In children undergoing a surgical procedure hair removal without a razor versus a razor prevents surgical site infections.
4. In children undergoing a surgical procedure chlorhexidine versus povidone-iodine decreases surgical site infections.
5. In children undergoing a surgical procedure requiring antibiotic prophylaxis appropriate antibiotic timing versus not prevents surgical site infections.
    a. Appropriate timing is 0-60 minutes prior to incision for all abxs except vanco and fluoroquinolones
    b. Vancomycin and fluoroquinolones 0-120 minutes prior to incision
6. In children undergoing an extended surgical procedure requiring antibiotics redosing versus not prevents surgical site infections.

Post-op

7. In children undergoing a surgical procedure requiring antibiotic prophylaxis the first post-operative dose should occur within 8 hours versus not prevents surgical site infections.

Question Originator:

Jason Newland, MD, Solutions for Patient Safety, Surgical Site Infection Hospital Acquired Condition Co-Team Leader

Plain Language Summary from The Office of Evidence Based Practice:

Data reported is cohorted into hair removal, pre-operative bath, topical antiseptics, drapes and antibiotics. The overall quality of the studies within this abbreviated meta-analysis is low to very low. Within all the trials reported in this document there were only three trials in which children were study participants. The recommendations for the different questions answered within this document follow (page numbers for the actual data review are found in parentheses behind the question).

<u>Pre-operative</u>

In children undergoing a surgical procedure does a pre-operative bath with Chlorhexidine versus no bath, placebo, or bath with soap and water prevent surgical site infections?

One cannot say with certainty that there is a statistically significant relationship between Chlorhexidine baths and its protective effect against surgical site infections (OR = 0.87, 95% CI 0.75 – 1.01). Recommendations may change when higher-quality evidence becomes available (see page 7 - 8).

Does Chlorhexidine *no-rinse cloths* versus standard of care make a difference in surgical site infections when patients are stratified by the NNIS surgical risk?

One cannot say with 95% confidence that Chlorhexidine *no-rinse cloth* baths provide a protective effect against surgical site infections (OR = 0.30, 95% CI 0.30 – 1.58). Recommendations may change when higher-quality evidence becomes available (see page 9 - 11).

Does the risk of a surgical site infection decrease if the patient takes one, two, or three baths pre-operatively with Chlorhexidine versus the standard of care?

One cannot say with certainty that there is a statistically significant relationship between the number of chlorhexidine baths and its protective effect against surgical site infections (OR = 0.79, 95% CI .57-1.10). Recommendations may change when higher-quality evidence becomes available (see page 12 - 14).

Intra-operative

In children undergoing a surgical procedure, which topical antiseptic (chlorhexidine [CHX], povidone-iodine, normal saline, betadine, Isopropyl alcohol, Soap and water with methylated spirits, Iodine Povacrylex in Isopropyl Alcohol) is more efficacious in decreasing surgical site infections?

Of the five different topical antiseptic comparisons reported, one can recommend based on low to very-low-quality evidence the use of chlorhexidine as a surgical scrub. The OR (OR = 0.68, 95% CI 0.55 – 0.85) indicates a reduced risk of surgical site infection when a chlorhexidine surgical scrub is used compared to a povidone-iodine surgical scrub (see page 15 - 17).

In children undergoing a neurosurgical procedure (shunts, DSB electrode placement, burr holes, spine surgery) should the hair be unshaved or shaved to prevent surgical site infections?

One cannot say with certainty that there is a statistically significant relationship between shaving the patient's hair and the actions protective effect against surgical site infections (OR = 0.77, 95% CI .51 - 1.17). In addition, in comparison 1.2.5 (see page 19), in which children were the only trial participants a statistical significant relationship is not reported (OR = 1.00, 95% 0.25 – 4.06). Therefore, one can strongly recommend based on varying degrees of quality evidence (low – high) that scalp hair does not need to be removed (see page 18 - 20).

In children undergoing a neurosurgical procedure should the scalp hair be clipped or not removed to prevent surgical site infections?

The risk (OR = 1.00, 95% CI 0.06 - 16.34) of surgical site infections is the same if the scalp hair is clipped or not. Therefore, one can strongly recommend based on low quality evidence that scalp hair does not need to be clipped (see page 21).

What is the most efficacious method of hair removal in children undergoing a non-neurosurgical procedure to prevent surgical site infections: shaving versus clipping, shaving versus no hair removal, cream depilatory versus no hair removal, shaving versus depilatory cream?

Three of the four comparisons (shaving versus no hair removal [OR = 0.58, 95% CI 0.28 – 1.19], cream depilatory versus no hair removal [OR = 0.98, 95% CI 0.40 – 2.40], shaving versus depilatory cream [OR = 2.05, 95% CI 0.92 – 4.61]) reported no statistically significant relationship in a protective effect against surgical site infections. The odds of acquiring a surgical site infection are increased two-fold (OR = 2.02, 95% CI 1.09 - 3.77) with clipping when compared to shaving. Therefore, one can strongly recommend based on low to moderate quality evidence that hair clipping should not occur and hair removal does not provide a statistically significant protective effect against surgical site infections (see page 22 - 25).

In the non-neurosurgical patient should an Iodophor/alcohol water insoluble film with iodine impregnated incise drape be used to decrease surgical site infection?

One can strongly recommend based on low to very-low-quality evidence the use of an iodophor/alcohol water insoluble film with iodine impregnated incise drape. The OR (OR = 0.29, 95% CI 0.12 – 0.69) indicates a reduced risk of surgical site infection when an iodophor/alcohol water insoluble film with iodine impregnated incise drape is used (see page 26).

In the non-neurosurgical patient is DuraPrep™ solution plus Ioban™ 2 drapes more efficacious in reducing surgical site infections than povidone iodine scrub and paint plus Ioban 2 drapes?

One cannot say with certainty that there is a statistically significant relationship (OR = 0.63, 95% CI 0.33 - 1.20) between employing the DuraPrep™ solution plus the Ioban™ 2 drapes and the combined protective effect against surgical site infections (see page 27).

Should intra-operative antibiotic practices be used for the surgical patient?

This question holds two separate comparisons: a.) Antibiotics administrated within 60 minutes before the surgical incision and b.) Antibiotic selection. For the question related to:

- Antibiotic administered less than 60 minutes prior to incision time:
  - One can strongly recommend based on very-low-quality evidence administering antibiotics < 60 minutes prior to incision time. The OR (OR = 0.66, 95% CI 0.51 – 0.85) indicates a reduced risk of surgical site infection when the antibiotics are administered < 60 minutes prior to incision time (see page 28 - 29).
    - **Note**: On page 30, Figure 4 is an excerpt from a meta-analysis (Sonabend et al., 2011) that supports the use of antibiotic-coated external ventricular drains (OR = 0.19, 95% CI 0.07-0.52) and antibiotics (OR = 0.45, 95% CI 0.27 – 0.74). The antibiotic-coated external ventricular drains question was not asked in the SSI questions but the author of this synthesis believed the finding could have merit for the SSI HACs. Furthermore, the primary antibiotic data is dated (Blomstedt, 1985; Poon, 1998) and therefore not included in the above analysis (see page 30).
- Appropriate selection of intravenous prophylactic antibiotics (based on Surgical Care Improvement Project [SCIP]-2):
  - One can strongly recommend based on very-low-quality evidence administering the SCIP-2 antibiotics. The OR (OR = 0.62, 95% CI 0.46 – 0.82) indicates a reduced risk of surgical site infection when the appropriate SCIP-2 antibiotics are administered (see page 28 - 29).

EBP team member responsible for reviewing, synthesizing, and developing this document: Jacqueline A. Bartlett, PhD, RN

Search Strategy and Results:
Preoperative bathing search: "Baths"[Mesh] AND ("Preoperative Care"[Mesh] OR "Preoperative Period"[Mesh] OR "Surgical Wound Infection/prevention and control"[Mesh]) Filters: From 2010/01/01 to 2013/12/31, Humans, English; 9 articles were found, 3 answered the question

Studies included in this review:

Chlebicki, Safdar et al. 2013; Jakobsson, Perlkvist et al. 2011; Webster and Osborne 2012

Studies not included in this review with rationale for exclusion:

Author	*Rationale for exclusion*
Bailey, Stuckey et al. 2011	Home preparation
Kamel, McGahan et al. 2012	Surgical Site Cleaning
Murray, Huerta et al. 2010	Review article
Nthumba, Stepita-Poenaru et al. 2010	Hand antiseptic
Timms and Pugh 2012	Pin Care
Webster and Osborne 2011	Home preparation

Chlorhexidine vs povidone-iodine skin preparation search: ("Surgical Wound Infection/prevention and control"[Majr] OR "Preoperative Care"[Mesh] OR "Preoperative Period"[Mesh]) AND ("Povidone-Iodine"[Mesh] OR "Chlorhexidine"[Mesh]) AND (("2010/01/01"[PDAT] : "2013/12/31"[PDAT]) AND "humans"[MeSH Terms] AND English[lang]) NOT (Comment[ptyp] OR Editorial[ptyp] OR Letter[ptyp]) 7 studies found; 2 answered the question

Studies included in this review:

Johnson, Daley et al. 2010; Noorani, Rabey et al. 2010

Studies not included in this review with rationale for exclusion:

Author	*Rationale for exclusion*
Naderi, Maw et al. 2012	Sterile bag
Ogbemudia, Bafor et al. 2010	Wound dressing
Tschudin-Sutter, Frei et al. 2012	Narrative
Weight, Lee et al. 2010	Hand antiseptic
Yavascan, Anil et al. 2011	Peritoneal catheter

Hair removal search: ("Surgical Wound Infection/prevention and control"[Majr] OR "Preoperative Care"[Mesh] OR "Preoperative Period"[Mesh]) AND ("Hair Removal"[Mesh] OR (("Hair"[Mesh] NOT "Wool"[Mesh]) AND ("Surgical Instruments"[Mesh] OR "scissor"[All Fields] OR "razor"[All Fields] OR "cut"[All Fields] OR "shave"[All Fields]))) AND (("2010/01/01"[PDAT] : "2013/12/31"[PDAT]) AND "humans"[MeSH Terms] AND English[lang]) NOT (Comment[ptyp] OR Editorial[ptyp] OR Letter[ptyp])

Studies included in this review:

Adisa, Lawal et al. 2011; Broekman, van Beijnum et al. 2011; Tanner, Norrie et al. 2011

Studies not included in this review with rationale for exclusion:

Author	*Rationale for exclusion*
Gaston and Kuremsky 2010	Review article
Lane, Young et al. 2010	Antibiotic article
Ibrahimi, Avram et al. 2011	Laser hair removal
Sebastian 2012	Systematic review
Jose and Dignon 2013	Review article

Antibiotic search: prophylactic antibiotics surgery AND (("2013/01/01"[PDat] : "2013/12/31"[PDat]))

Studies included in this review:

Hendren et al. (2013); Kestle et al. (2011); Meyer, Klarenbeek, and Meyer (2010); Sonabend et al. (2011)

Studies not included in this review with rationale for exclusion:

Author	*Rationale for exclusion*
Clemmensen, Rasmussen, and Mosdal (2010)	Did not compare patients that did and did not receive antibiotics prior to surgery
Molinari, Khera, and Molinari (2012)	Did not answer the question
Farber, Parker, Adogwa, McGirt, and Rigamonti (2011)	Did not answer the question
Doursounian, Maigne, Cherrier, and Pacanowski (2011)	Did not answer the question
Buffet-Bataillon et al. (2011)	Did not answer the question
Buffet-Bataillon et al. (2011); Rivero-Garvia, Marquez-Rivas, Jimenez-Mejias, Neth, and Rueda-Torres (2011)	Did not answer the question
Ramos et al. (2011)	Did not answer the question
Kanayama, Oha, Togawa, Shigenobu, and Hashimoto (2010)	Did not answer the question
Rehman, Rehman, Bashir, and Gupta (2010)	Did not answer the question

Method Used for Appraisal and Synthesis:
This abbreviated meta-analysis (MA) is a compilation of several MA's with additional single studies included when identified. The data is graded between very low to high for literature that answers to the questions as randomized control trials (RCT's) were combined with observational studies. In reading the forest plots for every comparison, the reader will find an overall analysis at the bottom of the forest plot. In addition, each subgroup has its own analysis. If heterogeneity was low <30%, fixed effects modeling was employed and for subgroups with moderate to high heterogeneity ≥30, a random effects modeling was employed. If the number of events were low, an Odds Ratio is reported and if the number of events was high a Risk Ratio (RR) is reported.

The Cochrane Collaborative computer program, Review Manager (version 5.2.3) was used to synthesize the data of the XXX included studies and the GRADE working group computer program, GRADEpro (version 3.6) was used to grade the studies included in this document.

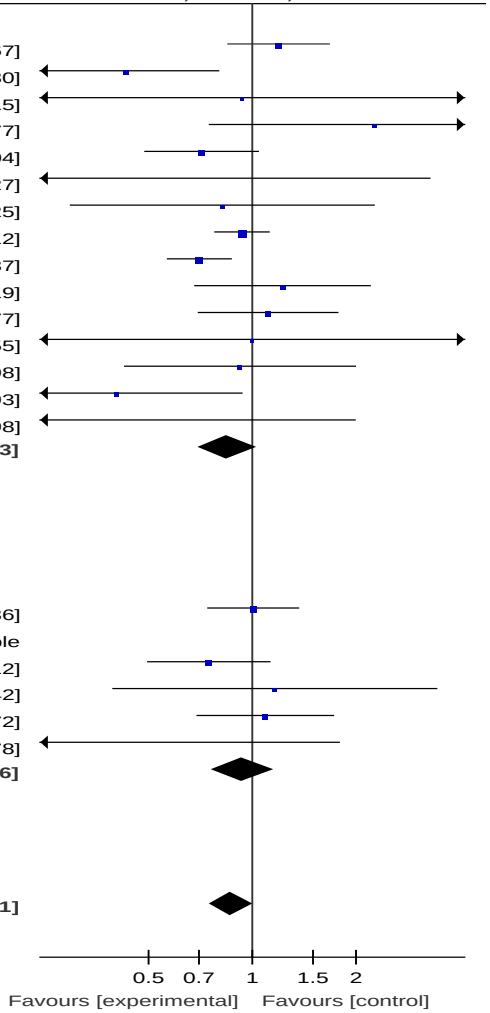
Updated 7/25/13

Included studies :

Pre-op bathing

Question: In children undergoing a clean or contaminated surgical procedure does a pre-operative bath with Chlorhexidine versus no bath or placebo prevent surgical site infections?

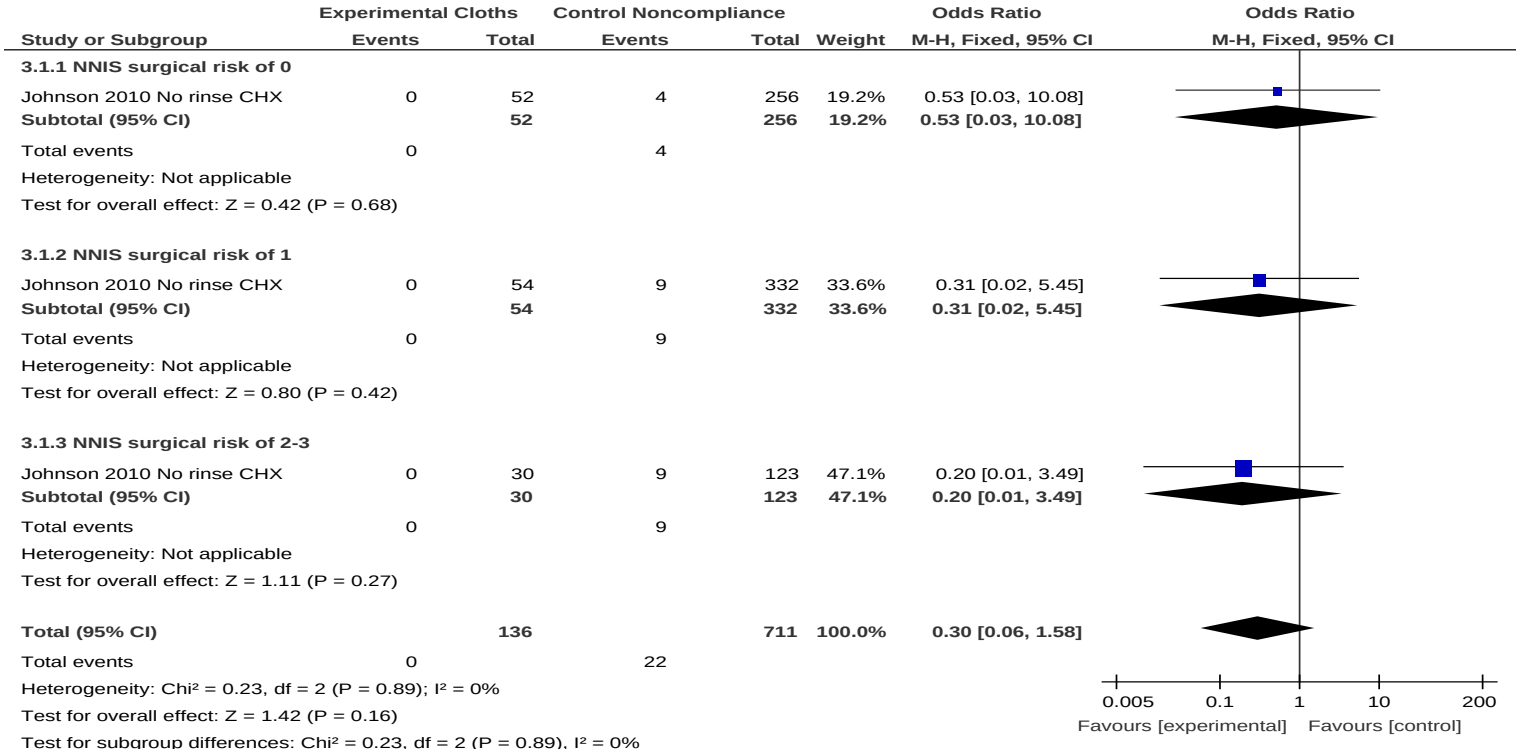
	Experimental--Chlorhex		Control			Risk Ratio	Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	M-H, Random, 95% CI
2.1.1 Clean surgery							
Ayliffe 1983	69	1748	62	1872	9.5%	1.19 [0.85, 1.67]	
Brandberg 1979	13	171	30	170	4.5%	0.43 [0.23, 0.80]	
Byrne 1991	2	29	2	27	0.6%	0.93 [0.14, 6.15]	
Earnshaw 1989	8	31	4	35	1.7%	2.26 [0.75, 6.77]	
Hayek 1987	34	472	93	920	8.5%	0.71 [0.49, 1.04]	
Johnson 2010	0	157	14	897	0.3%	0.20 [0.01, 3.27]	
Leigh 1983	6	77	8	84	1.9%	0.82 [0.30, 2.25]	
Lynch 1992	193	1263	210	1283	14.5%	0.93 [0.78, 1.12]	
Murray 2011	33	50	47	50	13.4%	0.70 [0.57, 0.87]	
Randall 1983	12	32	19	62	4.8%	1.22 [0.68, 2.19]	
Rotter 1988	37	1413	33	1400	6.6%	1.11 [0.70, 1.77]	
Veiga 2009	1	50	1	50	0.3%	1.00 [0.06, 15.55]	
Wells 1983	11	209	14	245	3.1%	0.92 [0.43, 1.98]	
Wihlborg 1987	8	400	16	323	2.7%	0.40 [0.18, 0.93]	
Zywiel 2011	0	136	21	711	0.3%	0.12 [0.01, 1.98]	
Subtotal (95% CI)		**6238**		**8129**	**72.7%**	**0.85 [0.70, 1.03]**	
Total events	427		574				
Heterogeneity: Tau² = 0.05; Chi² = 25.69, df = 14 (P = 0.03); I² = 45%							
Test for overall effect: Z = 1.68 (P = 0.09)							
2.1.2 Clean Contaminated / Contaminated							
Ayliffe 1983	78	955	78	961	10.5%	1.01 [0.74, 1.36]	
Dimitrov 1984	0	57	0	46		Not estimable	
Hayek 1987	28	217	70	406	7.8%	0.75 [0.50, 1.12]	
Leigh 1983	6	32	5	31	1.7%	1.16 [0.40, 3.42]	
Lynch 1992	36	312	31	293	6.8%	1.09 [0.69, 1.72]	
Wihlborg 1987	1	141	4	114	0.5%	0.20 [0.02, 1.78]	
Subtotal (95% CI)		**1714**		**1851**	**27.3%**	**0.94 [0.76, 1.16]**	
Total events	149		188				
Heterogeneity: Tau² = 0.00; Chi² = 3.89, df = 4 (P = 0.42); I² = 0%							
Test for overall effect: Z = 0.60 (P = 0.55)							
Total (95% CI)		**7952**		**9980**	**100.0%**	**0.87 [0.75, 1.01]**	
Total events	576		762				
Heterogeneity: Tau² = 0.03; Chi² = 30.16, df = 19 (P = 0.05); I² = 37%							
Test for overall effect: Z = 1.83 (P = 0.07)							
Test for subgroup differences: Chi² = 0.49, df = 1 (P = 0.48), I² = 0%							



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Chlorhexidine shower	placebo or no bath	Relative (95% CI)	Absolute		
Surgical Site Infections (follow-up NS-8 weeks; assessed with: SSI)												
16	observational studies[1]	serious[2]	serious[3]	no serious indirectness	serious[4]	none	576/7952 (7.2%)	762/9980 (7.6%)	RR 0.87 (0.75 to 1.01)	10 fewer per 1000 (from 19 fewer to 1 more)	⊕OOO VERY LOW	
								8.1%		11 fewer per 1000 (from 20 fewer to 1 more)		
Surgical Site Infections - Clean surgery (follow-up NS-8 weeks)												
15	observational studies[5]	serious[6]	serious[7]	no serious indirectness	serious[8]	none	427/6238 (6.8%)	574/8129 (7.1%)	RR 0.85 (0.7 to 1.03)	11 fewer per 1000 (from 21 fewer to 2 more)	⊕OOO VERY LOW	
								7.4%		11 fewer per 1000 (from 22 fewer to 2 more)		
Surgical Site Infections - Clean Contaminated / Contaminated (follow-up NS-8 weeks)												
6	observational studies[9]	very serious[10]	serious[11]	no serious indirectness	no serious imprecision[12]	none	149/1714 (8.7%)	188/1851 (10.2%)	RR 0.94 (0.76 to 1.16)	6 fewer per 1000 (from 24 fewer to 16 more)	⊕OOO VERY LOW	
								9.4%		6 fewer per 1000 (from 23 fewer to 15 more)		

[1] Studies varied from before/after to RCTs
[2] MA authors identified the bias ranged from low - high with a majority of trials identified as high risk.
[3] Type of surgeries (clean, CL/CONT, contaminated) definition of infection varied between studies.
[4] i2 statistic reported to be 37% which is considered a moderate amount of heterogeneity between the studies.
[5] See footnote #1
[6] See footnote #2
[7] See footnote #3
[8] i2 statistic reported to be 45% which is considered a moderate amount of heterogeneity between the studies.
[9] See footnote #1
[10] Five of the six studies were identified by the MA authors to have a high risk of bias.
[11] See footnote #3
[12] i2 statistic reported to be 0% which equates to a very low level of heterogeneity between the studies.

Question: Does Chlorhexidine No-rinse cloths vs standard of care make a difference in surgical site infections when patients are stratified by the NNIS surgical risk?



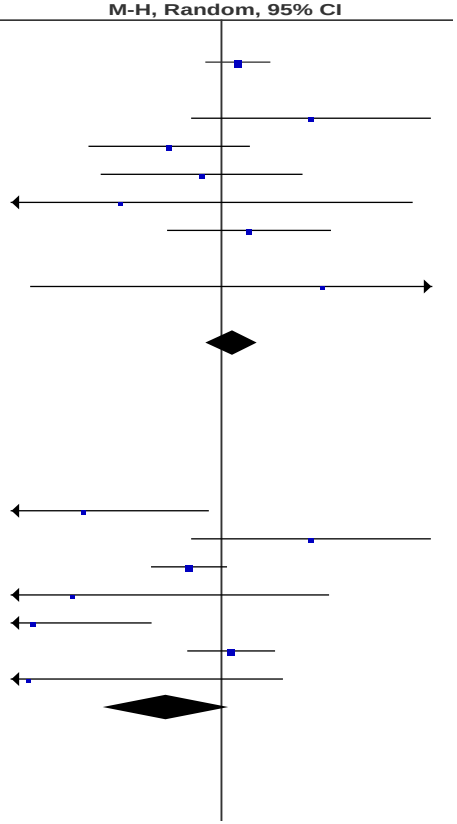
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Chlorhexidine No-rinse cloths**	**Standard of care**	**Relative (95% CI)**	**Absolute**		
Surgical Site Infections (follow-up NS)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/136 (0%)	22/711 (3.1%)	OR 0.3 (0.06 to 1.58)	21 fewer per 1000 (from 29 fewer to 17 more)	⊕⊕OO LOW	
								2.7%		19 fewer per 1000 (from 25 fewer to 15 more)		
Surgical Site Infections - NNIS surgical risk of 0 (follow-up NS)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	0/52 (0%)	4/256 (1.6%)	OR 0.53 (0.03 to 10.08)	7 fewer per 1000 (from 15 fewer to 122 more)	⊕OOO VERY LOW	
								1.6%		7 fewer per 1000 (from 16 fewer to 125 more)		
Surgical Site Infections - NNIS surgical risk of 1 (follow-up NS)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/54 (0%)	9/332 (2.7%)	OR 0.31 (0.02 to 5.45)	19 fewer per 1000 (from 27 fewer to 105 more)	⊕⊕OO LOW	
								2.7%		18 fewer per 1000 (from 26 fewer to 104 more)		

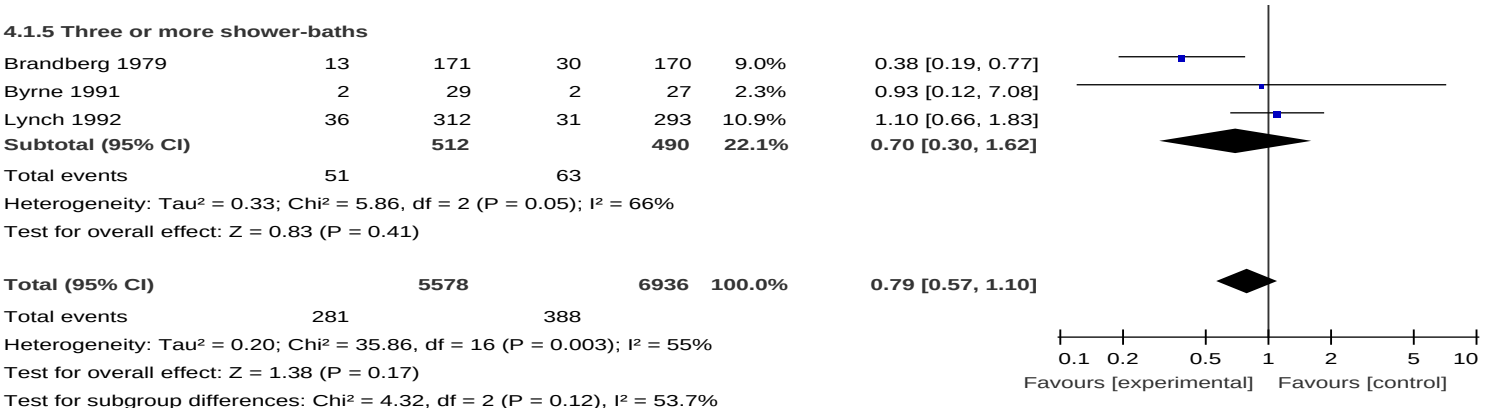
Surgical Site Infections - NNIS surgical risk of 2-3 (follow-up NS)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/30 (0%)	9/123 (7.3%)	OR 0.2 (0.01 to 3.49)	58 fewer per 1000 (from 72 fewer to 143 more)	⊕⊕OO LOW	
								7.3%		57 fewer per 1000 (from 72 fewer to 143 more)		

[1] Wide CI

Question: Does the risk of a surgical site infection decrease if the patient takes one, two, or three baths pre-operatively with Chlorhexidine or the standard of care?

	Experimental--CHX		Control--Placebo			Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	M-H, Random, 95% CI
4.1.3 One Preoperative Shower							
Ayliffe 1983	69	1748	62	1872	12.6%	1.20 [0.85, 1.70]	
Dimitrov 1984	0	57	0	46		Not estimable	
Earnshaw 1989	8	31	4	35	4.5%	2.70 [0.72, 10.05]	
Garibaldi 1988	11	262	10	138	7.2%	0.56 [0.23, 1.36]	
Leigh 1983	6	77	8	84	5.6%	0.80 [0.27, 2.43]	
Magera 2007	0	50	1	50	1.0%	0.33 [0.01, 8.21]	
Randall 1983	12	32	19	62	7.1%	1.36 [0.55, 3.33]	
Veiga 2008	0	57	0	57		Not estimable	
Veiga 2009	1	50	0	50	1.0%	3.06 [0.12, 76.95]	
Wihlborg 1987	8	400	0	0		Not estimable	
Subtotal (95% CI)		**2764**		**2394**	**38.9%**	**1.13 [0.85, 1.51]**	
Total events	115		104				
Heterogeneity: Tau² = 0.00; Chi² = 5.67, df = 6 (P = 0.46); I² = 0%							
Test for overall effect: Z = 0.85 (P = 0.39)							
4.1.4 Two Preoperative Showers							
Dizer 2009	3	43	10	39	4.2%	0.22 [0.05, 0.86]	
Earnshaw 1989	8	31	4	35	4.5%	2.70 [0.72, 10.05]	
Hayek 1987	34	472	92	920	12.0%	0.70 [0.46, 1.05]	
Johnson 2010	0	157	14	897	1.3%	0.19 [0.01, 3.26]	
Murray 2011	33	50	47	50	4.5%	0.12 [0.03, 0.46]	
Rotter 1988	37	1413	33	1400	11.3%	1.11 [0.69, 1.79]	
Zywiel 2010	0	136	21	711	1.3%	0.12 [0.01, 1.95]	
Subtotal (95% CI)		**2302**		**4052**	**38.9%**	**0.55 [0.27, 1.09]**	
Total events	115		221				
Heterogeneity: Tau² = 0.46; Chi² = 19.67, df = 6 (P = 0.003); I² = 70%							
Test for overall effect: Z = 1.71 (P = 0.09)							





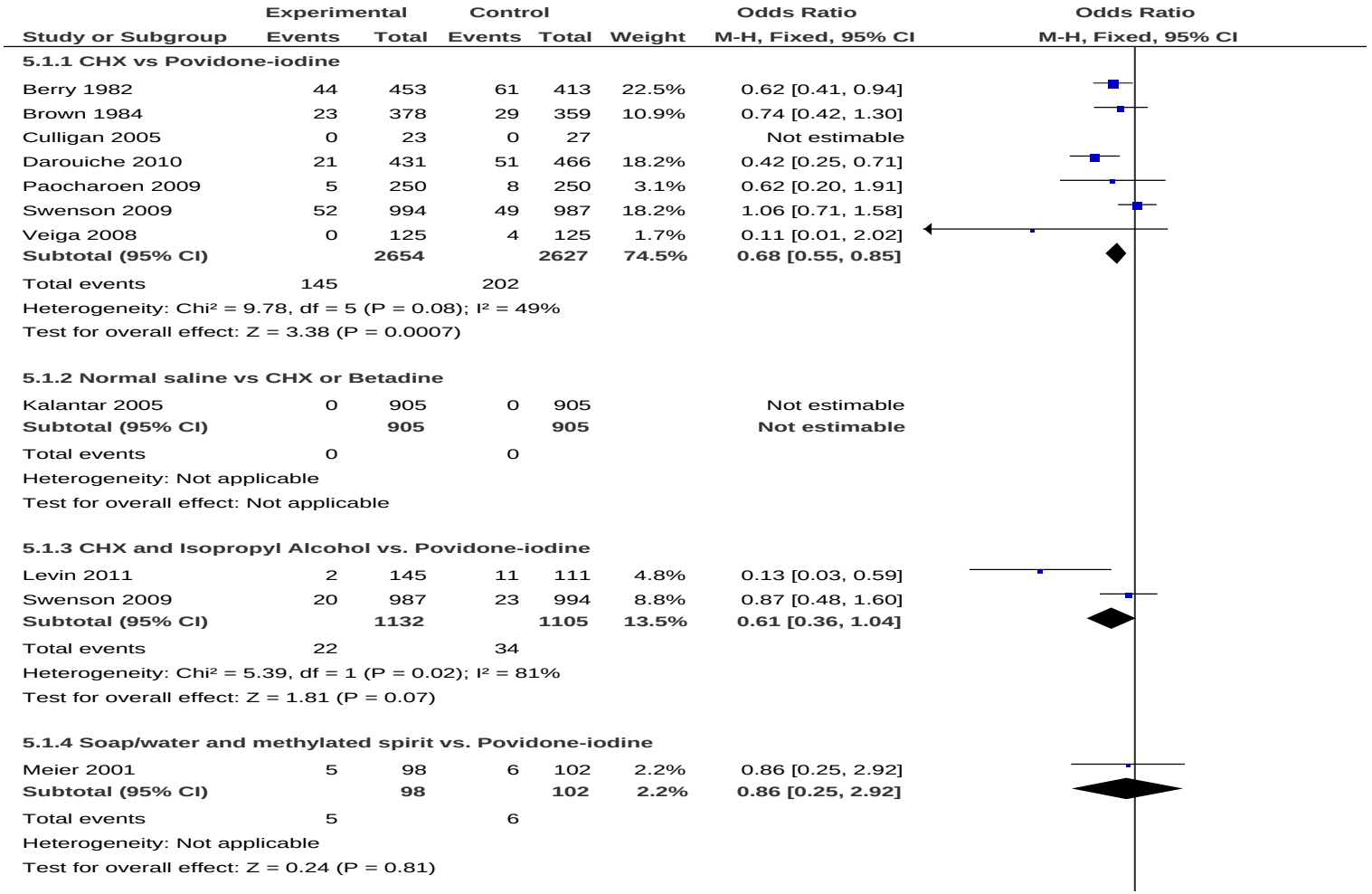
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Chlorhexidine**	**Standard of Care**	**Relative (95% CI)**	**Absolute**		
Surgical Site Infections (follow-up NS)												
19	observational studies[1]	very serious[2]	serious[3]	no serious indirectness	serious[4]	none	281/5578 (5%)	388/6936 (6.1%)	OR 0.79 (0.57 to 1.1)	11 fewer per 1000 (from 23 fewer to 5 more)	⊕OOO VERY LOW	
								7.4%		15 fewer per 1000 (from 30 fewer to 7 more)		
Surgical Site Infections - One Preoperative Shower (follow-up NS)												
10	observational studies[5]	serious[6]	serious	no serious indirectness	no serious imprecision	none	115/2764 (4.2%)	104/2394 (4.3%)	OR 1.13 (0.85 to 1.51)	5 more per 1000 (from 6 fewer to 21 more)	⊕OOO VERY LOW	
								3.3%		4 more per 1000 (from 5 fewer to 16 more)		

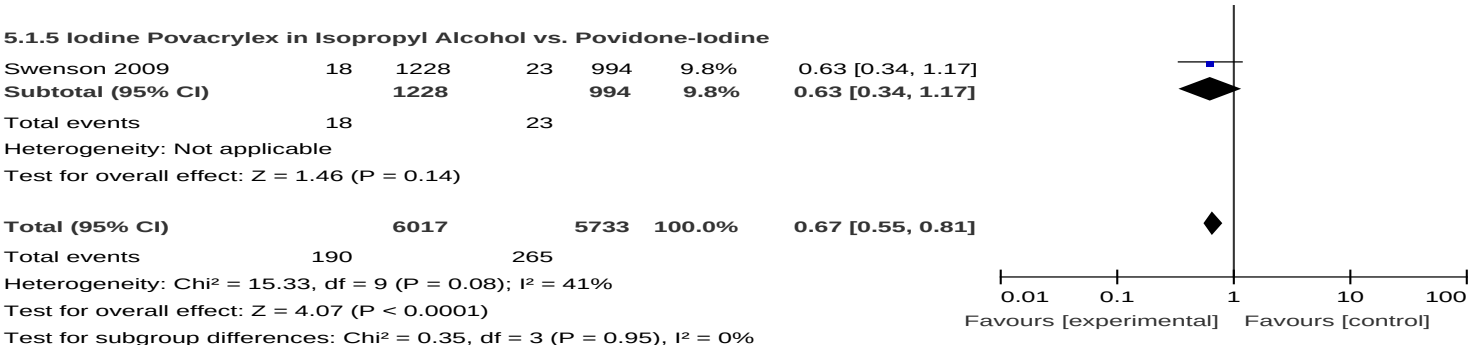
Surgical Site Infections - Two Preoperative Showers (follow-up NS)												
7	observational studies[7]	very serious[8]	serious[9]	no serious indirectness	very serious[10]	none	115/2302 (5%)	211/4052 (5.5%)	OR 0.55 (0.27 to 1.09)	24 fewer per 1000 (from 39 fewer to 5 more)	⊕OOO VERY LOW	
								10%		42 fewer per 1000 (from 71 fewer to 8 more)		
Surgical Site Infections - Three or more shower-baths (follow-up NS; assessed with: SSI)												
3	observational studies[11]	serious[12]	serious[13]	no serious indirectness	no serious imprecision[14]	none	51/512 (10%)	63/490 (12.9%)	OR 0.7 (0.3 to 1.62)	35 fewer per 1000 (from 86 fewer to 64 more)	⊕OOO VERY LOW	
								10.6%		29 fewer per 1000 (from 72 fewer to 55 more)		

[1] Studies varied from before/after to RCTs
[2] MA authors identified the bias ranged from low - high with a majority of trials identified as high risk.
[3] Type of surgeries (clean, CL/CONT, contaminated) definition of infection varied between studies.
[4] i2 statistic reported to be 55% which is considered a moderate amount of heterogeneity between the studies.
[5] See footnote #1
[6] MA authors identified the bias ranged from low - high with a majority of trials identified as high risk.
[7] See footnote #1
[8] Risk of bias not reported for a majority of the included studies.
[9] See footnote #3
[10] i2 statistic reported to be 70% which is considered to be a high amount of heterogeneity between studies.
[11] Two trials were RCTs while the third used a prospective nonrandomized design.
[12] Risk of bias not reported for two of the trials while the third was identified as having a high risk of bias.
[13] Definition of infection not stated by MA authors.
[14] i2 statistic 66% which is considered to be a large amount of heterogeneity between the studies.

Intra-op

Question: In children undergoing a surgical procedure, which topical antiseptic (chlorhexidine [CHX], povidone-iodine, normal saline, betadine, Isopropyl alcohol, Soap and water with methylated spirits, Iodine Povacrylex in Isopropyl Alcohol) is more efficacious in decreasing surgical site infections?





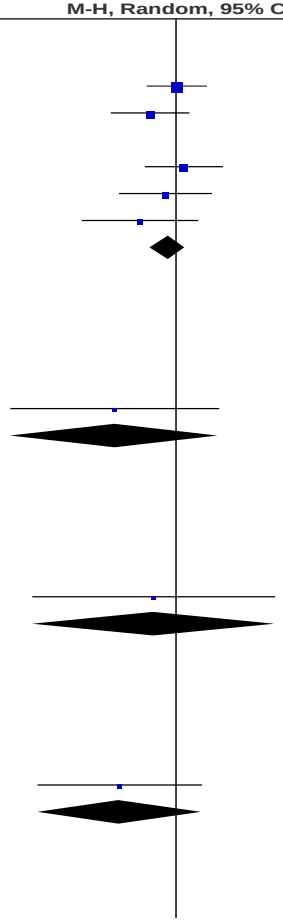
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Topical Antiseptics	Control	Relative (95% CI)	Absolute		
Surgical Site Infections--Topical Preparation												
10	observational studies[1]	serious[2]	serious[3]	no serious indirectness	serious[4]	none	190/6017 (3.2%)	265/5733 (4.6%)	OR 0.67 (0.55 to 0.81)	15 fewer per 1000 (from 8 fewer to 20 fewer)	⊕OOO VERY LOW	
								4.1%		13 fewer per 1000 (from 8 fewer to 18 fewer)		
Surgical Site Infections--Topical Preparation - CHX vs Povidone-iodine (follow-up NS)												
7	observational studies[5]	serious[6]	serious[7]	no serious indirectness	serious[8]	none	145/2654 (5.5%)	202/2627 (7.7%)	OR 0.68 (0.55 to 0.85)	23 fewer per 1000 (from 11 fewer to 33 fewer)	⊕OOO VERY LOW	
								5%		15 fewer per 1000 (from 7 fewer to 22 fewer)		
Surgical Site Infections--Topical Preparation - Normal saline vs CHX or Betadine (follow-up NS)												
1	randomised trials	serious[9]	no serious inconsistency	no serious indirectness	serious[10]	none	0/905 (0%)	0/905 (0%)	not pooled	not pooled	⊕⊕OO LOW	
								0%		not pooled		

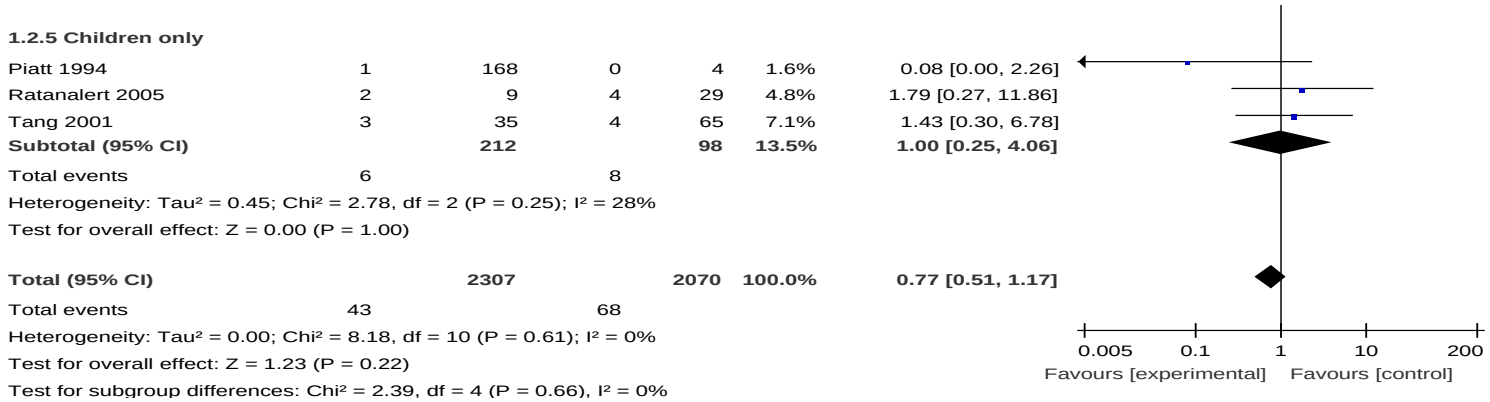
Surgical Site Infections--Topical Preparation - CHX and Isopropyl Alcohol vs. Povidone-iodine (follow-up NS)												
2	observational studies	serious[11]	serious[12]	no serious indirectness	very serious[13]	none	22/1132 (1.9%)	34/1105 (3.1%)	OR 0.61 (0.36 to 1.04)	12 fewer per 1000 (from 19 fewer to 1 more)	⊕OOO VERY LOW	
								6.1%		23 fewer per 1000 (from 38 fewer to 2 more)		
Surgical Site Infections--Topical Preparation - Soap/water and methylated spirit vs. Povidone-iodine (follow-up NS)												
1	randomised trials	serious[14]	no serious inconsistency	no serious indirectness	serious[15]	none	5/98 (5.1%)	6/102 (5.9%)	OR 0.86 (0.25 to 2.92)	8 fewer per 1000 (from 43 fewer to 96 more)	⊕⊕OO LOW	
								5.9%		8 fewer per 1000 (from 44 fewer to 96 more)		
Surgical Site Infections--Topical Preparation - Iodine Povacrylex in Isopropyl Alcohol vs. Povidone-Iodine												
1	observational studies	serious[16]	no serious inconsistency	no serious indirectness	serious[17]	none	18/1228 (1.5%)	23/994 (2.3%)	OR 0.63 (0.34 to 1.17)	8 fewer per 1000 (from 15 fewer to 4 more)	⊕OOO VERY LOW	
								2.3%		8 fewer per 1000 (from 15 fewer to 4 more)		

[1] Eight of the 10 included studies are RCTs with the two remaining studies being cohort studies.
[2] Six of the eight RCTs had and averaged Jadad score of 2 and the remaining four studies the risk of bias was not reported by the MA authors.
[3] Surgeries, wound, and intervention types were mixed.
[4] i2 statistic reported to be 41% which is considered a moderate amount of heterogeneity between the studies.
[5] Six of the seven trials are RCTs with the seventh study using a prospective sequential implementation design.
[6] Risk of bias ranged from 0-3 based on the Jadad score with a majority of studies ranking between 0-2.
[7] Type of surgeries (clean, CL/CONT, contaminated) definition of infection varied between studies.
[8] i2 statistic reported to be 49% which is considered a moderate amount of heterogeneity between the studies.
[9] Risk of bias not reported by MA authors.
[10] No events reported in 1810 patients.
[11] See footnote #5
[12] Wound and surgery types were mixed.
[13] i2 statistic reported to be 81% which is considered a large amount of heterogeneity between the studies.
[14] Risk of bias not reported by MA author.
[15] 95% CI crosses 1 decreasing the study precision.
[16] See footnote #10.
[17] See footnote #11.

Question: In children undergoing a neurosurgical procedure (shunts, DSB electrode placement, burr holes, spine surgery) should the hair be unshaved or shaved to prevent surgical site infections?

	Experimental--Unshaved		Control--Shaved			Odds Ratio	Odds Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Random, 95% CI**	**M-H, Random, 95% CI**
1.2.1 Shunt infections							
Abouzari 2009	0	0	0	0		Not estimable	
Bekar 2001	13	1038	12	980	27.8%	1.02 [0.46, 2.25]	
Horgan 1997	5	141	15	218	16.2%	0.50 [0.18, 1.40]	
Horgan 1999	0	10	0	10		Not estimable	
Miller 2001	11	150	6	100	16.4%	1.24 [0.44, 3.47]	
Ratanalert 1999	4	89	8	136	11.4%	0.75 [0.22, 2.58]	
Ratanalert 2005	2	32	13	87	7.2%	0.38 [0.08, 1.78]	
Subtotal (95% CI)		**1460**		**1531**	**79.0%**	**0.80 [0.50, 1.28]**	
Total events	35		54				
Heterogeneity: Tau² = 0.00; Chi² = 2.79, df = 4 (P = 0.59); I² = 0%							
Test for overall effect: Z = 0.92 (P = 0.36)							
1.2.2 DBS electrodes							
Miyagi 2002	1	199	1	39	2.2%	0.19 [0.01, 3.14]	
Subtotal (95% CI)		**199**		**39**	**2.2%**	**0.19 [0.01, 3.14]**	
Total events	1		1				
Heterogeneity: Not applicable							
Test for overall effect: Z = 1.16 (P = 0.25)							
1.2.3 Bur hole ops							
Ratanalert 1999	0	18	1	31	1.6%	0.55 [0.02, 14.21]	
Subtotal (95% CI)		**18**		**31**	**1.6%**	**0.55 [0.02, 14.21]**	
Total events	0		1				
Heterogeneity: Not applicable							
Test for overall effect: Z = 0.36 (P = 0.72)							
1.2.4 Spine surgery							
Celik 2007	1	418	4	371	3.6%	0.22 [0.02, 1.98]	
Subtotal (95% CI)		**418**		**371**	**3.6%**	**0.22 [0.02, 1.98]**	
Total events	1		4				
Heterogeneity: Not applicable							
Test for overall effect: Z = 1.35 (P = 0.18)							





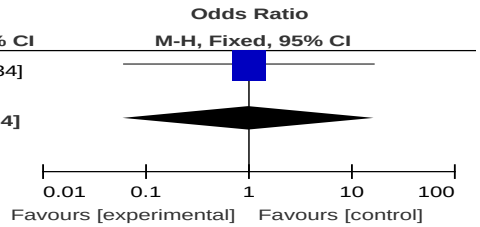
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Hair be unshaved versus shaved	Control	Relative (95% CI)	Absolute		
Surgical Site Infections (follow-up NS[1]; assessed with: SSI)												
10	observational studies[2]	serious[3]	serious[4]	no serious indirectness	no serious imprecision[5]	none	43/2307 (1.9%)	68/2070 (3.3%)	OR 0.77 (0.51 to 1.17)	7 fewer per 1000 (from 16 fewer to 5 more)	⊕OOO VERY LOW	
								4.6%		10 fewer per 1000 (from 22 fewer to 7 more)		
Surgical Site Infections - Shunts (follow-up NS; assessed with: SSI)												
6	observational studies	serious[6]	serious[7]	no serious indirectness	no serious imprecision	none	35/1460 (2.4%)	54/1531 (3.5%)	OR 0.8 (0.5 to 1.28)	7 fewer per 1000 (from 17 fewer to 9 more)	⊕OOO VERY LOW	
								5.9%		11 fewer per 1000 (from 29 fewer to 15 more)		

Surgical Site Infections - DBS electrodes (follow-up NS; assessed with: SSI)												
1	observational studies[2,8]	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1/199 (0.5%)	1/39 (2.6%)	OR 0.22 (0.02 to 1.98)	8 fewer per 1000 (from 11 fewer to 10 more)	⊕⊕OO LOW	
								2.6%		9 fewer per 1000 (from 11 fewer to 11 more)		
Surgical Site Infections - Bur hole ops (follow-up NS; assessed with: SSI)												
1	observational studies[9]	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/18 (0%)	1/31 (3.2%)	OR 0.55 (0.02 to 14.21)	14 fewer per 1000 (from 32 fewer to 289 more)	⊕⊕OO LOW	
								3.2%		14 fewer per 1000 (from 31 fewer to 288 more)		
Surgical Site Infections - Spine surgery (follow-up NS; assessed with: SSI)												
1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1/418 (0.2%)	4/371 (1.1%)	OR 0.22 (0.02 to 1.98)	8 fewer per 1000 (from 11 fewer to 10 more)	⊕⊕⊕⊕ HIGH	
								1.1%		9 fewer per 1000 (from 11 fewer to 11 more)		
Surgical Site Infections - Children only (follow-up NS; assessed with: SSI)												
3	observational studies[10]	serious[11]	no serious inconsistency	no serious indirectness	no serious imprecision	strong association[12]	6/212 (2.8%)	8/98 (8.2%)	OR 1 (0.25 to 4.06)	0 fewer per 1000 (from 60 fewer to 184 more)	⊕⊕OO LOW	
								6.2%		0 fewer per 1000 (from 46 fewer to 150 more)		

[1] NS = not specified by MA authors
[2] Studies ranged from randomized control trial to prospective case series without controls.
[3] Varying study designs included in MA
[4] Perioperative management regarding shampooing, disinfection, and shaving varied between trials
[5] i2 statistic was 0% which reflects no hetergeneity measured between studies
[6] See footnote #3
[7] See footnote #4
[8] Retrospective case series without controls
[9] Nonrandomized concurrent cohort study
[10] Studies ranged from nonrandomized concurrent cohort studies to prospective case series without controls.
[11] Study types and shampooing, disinfection, and shaving varied between trials.
[12] There is no significant difference in children that had their head shaved versus children that did not have their head shaved in surgical site infections.

Question: In children undergoing a neurosurgical procedure should the scalp hair be clipped or not removed to prevent surgical site infections?

Study or Subgroup	Experimental--no removal Events	Total	Control--clipping Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Abouzari 2009	1	65	1	65	100.0%	1.00 [0.06, 16.34]
Total (95% CI)		**65**		**65**	**100.0%**	**1.00 [0.06, 16.34]**
Total events	1		1			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.00 (P = 1.00)						



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Clipped versus no hair removed	Control	Relative (95% CI)	Absolute		
Surgical Site Infections (follow-up mean 21 days; assessed with: SSI)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	1/65 (1.5%)	1/65 (1.5%)	OR 1 (0.06 to 16.34)	0 fewer per 1000 (from 14 fewer to 188 more)	⊕⊕OO LOW	
								1.5%		0 fewer per 1000 (from 14 fewer to 184 more)		

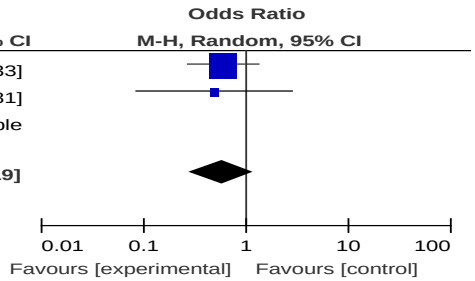
[1] Details of randomisation, allocation concealment or blinding were not given
[2] Wide CI

Question: In children undergoing a non-neurosurgical procedure should the hair be shaved or unshaved to prevent surgical site infections?

Study or Subgroup	Experimental--unshaved Events	Total	Control--shaved Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Court Brown 1981	11	141	17	137	82.8%	0.60 [0.27, 1.33]
Nascimento 1991	2	43	4	44	17.2%	0.49 [0.08, 2.81]
Rojanapirom 1992	0	40	0	40		Not estimable
Total (95% CI)		**224**		**221**	**100.0%**	**0.58 [0.28, 1.19]**
Total events	13		21			

Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.84); I² = 0%

Test for overall effect: Z = 1.48 (P = 0.14)



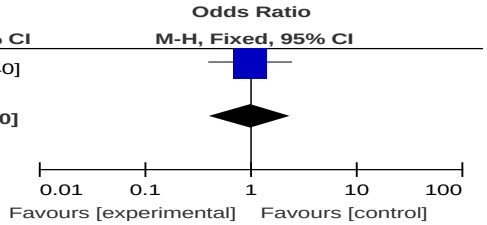
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Hair be shaved versus unshaved	Control	Relative (95% CI)	Absolute		
Surgical Site Infections (follow-up NS-28 days; assessed with: SSI)												
3	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	13/224 (5.8%)	21/221 (9.5%)	OR 0.58 (0.28 to 1.19)	38 fewer per 1000 (from 66 fewer to 16 more)	⊕⊕⊕O MODERATE	
								9.1%		36 fewer per 1000 (from 64 fewer to 15 more)		

[1] None of the studies reported details of the method of randomisation, allocation concealment and blinding.

Question: In children undergoing a non-neurosurgical procedure should cream depilatory versus no hair removal occur to prevent surgical site infections?

Study or Subgroup	Experimental--Unshaved Events	Total	Control--cream Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Court Brown 1981	11	141	10	126	100.0%	0.98 [0.40, 2.40]
Total (95% CI)		**141**		**126**	**100.0%**	**0.98 [0.40, 2.40]**
Total events	11		10			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.04 (P = 0.97)



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Cream depilatory versus no hair removal	Control	Relative (95% CI)	Absolute		
Unshaved versus use of cream (follow-up 1-28 days)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	11/141 (7.8%)	10/126 (7.9%)	OR 0.98 (0.4 to 2.4)	1 fewer per 1000 (from 46 fewer to 92 more)	⊕⊕⊕O MODERATE	
								7.9%		1 fewer per 1000 (from 46 fewer to 92 more)		

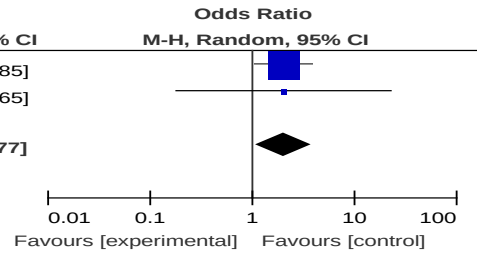
[1] Trial did not provide details about methods of randomisation, allocation concealment or blinding.

Question: In the non-neurosurgical patient should body hair be removed by shaving versus clipping to decrease surgical site infection?

Study or Subgroup	Experimental--Clipping Events	Total	Control--Shaving Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Alexander 1983	31	537	14	476	93.4%	2.02 [1.06, 3.85]
Balthazar 1983	2	100	1	100	6.6%	2.02 [0.18, 22.65]
Total (95% CI)		**637**		**576**	**100.0%**	**2.02 [1.09, 3.77]**
Total events	33		15			

Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 1.00); I² = 0%

Test for overall effect: Z = 2.22 (P = 0.03)



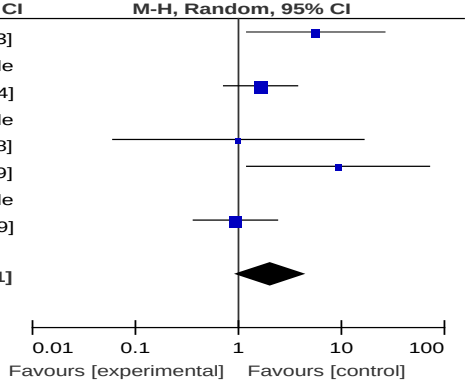
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Hair be removed by Shaving versus Clipping	Control	Relative (95% CI)	Absolute		
Surgical site infection (follow-up NS-14 days)												
2	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	33/637 (5.2%)	15/576 (2.6%)	OR 2.02 (1.09 to 3.77)	25 more per 1000 (from 2 more to 66 more)	⊕⊕⊕⊕ HIGH	
								2%		20 more per 1000 (from 2 more to 51 more)		

Question: In the non-neurosurgical patient should body hair be removed by shaving versus depilatory cream to decrease surgical site infection?

Study or Subgroup	Experimental--Shaving Events	Total	Control--Cream Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Adisa 2011	11	86	2	79	17.8%	5.65 [1.21, 26.33]
Breiting 1981	0	29	0	23		Not estimable
Court Brown 1981	17	137	10	126	33.1%	1.64 [0.72, 3.74]
Goeau-Brissonniere 1987	0	49	0	51		Not estimable
Powis 1976	1	46	1	46	7.1%	1.00 [0.06, 16.48]
Seropian 1971	14	249	1	157	12.0%	9.29 [1.21, 71.39]
Thorup 1985	0	23	24	13		Not estimable
Thur de Koos 1983	10	137	9	116	30.0%	0.94 [0.37, 2.39]
Total (95% CI)		**756**		**611**	**100.0%**	**2.05 [0.92, 4.61]**
Total events	53		47			

Heterogeneity: Tau² = 0.34; Chi² = 7.01, df = 4 (P = 0.14); I² = 43%

Test for overall effect: Z = 1.74 (P = 0.08)



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Hair be removed by Shaving versus Cream	Control	Relative (95% CI)	Absolute		
Surgical site infections (follow-up NS-28 days)												
7	randomised trials	serious[1]	serious[2]	no serious indirectness	no serious imprecision[3]	none	42/670 (6.3%)	45/532 (8.5%)	OR 1.6 (0.72 to 3.53)	44 more per 1000 (from 22 fewer to 161 more)	⊕⊕OO LOW	
								2.2%		13 more per 1000 (from 6 fewer to 52 more)		

[1] A majority of the studies did not report clearly on blinding.

[2] Range of surgeries were included and outcome assessment time was varied or not specified.

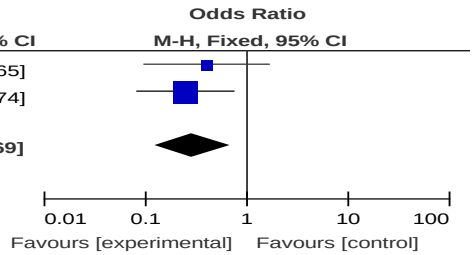
[3] I2 statistic is 32%

Question: In the non-neurosurgical patient should an Iodophor/alcohol water insoluble film with iodine impregnated incise drape be used to decrease surgical site infection?

Study or Subgroup	Experimental--DP& Ioban 2 Events	Total	Control--PI paint Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Segal 2002	3	48	7	49	27.9%	0.40 [0.10, 1.65]
Yoshimura 2003	4	122	21	174	72.1%	0.25 [0.08, 0.74]
Total (95% CI)		**170**		**223**	**100.0%**	**0.29 [0.12, 0.69]**
Total events	7		28			

Heterogeneity: Chi² = 0.28, df = 1 (P = 0.60); I² = 0%

Test for overall effect: Z = 2.82 (P = 0.005)



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Iodophor/alcohol water insoluble film with iodine impregnated incise drape	Control	Relative (95% CI)	Absolute		
SSI - Iodophor/alcohol water insoluble film with iodine impregnated incise drape vs. PI paint (follow-up NS-30 days)												
2	observational studies[1]	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision[3]	none	7/170 (4.1%)	28/223 (12.6%)	OR 0.29 (0.12 to 0.69)	86 fewer per 1000 (from 35 fewer to 109 fewer)	⊕OOO VERY LOW	
								13.2%		90 fewer per 1000 (from 37 fewer to 114 fewer)		

[1] One trial was an RCT while the other was a cohort

[2] Data from one trial was a secondary data analysis

[3] I2 statistic was 0% which reflects no heterogeneity was present between the two studies.

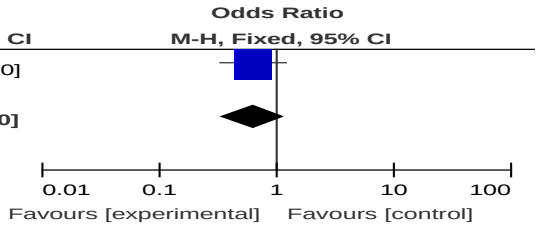
Intra-op

Question: In the non-neurosurgical patient is DuraPrep™ solution plus Ioban™ 2 drapes more efficacious in reducing surgical site infections than povidone iodine scrub and paint plus Ioban 2 drapes?

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Jacobson 2005	23	87	32	88	100.0%	0.63 [0.33, 1.20]
Total (95% CI)		**87**		**88**	**100.0%**	**0.63 [0.33, 1.20]**
Total events	23		32			

Heterogeneity: Not applicable

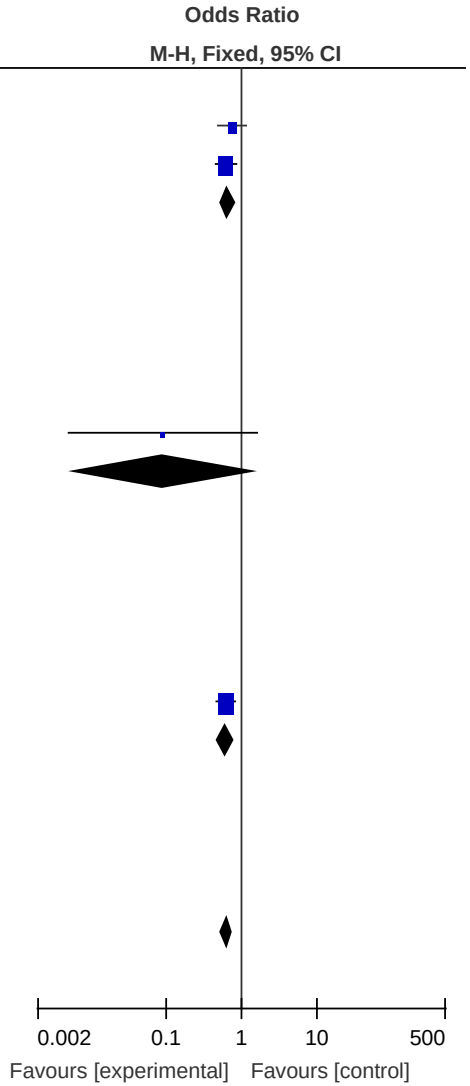
Test for overall effect: Z = 1.41 (P = 0.16)



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**DuraPrep + Ioban 2**	**PI + Ioban 2**	**Relative (95% CI)**	**Absolute**		
SSI (follow-up 30 days)												
1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	23/87 (26.4%)	32/88 (36.4%)	OR 0.63 (0.33 to 1.2)	99 fewer per 1000 (from 205 fewer to 43 more)	⊕⊕⊕⊕ HIGH	
								36.4%		99 fewer per 1000 (from 205 fewer to 43 more)		

Question: Should antibiotic intra-operative practices be used for the surgical patient?

Study or Subgroup	Experimental--Yes Events	Total	Control--No Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
13.1.1 Timely administration of prophylactic intravenous ATB w/i 60 minutes before incision						
Hendren 2013	338	3936	25	224	17.3%	0.75 [0.49, 1.15]
Kestle 2011	89	1571	79	896	38.0%	0.62 [0.45, 0.85]
Subtotal (95% CI)		**5507**		**1120**	**55.3%**	**0.66 [0.51, 0.85]**
Total events	427		104			
Heterogeneity: Chi² = 0.47, df = 1 (P = 0.49); I² = 0%						
Test for overall effect: Z = 3.22 (P = 0.001)						
13.1.2 Adminstration of ATB at between no more than 2 hrs before to at least 30 minutes before incision						
Meyer 2010	0	887	6	1048	2.4%	0.09 [0.01, 1.61]
Subtotal (95% CI)		**887**		**1048**	**2.4%**	**0.09 [0.01, 1.61]**
Total events	0		6			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.64 (P = 0.10)						
13.1.3 Antibiotic Selection						
Hendren 2013	290	3582	66	528	42.3%	0.62 [0.46, 0.82]
Subtotal (95% CI)		**3582**		**528**	**42.3%**	**0.62 [0.46, 0.82]**
Total events	290		66			
Heterogeneity: Not applicable						
Test for overall effect: Z = 3.33 (P = 0.0009)						
Total (95% CI)		**9976**		**2696**	**100.0%**	**0.63 [0.52, 0.76]**
Total events	717		176			
Heterogeneity: Chi² = 2.39, df = 3 (P = 0.49); I² = 0%						
Test for overall effect: Z = 4.85 (P < 0.00001)						
Test for subgroup differences: Chi² = 1.90, df = 2 (P = 0.39), I² = 0%						



Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Antibiotic Perioperative Practices**	**Control**	**Relative (95% CI)**	**Absolute**		
ATB Perioperative Practices - Timely administration of prophylactic intravenous ATB w/i 60 minutes before incision												
2	observational studies[1]	no serious risk of bias[2]	very serious[3]	no serious indirectness	no serious imprecision	none	427/5507 (7.8%)	104/1120 (9.3%)	OR 0.66 (0.51 to 0.85)	30 fewer per 1000 (from 13 fewer to 43 fewer)	⊕OOO VERY LOW	
								10%		32 fewer per 1000 (from 14 fewer to 46 fewer)		
ATB Perioperative Practices - Adminstration of ATB at between no more than 2 hrs before to at least 30 minutes before incision												
1	observational studies	no serious risk of bias[4]	no serious inconsistency	no serious indirectness	serious[5]	none	0/887 (0%)	6/1048 (0.6%)	OR 0.09 (0.01 to 1.61)	5 fewer per 1000 (from 6 fewer to 3 more)	⊕OOO VERY LOW	
								0.6%		5 fewer per 1000 (from 6 fewer to 4 more)		
ATB Perioperative Practices - Antibiotic Selection												
1	observational studies	no serious risk of bias[6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	290/3582 (8.1%)	66/528 (12.5%)	OR 0.62 (0.46 to 0.82)	44 fewer per 1000 (from 20 fewer to 63 fewer)	⊕⊕OO LOW	
								12.5%		44 fewer per 1000 (from 20 fewer to 63 fewer)		

[1] Retrospective and Quality Improvement designs used

[2] The study methods employed were reasonable based on the study designs employed. Therefore, the studies were not further downgraded for their risk of bias.

[3] One study (Hendren, 2013) reported on colectomy patients and Kestle (2011) reported on ventriculoperitoneal shunt patients. Not only is there inconsistency between patient populations but also differences between approaches and techniques employed.

[4] See footnote #2. This study was not combined with the previously reported ATB timing studies due to the large variance in ATB timing (30 minutes - 2 hours before incision). However if it was combined the OR for the three studies would be .64 with a CI of 0.50, 0.82. This OR further supports the use of ATB prior to surgery.

[5] Meyer (2010) did not stratify the timing of ATBs and therefore was downgraded for inconsistency.

[6] See footnote #2.

Sonabend 2011

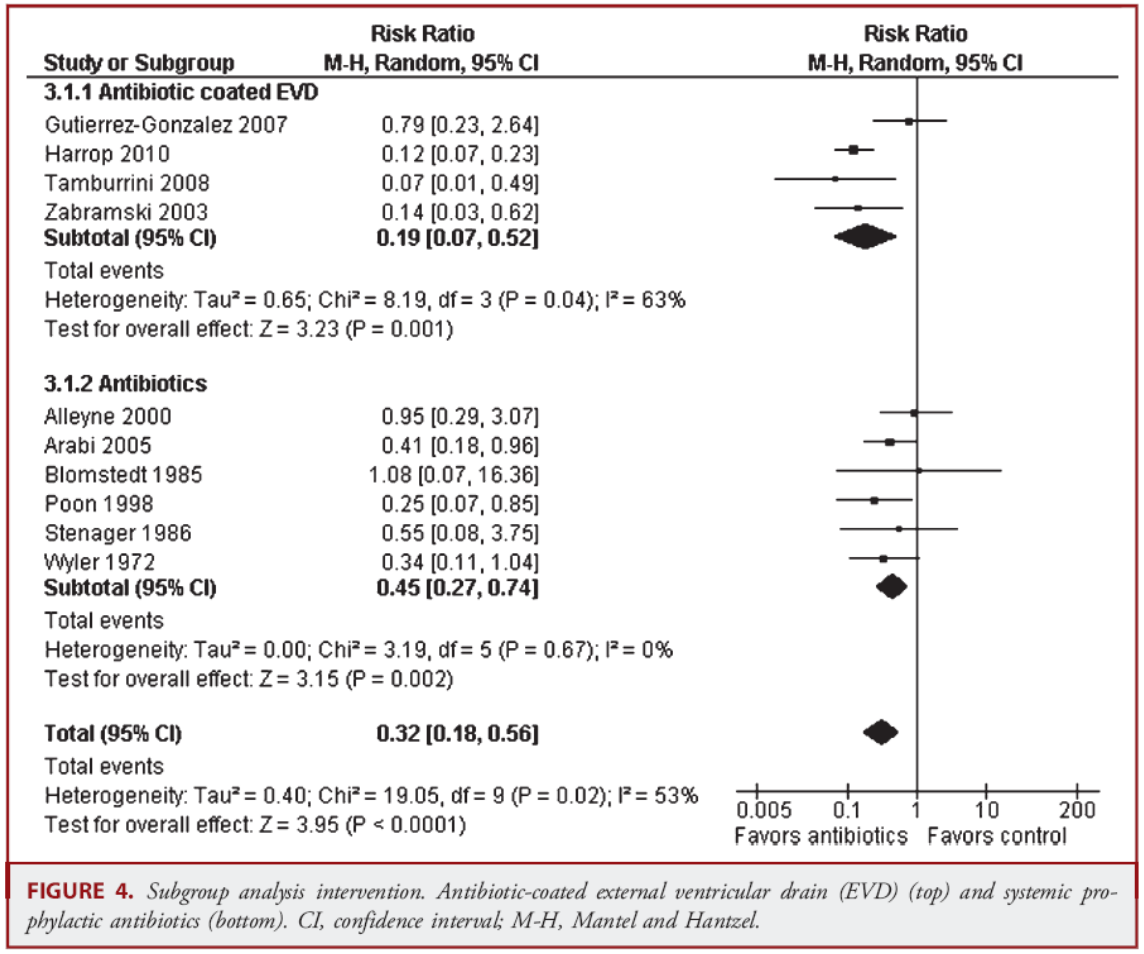


FIGURE 4. *Subgroup analysis intervention. Antibiotic-coated external ventricular drain (EVD) (top) and systemic prophylactic antibiotics (bottom). CI, confidence interval; M-H, Mantel and Hantzel.*

Included studies

Adisa, A. O., O. O. Lawal and O. Adejuyigbe (2011). "Evaluation of two methods of preoperative hair removal and their relationship to postoperative wound infection." J Infect Dev Ctries **5**(10): 717-722.

Broekman, M. L., J. van Beijnum, W. C. Peul and L. Regli (2011). "Neurosurgery and shaving: what's the evidence?" J Neurosurg **115**(4): 670-678.

Chlebicki, M. P., N. Safdar, J. C. O'Horo and D. G. Maki (2013). "Preoperative chlorhexidine shower or bath for prevention of surgical site infection: a meta-analysis." Am J Infect Control **41**(2): 167-173.

Hendren, S., Fritze, D., Banerjee, M., Kubus, J., Cleary, R. K., Englesbe, M. J., & Campbell, D. A., Jr. (2013). Antibiotic choice is independently associated with risk of surgical site infection after colectomy: a population-based cohort study. *Ann Surg, 257*(3), 469-475. doi: 10.1097/SLA.0b013e31826c4009

Jakobsson, J., A. Perlkvist and C. Wann-Hansson (2011). "Searching for evidence regarding using preoperative disinfection showers to prevent surgical site infections: a systematic review." Worldviews Evid Based Nurs **8**(3): 143-152.

Johnson, A. J., J. A. Daley, M. G. Zywiel, R. E. Delanois and M. A. Mont (2010). "Preoperative chlorhexidine preparation and the incidence of surgical site infections after hip arthroplasty." J Arthroplasty **25**(6 Suppl): 98-102.

Kestle, J. R., Riva-Cambrin, J., Wellons, J. C., 3rd, Kulkarni, A. V., Whitehead, W. E., Walker, M. L., . . . Hydrocephalus Clinical Research, Network. (2011). A standardized protocol to reduce cerebrospinal fluid shunt infection: the Hydrocephalus Clinical Research Network Quality Improvement Initiative. *J Neurosurg Pediatr, 8*(1), 22-29. doi: 10.3171/2011.4.PEDS10551

Meyer, D., Klarenbeek, R., & Meyer, F. (2010). Current concepts in perioperative care for the prevention of deep surgical site infections in elective spinal surgery. *Cent Eur Neurosurg, 71*(3), 117-120. doi: 10.1055/s-0029-1224194

Noorani, A., N. Rabey, S. R. Walsh and R. J. Davies (2010). "Systematic review and meta-analysis of preoperative antisepsis with chlorhexidine versus povidone-iodine in clean-contaminated surgery." Br J Surg **97**(11): 1614-1620.

Sonabend, A. M., Korenfeld, Y., Crisman, C., Badjatia, N., Mayer, S. A., & Connolly, E. S., Jr. (2011). Prevention of ventriculostomy-related infections with prophylactic antibiotics and antibiotic-coated external ventricular drains: a systematic review. *Neurosurgery, 68*(4), 996-1005. doi: 10.1227/NEU.0b013e3182096d84

Tanner, J., P. Norrie and K. Melen (2011). "Preoperative hair removal to reduce surgical site infection." Cochrane Database Syst Rev(11): CD004122.

Webster, J. and S. Osborne (2011). "Home-based preoperative chlorhexidine bathing cloths to prevent surgical site infection." Infect Control Hosp Epidemiol **32**(10): 1047; author reply 1047-1048.

Excluded studies

Bailey, R. R., D. R. Stuckey, B. A. Norman, A. P. Duggan, K. M. Bacon, D. L. Connor, I. Lee, R. R. Muder and B. Y. Lee (2011). "Economic value of dispensing home-based preoperative chlorhexidine bathing cloths to prevent surgical site infection." Infect Control Hosp Epidemiol **32**(5): 465-471.

Buffet-Bataillon, S., Haegelen, C., Riffaud, L., Bonnaure-Mallet, M., Brassier, G., & Cormier, M. (2011). Impact of surgical site infection surveillance in a neurosurgical unit. *J Hosp Infect, 77*(4), 352-355. doi: 10.1016/j.jhin.2010.10.011

Clemmensen, D., Rasmussen, M. M., & Mosdal, C. (2010). A retrospective study of infections after primary VP shunt placement in the newborn with myelomeningocele without prophylactic antibiotics. *Childs Nerv Syst, 26*(11), 1517-1521. doi: 10.1007/s00381-010-1113-2

Doursounian, L., Maigne, J. Y., Cherrier, B., & Pacanowski, J. (2011). Prevention of post-coccygectomy infection in a series of 136 coccygectomies. *Int Orthop, 35*(6), 877-881. doi: 10.1007/s00264-010-1058-9

Farber, S. H., Parker, S. L., Adogwa, O., McGirt, M. J., & Rigamonti, D. (2011). Effect of antibiotic-impregnated shunts on infection rate in adult hydrocephalus: a single institution's experience. *Neurosurgery, 69*(3), 625-629; discussion 629. doi: 10.1227/NEU.0b013e31821bc435Gaston, R. G. and M. A. Kuremsky (2010). "Postoperative infections: prevention and management." Hand Clin **26**(2): 265-280.

Ibrahimi, O. A., M. M. Avram, C. W. Hanke, S. L. Kilmer and R. R. Anderson (2011). "Laser hair removal." Dermatol Ther **24**(1): 94-107.

Jose, B. and A. Dignon (2013). "Is there a relationship between preoperative shaving (hair removal) and surgical site infection?" J Perioper Pract **23**(1-2): 22-25.

Kamel, C., L. McGahan, J. Polisena, M. Mierzwinski-Urban and J. M. Embil (2012). "Preoperative skin antiseptic preparations for preventing surgical site infections: a systematic review." Infect Control Hosp Epidemiol **33**(6): 608-617.

Kanayama, M., Oha, F., Togawa, D., Shigenobu, K., & Hashimoto, T. (2010). Is closed-suction drainage necessary for single-level lumbar decompression?: review of 560 cases. *Clin Orthop Relat Res, 468*(10), 2690-2694. doi: 10.1007/s11999-010-1235-6

Lane, M. A., V. L. Young and B. C. Camins (2010). "Prophylactic antibiotics in aesthetic surgery." Aesthet Surg J **30**(6): 859-871; quiz 873.

Molinari, R. W., Khera, O. A., & Molinari, W. J., 3rd. (2012). Prophylactic intraoperative powdered vancomycin and postoperative deep spinal wound infection: 1,512 consecutive surgical cases over a 6-year period. *Eur Spine J, 21 Suppl 4*, S476-482. doi: 10.1007/s00586-011-2104-z

Murray, B. W., S. Huerta, S. Dineen and T. Anthony (2010). "Surgical site infection in colorectal surgery: a review of the nonpharmacologic tools of prevention." J Am Coll Surg **211**(6): 812-822.

Naderi, N., K. Maw, M. Thomas, D. E. Boyce and K. Shokrollahi (2012). "A quick and effective method of limb preparation with health, safety and efficiency benefits." Ann R Coll Surg Engl **94**(2): 83-86.

Nthumba, P. M., E. Stepita-Poenaru, D. Poenaru, P. Bird, B. Allegranzi, D. Pittet and S. Harbarth (2010). "Cluster-randomized, crossover trial of the efficacy of plain soap and water versus alcohol-based rub for surgical hand preparation in a rural hospital in Kenya." Br J Surg **97**(11): 1621-1628.

Ogbemudia, A. O., A. Bafor, E. Edomwonyi and R. Enemudo (2010). "Prevalence of pin tract infection: the role of combined silver sulphadiazine and chlorhexidine dressing." Niger J Clin Pract **13**(3): 268-271.

Ramos, N., Skeete, F., Haas, J. P., Hutzler, L., Slover, J., Phillips, M., & Bosco, J. (2011). Surgical site infection prevention initiative - patient attitude and compliance. *Bull NYU Hosp Jt Dis, 69*(4), 312-315.

Rehman, A. U., Rehman, T. U., Bashir, H. H., & Gupta, V. (2010). A simple method to reduce infection of ventriculoperitoneal shunts. *J Neurosurg Pediatr, 5*(6), 569-572. doi: 10.3171/2010.2.PEDS09151

Rivero-Garvia, M., Marquez-Rivas, J., Jimenez-Mejias, M. E., Neth, O., & Rueda-Torres, A. B. (2011). Reduction in external ventricular drain infection rate. Impact of a minimal handling protocol and antibiotic-impregnated catheters. *Acta Neurochir (Wien), 153*(3), 647-651. doi: 10.1007/s00701-010-0905-1

Sebastian, S. (2012). "Does preoperative scalp shaving result in fewer postoperative wound infections when compared with no scalp shaving? A systematic review." J Neurosci Nurs **44**(3): 149-156.

Timms, A. and H. Pugh (2012). "Pin site care: guidance and key recommendations." Nurs Stand **27**(1): 50-55; quiz 56.

Tschudin-Sutter, S., R. Frei, D. Egli-Gany, F. Eckstein, V. Valderrabano, M. Dangel, M. Battegay and A. F. Widmer (2012). "No risk of surgical site infections from residual bacteria after disinfection with povidone-iodine-alcohol in 1014 cases: a prospective observational study." Ann Surg **255**(3): 565-569.

Webster, J. and S. Osborne (2012). "Preoperative bathing or showering with skin antiseptics to prevent surgical site infection." Cochrane Database Syst Rev **9**: CD004985.

Weight, C. J., M. C. Lee and J. S. Palmer (2010). "Avagard hand antisepsis vs. traditional scrub in 3600 pediatric urologic procedures." Urology **76**(1): 15-17.

Yavascan, O., M. Anil, O. D. Kara, A. Bal, N. Akcan, S. Senturk, S. Unturk and N. Aksu (2011). "The comparison of exit-site care with normal saline and povidone-iodine in preventing exit-site infection and peritonitis in children on chronic peritoneal dialysis treatment." Saudi J Kidney Dis Transpl **22**(5): 931-934.