

# Reducing Surgical Site Infections (SSI): Tried and True or New?

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# Thanks, Disclosure and Admissions

- Disclosures: Medimmune grant to UTSW



# Objectives

- To describe several strategies to prevent SSI
  - Pre-operative
  - Intra-operative
  - Post-operative
- To review the data behind these strategies

# Caveats

- Grading systems used by the various societies differ and commonly the interpretation of the evidence varies.
- We are not discussing the surgical prophylaxis guidelines in detail.





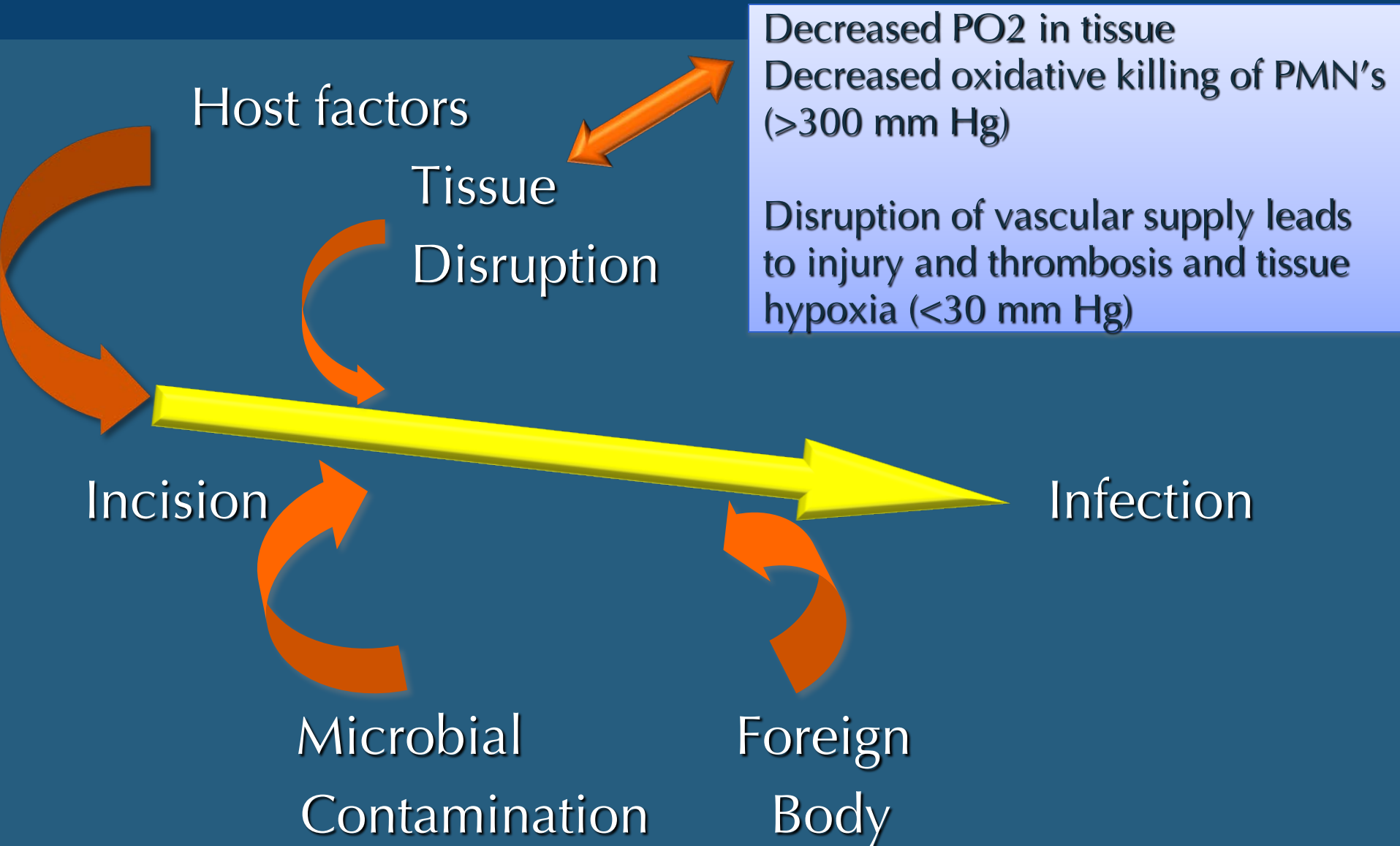
# SSIs: Impact

- 1<sup>st</sup> or 2<sup>nd</sup> most frequent HAI ~ 22%; likely underreported by 50%
- Most frequent HAI in surgical pts and complicate 1.9%-5% of procedures (~70% superficial, ~30% organ/space)
- 5.6% in HK
- Patients with SSI have a 2-11 times higher risk of death and 77% of deaths among patients with SSI are attributable to SSI

# SSIs: Impact

- ~8,000 deaths annually due to SSI
- Each SSI results in 7-10 additional patient hospital days
- Cost (2007 US dollars): \$11,874 to \$34,670 per SSI (total = \$3.45-\$10 billion)
- Costs can exceed \$90,000 when the SSI involves a prosthetic joint replacement or an antimicrobial resistant organism

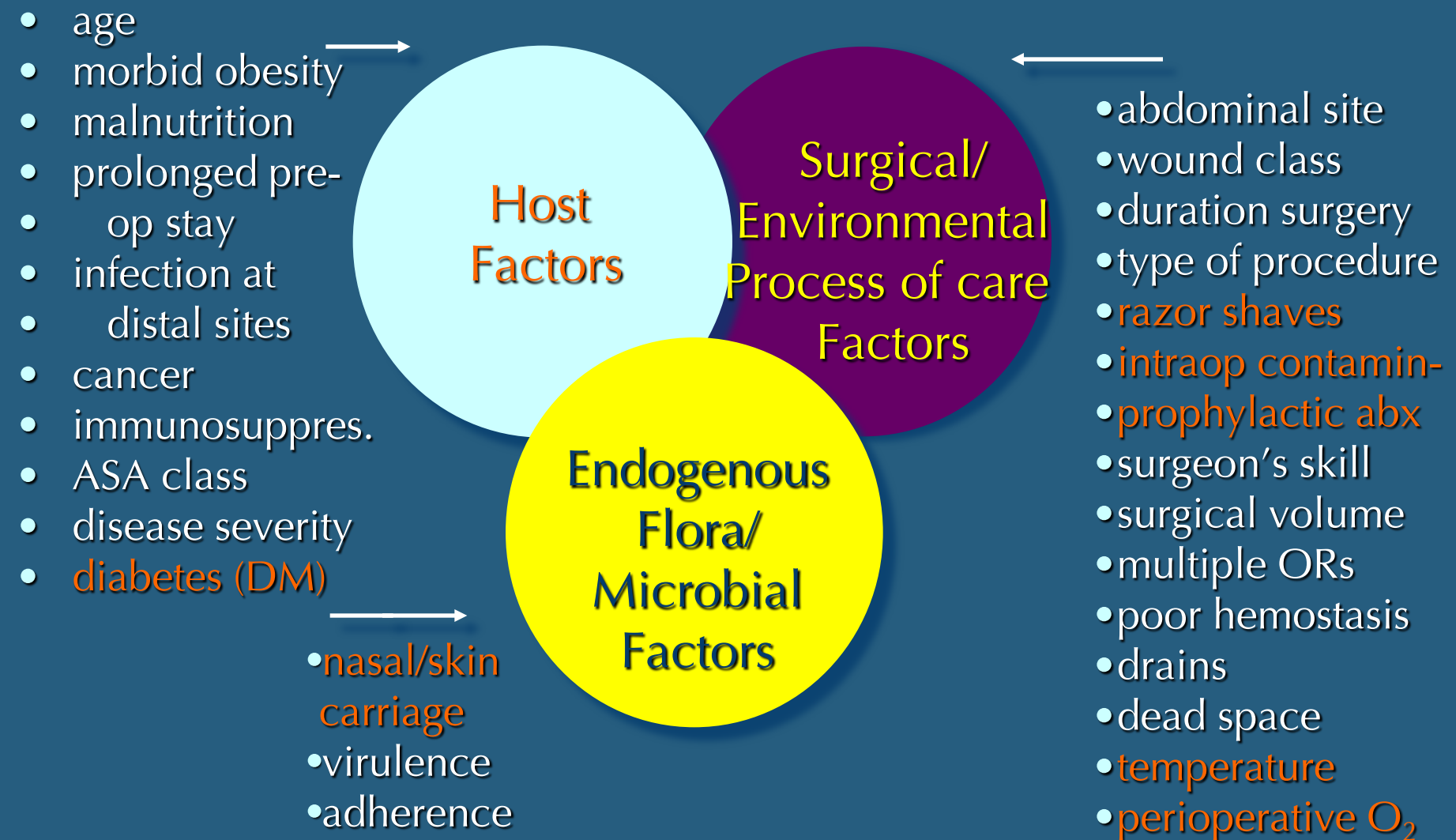
# Pathogenesis: Direct Innoculation



# Pathogenesis: Additional Possibility

- *Exogenous* contamination during or after surgery possible
  - Ex: contamination with HCW's flora (GABHS)
  - Ex: contaminated dressings, bandages, irrigants (rhizopus)

# Risk Factors for SSI: A View Towards Prevention





## Strategies to Prevent Surgical Site Infections in Acute Care Hospitals: 2014 Update

Deverick J. Anderson, MD, MPH;<sup>1</sup> Kelly Podgorny, DNP, MS, RN;<sup>2</sup> Sandra I. Berrios-Torres, MD;<sup>3</sup>  
Dale W. Bratzler, DO, MPH;<sup>4</sup> E. Patchen Dellinger, MD;<sup>5</sup> Linda Greene, RN, MPS, CIC;<sup>6</sup>  
Ann-Christine Nyquist, MD, MSPH;<sup>7</sup> Lisa Saiman, MD, MPH;<sup>8</sup> Deborah S. Yokoe, MD, M  
Lisa L. Maragakis, MD, MPH;<sup>10</sup> Keith S. Kaye, MD, MPH<sup>11</sup>

### Surgical site infections 2

#### New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective

*Benedetta Allegranzi, Bassim Zayed, Peter Bischoff, N Zeynep Kubilay, Stijn de Jonge, Fleur de Vries, Stacey M Gomes, Sarah Gans,  
Xiuwen Wu, Mohamed Abbas, Marja A Boermeester, E Patchen Dellinger, Matthias Egger, Petra Gastmeier, Xavier Guirao, Jjianan  
Joseph S Solomkin, and the WHO Guidelines Development Group*

Surgical site infections (SSIs) are the most common health-care-associated infections in developing c  
also represent a substantial epidemiological burden in high-income countries. The prevention of t

### Clinical Review & Education

# Recent SSI Prevention Guidelines

### Surgical site infections 1

#### New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective

*Benedetta Allegranzi, Peter Bischoff, Stijn de Jonge, N Zeynep Kubilay, Bassim Zayed, Stacey M  
Sarah Gans, Miranda van Rijen, Marja A Boermeester, Matthias Egger, Jan Kluytmans, Didier Pi  
Development Group\**

Surgical site infections (SSIs) are among the most preventable health-care-a  
burden to health-care systems and service payers worldwide in terms of pa



THE APSIC GUIDELINES

FOR

THE PREVENTION OF SURGICAL SITE INFECTIONS

### JAMA Surgery | Special Communication

## Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017

Sandra I. Berrios-Torres, MD; Craig A. Umscheid, MD, MSCE; Dale W. Bratzler, DO, MPH; Brian Leas, MA, MS;  
Erin C. Stone, MA; Rachel R. Kelz, MD, MSCE; Caroline E. Reinke, MD, MSHP; Sherry Morgan, RN, MLS, PhD;  
Joseph S. Solomkin, MD; John E. Mazuski, MD, PhD; E. Patchen Dellinger, MD; Kamal M. F. Itani, MD;  
Elie F. Barbari, MD; John Segreti, MD; Javad Parvizi, MD; Joan Blanchard, MSS, BSN, RN, CNOR, CIC;  
George Allen, PhD, CIC, CNOR; Jan A. J. W. Kluytmans, MD; Rodney Donlan, PhD; William P. Schecter, MD;  
for the Healthcare Infection Control Practices Advisory Committee



**Recommendations on  
Prevention of Surgical Site Infection**



# Worth Mentioning But More General

## Patient related—prior to surgery

- Stop smoking – Category IA
- Reduce Hgb A1c to less than 7 % - Category IA
- Enhance nutritional support
- Discontinue immunosuppressants



# Implement Glycemic Control

- I-A recommendation

Peri-operative  
glycemic control

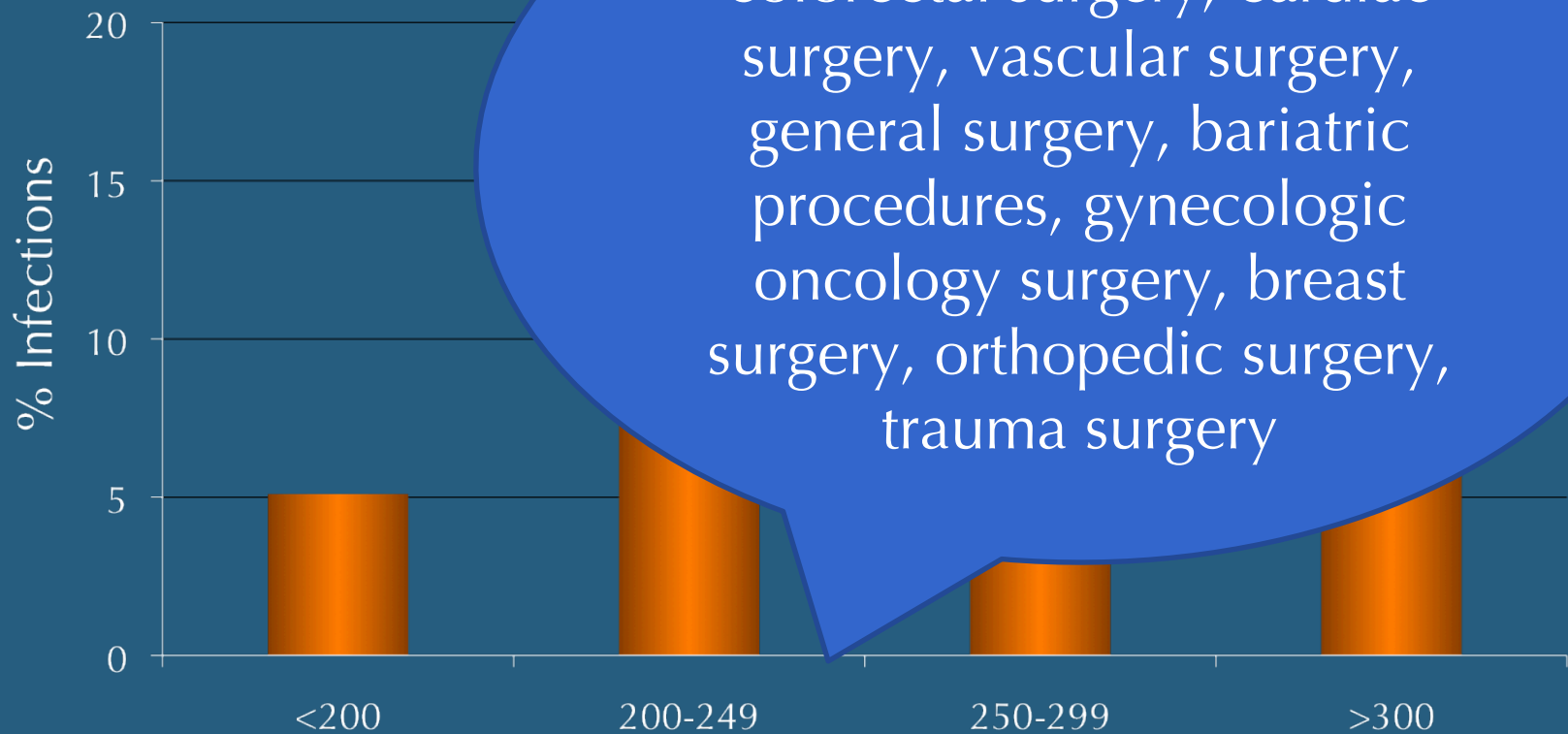


Control blood glucose levels < 200 mg/dL  
SHEA guideline recommend lower than 180 mg/dL  
and this be maintained for 18-24 hours. The optimal  
hemoglobin A1C target has not been identified.

CDC, SHEA, HK < APSIC

WHO suggests use of protocols for intensive  
monitoring

# Diabetes, Glucose Control, and SSIs After Median Sternotomy



# Do Patients Get Hyperglycemic After Operations?

- Hyperglycemia after cardiac operations
  - 48% of diabetics
  - 12% of nondiabetics
  - 30% of all patients
- 47% of hyperglycemic episodes were in nondiabetics

# Minimize Pre-operative LOS

- I-A recommendation

Minimize Pre-operative stay



HK

Use a checklist based on the WHO checklist to enhance compliance with best practices



WHO 19 item safety checklist

SHEA

# Duration of Pre-operative Hospital Stay

No. days hospitalized pre-operatively	Infection rate	
	Cruse	NRC
1 day	1.4%	6.0%
1 week	2.1%	---
> 2 weeks	3.4%	14.7%

*Cruse, SCNA 1980*

*NRC, Ann Surg 1964*

# Processes

- I-A recommendation

Perform surveillance for SSI



High-volume, high-risk procedures

Implement system to track data

Identify trends and feedback data

Use CDC/NHSN definitions or accepted methodology

SHEA, APSIC, HK

Use a checklist based on the WHO checklist to enhance compliance with best practices



WHO 19 item safety checklist

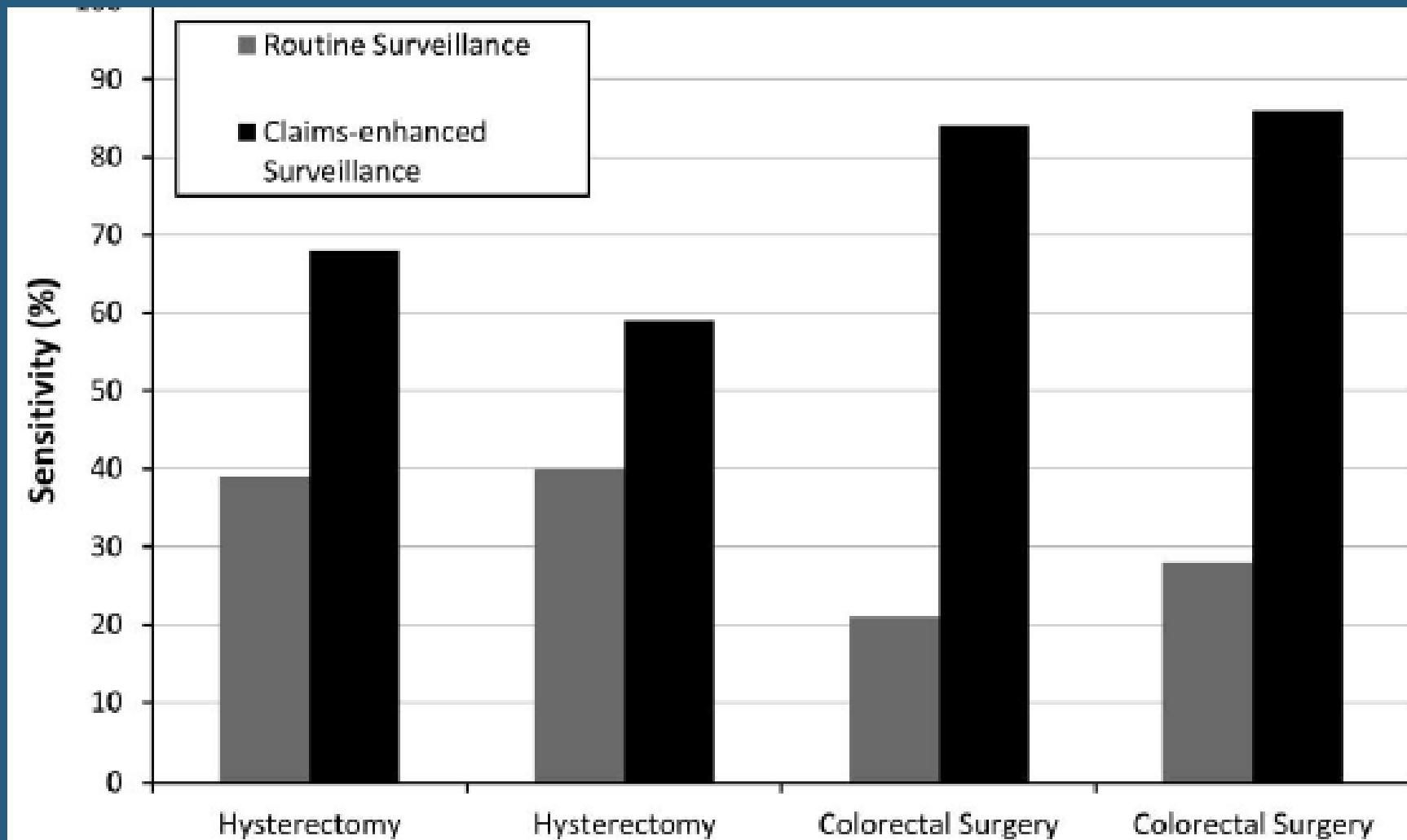
SHEA

# SSI Detection: Validity of Data from One Hospital

- Retrospective cohort: 1/1/2006-31/12/2009
- 91,121 THR and 121,640 TKR were identified with SSI rates of 2.3% (2,214) and 2.0% (2,465), respectively
- 17% of SSI were missed if surveillance was limited to one hospital
- Hospital ranking affected in 61% of cases



# SSI detection: Claims Data



# Do Intra-operative Checklists Work?

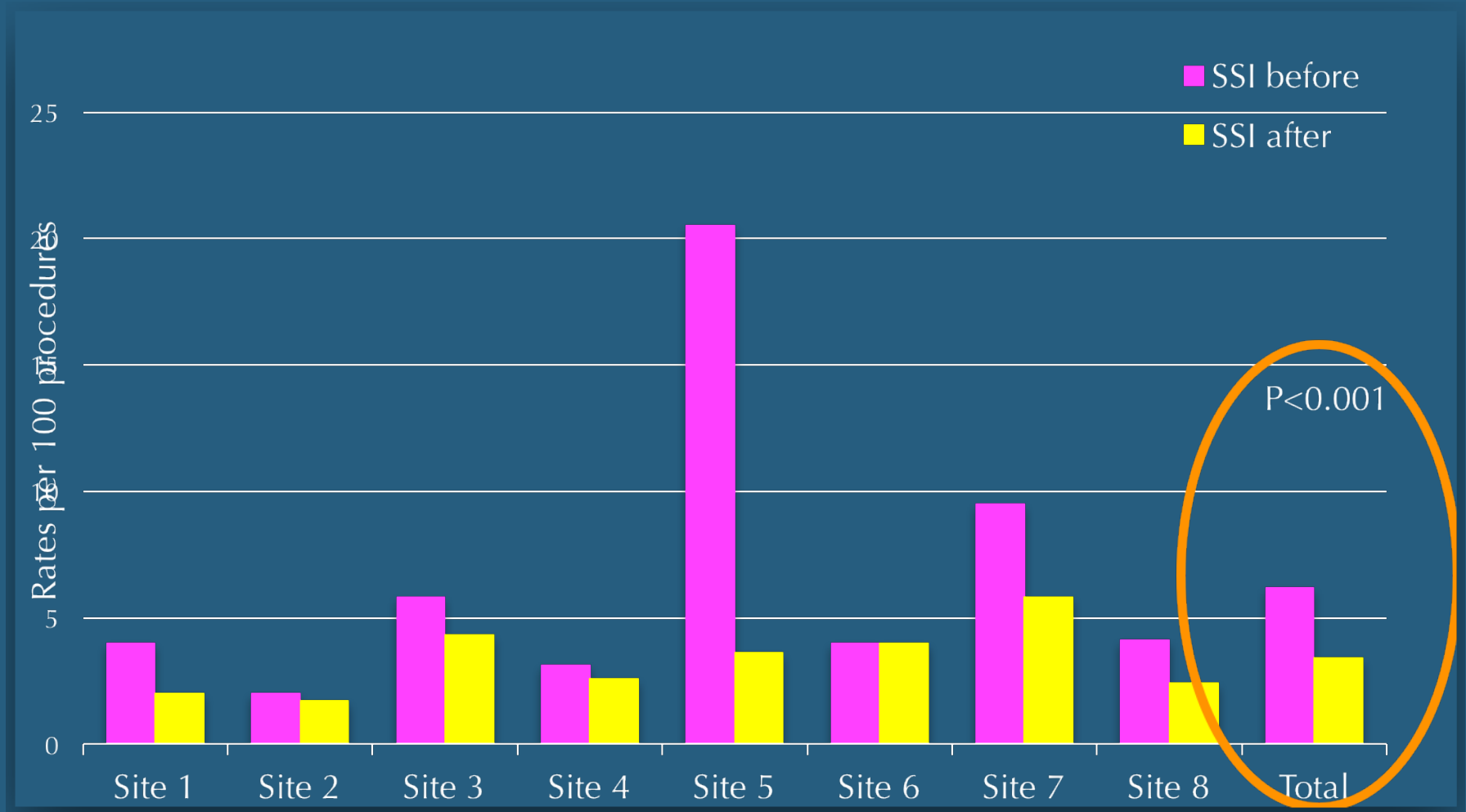
- Before (n=3733) and after (n=3955) evaluation of a 19 element checklist
- 8 hospitals representing a variety of economic circumstances & diverse patient populations (WHO Safe Surgery Saves Lives Study Group).

**Table 1. Elements of the Surgical Safety Checklist.\***

Sign in
Before induction of anesthesia, members of the team (at least the nurse and an anesthesia professional) orally confirm that:
The patient has verified his or her identity, the surgical site and procedure, and consent
The surgical site is marked or site marking is not applicable
The pulse oximeter is on the patient and functioning
All members of the team are aware of whether the patient has a known allergy
The patient's airway and risk of aspiration have been evaluated and appropriate equipment and assistance are available
If there is a risk of blood loss of at least 500 ml (or 7 ml/kg of body weight, in children), appropriate access and fluids are available
Time out
Before skin incision, the entire team (nurses, surgeons, anesthesia professionals, and any others participating in the care of the patient) orally:
Confirms that all team members have been introduced by name and role
Confirms the patient's identity, surgical site, and procedure
Reviews the anticipated critical events
Surgeon reviews critical and unexpected steps, operative duration, and anticipated blood loss
Anesthesia staff review concerns specific to the patient
Nursing staff review confirmation of sterility, equipment availability, and other concerns
Confirms that prophylactic antibiotics have been administered $\leq 60$ min before incision is made or that antibiotics are not indicated
Confirms that all essential imaging results for the correct patient are displayed in the operating room
Sign out
Before the patient leaves the operating room:
Nurse reviews items aloud with the team
Name of the procedure as recorded
That the needle, sponge, and instrument counts are complete (or not applicable)
That the specimen (if any) is correctly labeled, including with the patient's name
Whether there are any issues with equipment to be addressed
The surgeon, nurse, and anesthesia professional review aloud the key concerns for the recovery and care of the patient

\* The checklist is based on the first edition of the WHO Guidelines for Safe Surgery.<sup>15</sup> For the complete checklist, see the Supplementary Appendix.

# SSI Outcomes Before and After Checklist Implementation



# Skin Antisepsis

- I-B recommendation

Pre-operative bathe  
or shower



Night before

The number of showers/bathes is an unresolved issue.  
WHO suggest that this is indicated but the level of  
evidence is moderate  
CDC-Category 1B; APSIC

- I-A recommendation

Surgical site skin  
preparation



Intra-operative

Other Skin prep with **alcohol** and iodine or CHG skin prep  
of operative site.  
CDC (Category 1A), SHEA, APSIC  
WHO, HK guideline preferentially recommends CHG +  
alcohol

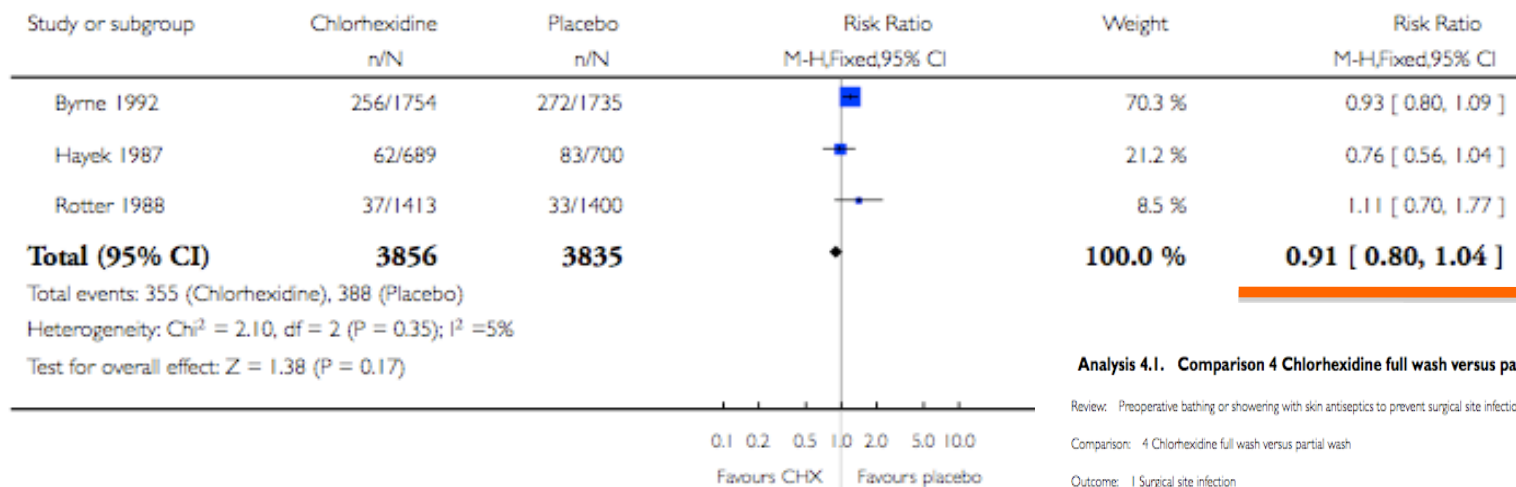
# Pre-operative CHG bathing or showering with CHG vs placebo: SSI

## Analysis 1.1. Comparison 1 Chlorhexidine 4% versus placebo, Outcome 1 Surgical site infection.

Review: Preoperative bathing or showering with skin antiseptics to prevent surgical site infection

Comparison: 1 Chlorhexidine 4% versus placebo

Outcome: 1 Surgical site infection

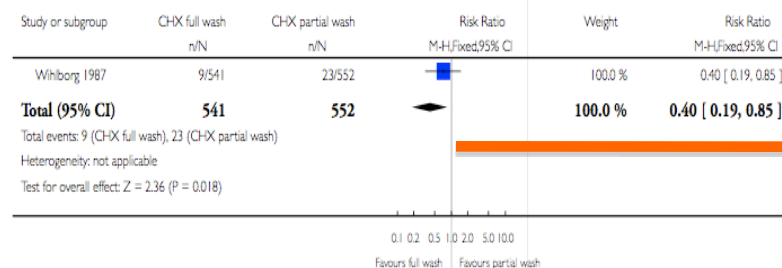


## Analysis 4.1. Comparison 4 Chlorhexidine full wash versus partial wash, Outcome 1 Surgical site infection.

Review: Preoperative bathing or showering with skin antiseptics to prevent surgical site infection

Comparison: 4 Chlorhexidine full wash versus partial wash

Outcome: 1 Surgical site infection



# Are We Applying CHG Correctly? 4% vs. 2% Cloth

Group 1: morning cleansing  
Group 2: evening cleansing  
Group 3: both morning and  
evening cleansing

Group	n	Subgroups		p Value
		A	B	
		4% CHG soap	2% CHG-impregnated cloth	
1*	20			0.001
LA		22.5	361.5	
RA		17.2	379.8	
ABD		21.5	589.5	
LP		29.0	405.3	
RP		31.6	443.8	
2†	20			0.0001
LA		71.6	907.0	
RA		63.4	1,013.2	
ABD		51.6	958.2	
LP		89.8	1,049.6	
RP		119.6	1,028.5	
3‡	20			0.0001
LA		113.3	1,484.6	
RA		101.4	1,633.1	
ABD		140.1	1,781.7	
LP		127.9	1,797.8	
RP		149.4	2,031.3	

\*Shows cleansing with CHG morning

# Skin Antisepsis

- No recommendation

Repeat application  
of skin antiseptics



Immediate application before wound closure

CDC, APSIC, HK-No recommendation



# What About Hands



- Strong recommendation (Category IB-II)

Hand skin prep



Hands should be scrubbed with antimicrobial soap and water or using a suitable alcohol based hand rub before donning gloves

WHO, SHEA, HK, APSIC (IA)

# What Did They Find?



**Cochrane  
Library**

Cochrane

**Surgical hand  
(Review)**

14 studies included; 4 RTC with SSI as an outcome, the remaining looked at CFU. There is no firm evidence that one type of surgical hand scrub is superior to another; A 3 minute scrub reduces CFU's more than a 2 minute scrub but not consistently and the evidence is low quality.

Tanner J, Dumville JC, Norman G,

# *S. aureus* Decolonization

- I-A recommendation

Use mupirocin prophylaxis for certain pre-op patients colonized with *S. aureus*



Cardiac surgery, orthopedic surgery and perhaps neurosurgery. Data in other surgical procedures needs clarification.

SHEA (II recommendation); APSIC (IIB and IA for cardiac and orthopedic procedures), HK (for MRSA).

WHO guideline recommends for cardiac and orthopedic and only moderately recommends for other procedures with *S. aureus* carriers.

# *S. aureus* Nasal Carriage and Attributable Risk of SSI

- SSI
  - OR= 9.6, 95% CI 3.9–23.7
  - Attributable risk = 86.3%
- Harvest site SSI
  - RR= 7.12, 95% CI 2.22–3.0
  - Attributable risk = 86%
- Orthopedic SSI
  - RR= 8.9, P=0.002
- SSI
  - RR= 4.5 (95 %CI 2.47,8.21; P < 0.001)

RR=relative risk; OR=odd's ratio

# *S. aureus* Decolonization

**TABLE 4. OVERALL AND *STAPHYLOCOCCUS AUREUS*-SPECIFIC RATES OF NOSOCOMIAL INFECTION AMONG PATIENTS WHO RECEIVED MUPIROICIN AND THOSE WHO RECEIVED PLACEBO.**

TYPE OF INFECTION	MUPIROICIN RECIPIENTS			PLACEBO RECIPIENTS		
	TOTAL (N=1933)	<i>S. AUREUS</i> CARRIERS (N=444)	NONCARRIERS (N=1489)	TOTAL (N=1931)	<i>S. AUREUS</i> CARRIERS (N=447)	NONCARRIERS (N=1484)
	number/total number (percent)					
Nosocomial infection*	218/1933 (11.3)	57/444 (12.8)	161/1489 (10.8)	220/1931 (11.4)	72/447 (16.1)	148/1484 (10.0)
Nosocomial <i>S. aureus</i> infection*	45/1884 (2.4)	17/430 (4.0)	28/1454 (1.9)	55/1886 (2.9)	34/439 (7.7)†	21/1447 (1.5)
Surgical-site infection	152/1933 (7.9)	44/444 (9.9)	108/1489 (7.3)	164/1931 (8.5)	52/447 (11.6)	112/1484 (7.5)
<i>S. aureus</i> surgical-site infections‡	43/1892 (2.3)	16/432 (3.7)	27/1460 (1.8)	46/1894 (2.4)	26/439 (5.9)	20/1455 (1.4)

\*This group includes *S. aureus* infections of the bloodstream, respiratory tract, catheter, and surgical site.

†P=0.02 for the comparison with the *S. aureus* carriers in the mupirocin group (odds ratio, 0.49; 95 percent confidence interval, 0.25 to 0.92).

‡P=0.001 for the comparison with the *S. aureus* carriers in the mupirocin group (odds ratio, 0.54; 95 percent confidence interval, 0.25 to 1.17).

# *S. aureus* Decolonization and CHG Baths

**Table 2.** Relative Risk of Hospital-Acquired *Staphylococcus aureus* Infection and Characteristics of Infections (Intention-to-Treat Analysis).

Variable	Mupirocin– Chlorhexidine (N = 504)  no. (%)	Placebo (N = 413)  no. (%)	Relative Risk (95% CI)*
<i>S. aureus</i> infection	17 (3.4)	32 (7.7)	0.42 (0.23–0.75)
Source of infection†			
Endogenous	12 (2.4)	25 (6.1)	0.39 (0.20–0.77)
Exogenous	4 (0.8)	6 (1.5)	0.55 (0.16–1.92)
Unknown	1 (0.2)	1 (0.2)	
Localization of infection			
Deep surgical site‡	4 (0.9)	16 (4.4)	0.21 (0.07–0.62)
Superficial surgical site‡	7 (1.6)	13 (3.5)	0.45 (0.18–1.11)
Lower respiratory tract	2 (0.4)	2 (0.5)	0.82 (0.12–5.78)
Urinary tract	1 (0.2)	0	
Bacteremia	1 (0.2)	1 (0.2)	
Soft tissue	2 (0.4)	0	

\* Relative risks are for *S. aureus* infection in the mupirocin–chlorhexidine group.

† The source of the *S. aureus* infections was determined by comparing nasal strains with strains isolated from the infection site by pulsed-field gel electrophoresis.

‡ Data are for surgical patients only: 441 in the mupirocin–chlorhexidine group and 367 in the placebo group.

*Bode et al.,  
NEJM 2010; 362:9-16*

# Does Nasal Decolonization Work in Surgical Patients?



	# Studies	OR* 95% CI	Nasal Decolonization Studies (No Bundle)	No Bundle OR* 95% CI
Cardiac Studies	11	0.58 (0.45, 0.77)	6	0.64 (0.45, 0.92)
Orthopedic Studies	9	0.46 (0.33, 0.63)	4	0.50 (0.29, 0.84)
All	20	0.45 (0.34, 0.59)	10	0.53 (0.38, 0.74)

\*Pooled Random Effects Odds Ratio (OR)



# Antimicrobial Prophylaxis

- I-B recommendation

<p>Surgeries <b>requiring</b> prophylaxis</p> 	<p><u>Clean-contaminated surgery</u> requiring entry in a hollow viscus under controlled conditions;</p> <p>Some <u>clean surgeries</u> also require AP: cardiac surgery; whenever prosthetic material (intravascular, joint) is inserted and most neurosurgical operations.</p> <p>CDC, SHEA, WHO</p>
<p>Surgeries <b>not requiring</b> prophylaxis</p> 	<p>Other clean surgeries not mentioned above; dirty or contaminated wound surgeries.</p>

- Administer timed to maximize tissue concentration. Once the incision is made, delivery to the wound is impaired

# Antimicrobial Prophylaxis

- Right Agent
- Right Dose
- Right Time
- Right Duration



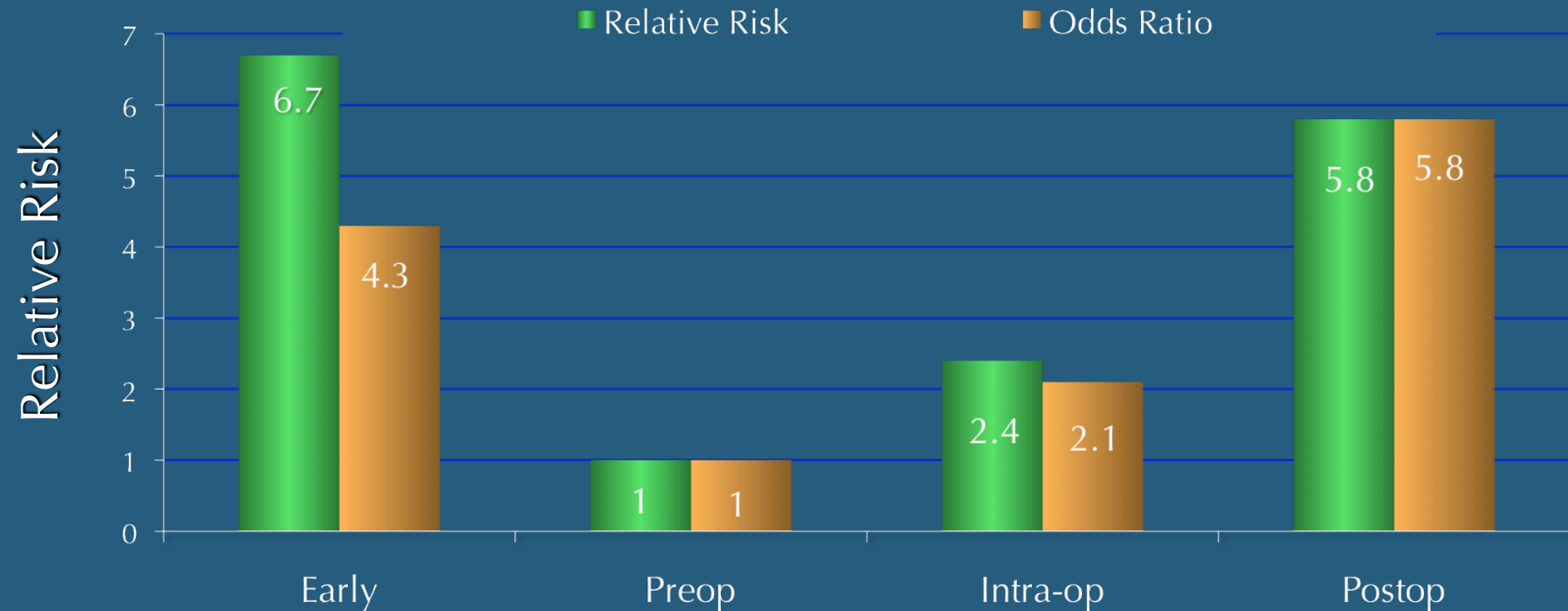
Use peri-operative antibiotic guidelines which are generally procedure specific



# Antibiotic Timing

- Antibiotics should be timed such that the bacteriocidal concentration is established in the tissue and serum (SHEA, WHO, APSIC, HK)
  - In general; administer within 1 hour prior to the incision to maximize tissue concentration
  - 2 hours for vancomycin and fluoroquinolones that must be fully infused before the procedure
- C. section (Category 1A): administer peri-operative antibiotic before skin incision
- Use oral antibiotics with mechanical bowel prep for colorectal surgery (WHO-conditional; SHEA; APSIC)

# Timing of Administration of Perioperative Prophylactic Abx



*Classen. NEJM. 1992;328:281.*

# How Much Antibiotic is Present?

	Serum levels (mg/dL)	
Timing	On call	Anesthesia
Incision	87	148
1 hour	37	57
2 hours	25	39
	Muscle levels (mg/dL)	
Incision	9	17
Wound closure	7	11
No drug detect- able	38%	14%


# Antibiotic Dose

- Weight based dosing:

-  – E.g. cefazolin use 2 grams for >80 kg; 3 grams for those > 120kg; Vancomycin 15 mg/kg

- Re-dosing:

- Re-dose based on duration of procedure

-  – Every 3-4 hours or as appropriate **based on half-life** of the agent

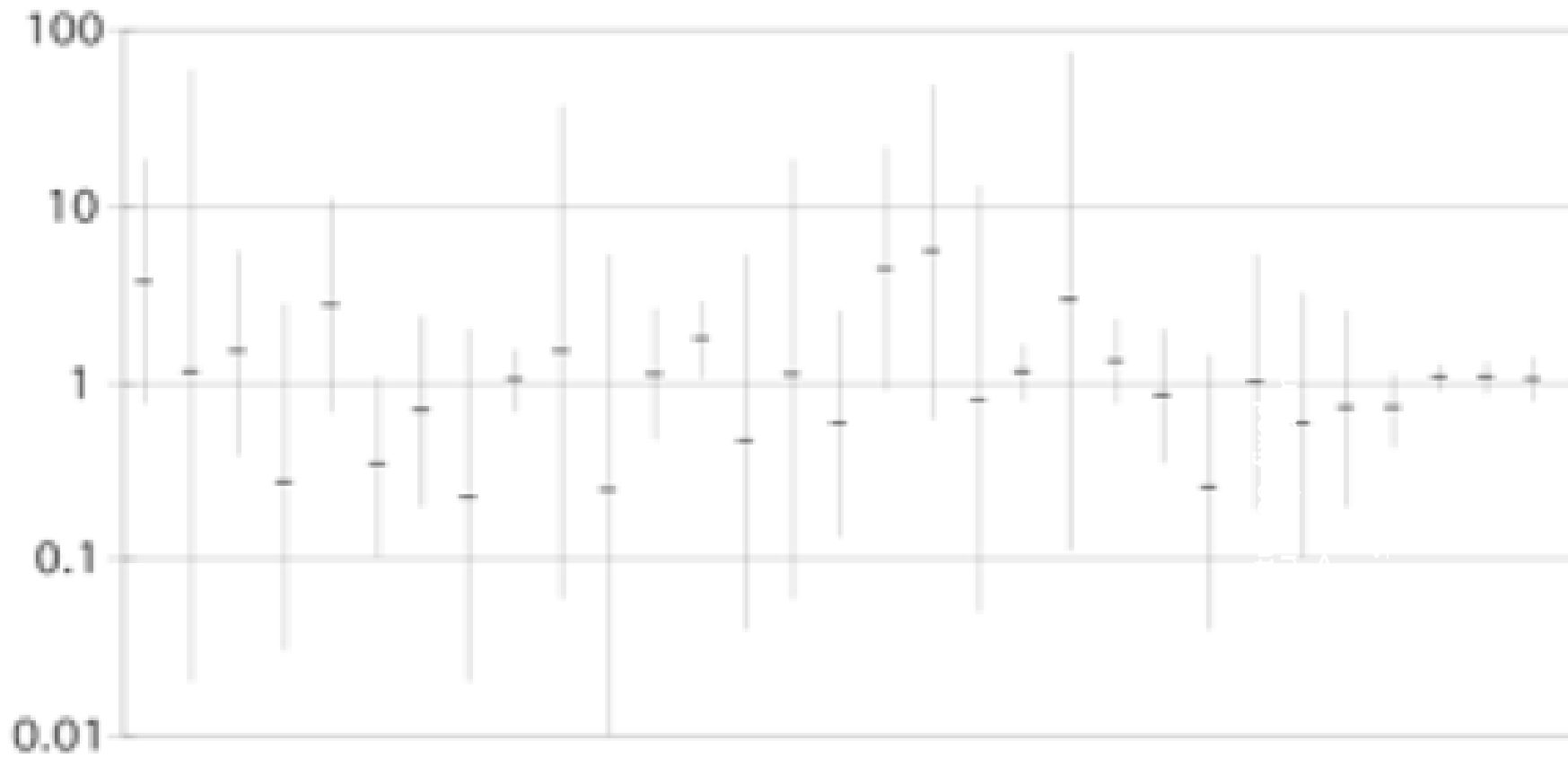
- For every 1500 ml of blood loss

SHEA Category 1; CDC-no recommendation;  
WHO silent; HK

# Single vs Multiple Dose Surgical Prophylaxis: Systematic Review

Favors multiple dose

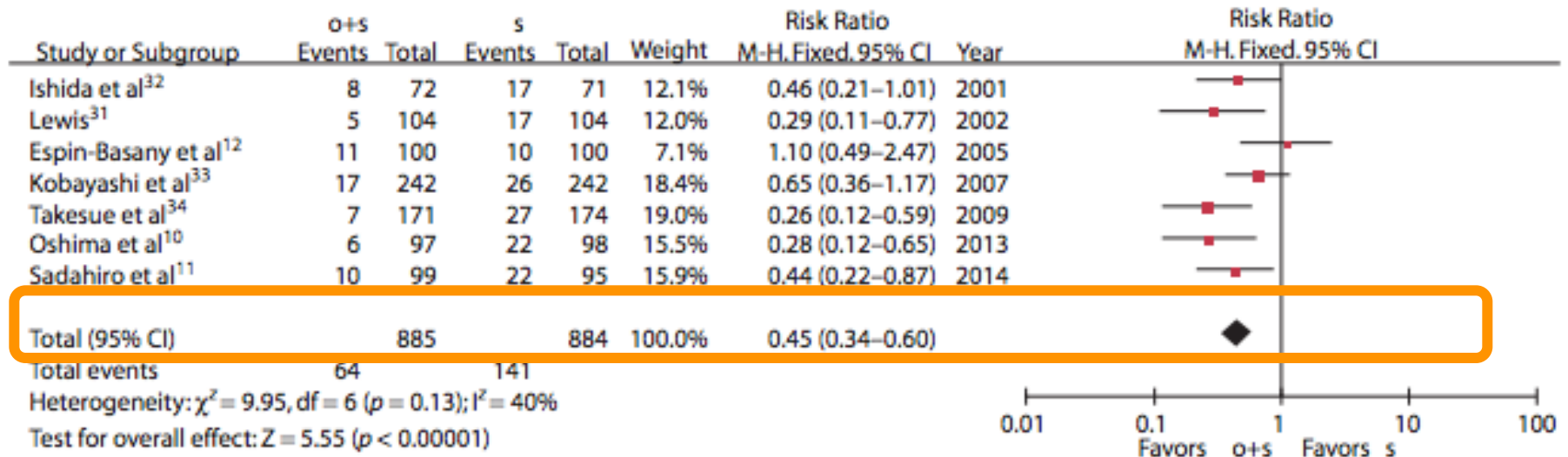
Favors single dose





# Why Oral and Systemic Abx for Colorectal Procedures

## All Surgical Procedures



- RR (95% CI) of SSI among incisional SSI: 0.38 (0.26–0.56)
- RR (95% CI) of SSI among organ space SSI: 0.85 (0.51–1.44)
- RR (95% CI) of SSI among total SSI after CRS: 0.47 (0.26–0.86)
- RR (95% CI) of SSI among patient after Ulcerative Colitis: 0.21 (0.11–0.42).

# Antibiotic Duration & Drains

- 1-A recommendation

Duration of prophylaxis



Do not administer additional prophylactic antimicrobial agent doses AFTER the surgical incision is closed in the OR even in the presence of a drain.

CDC and WHO;  
SHEA, HK uses 24 hours; APSIC 1 dose

Drains



Peri-operative prophylaxis should not be continued in the presence of a drain for the purpose of preventing infection.

CDC and WHO

# Do Repeat Doses Reduce the Risk of Infection?

- 1548 cardiac operations longer than 240 min
- 459 (30%) received repeat doses
- 276 (18%) re-dosed within 240 min
- 6 additional post-operative doses given

# Normothermia

- Maintain peri-operative normothermia  $T > 35.5^{\circ}\text{C}$  (Category 1A)

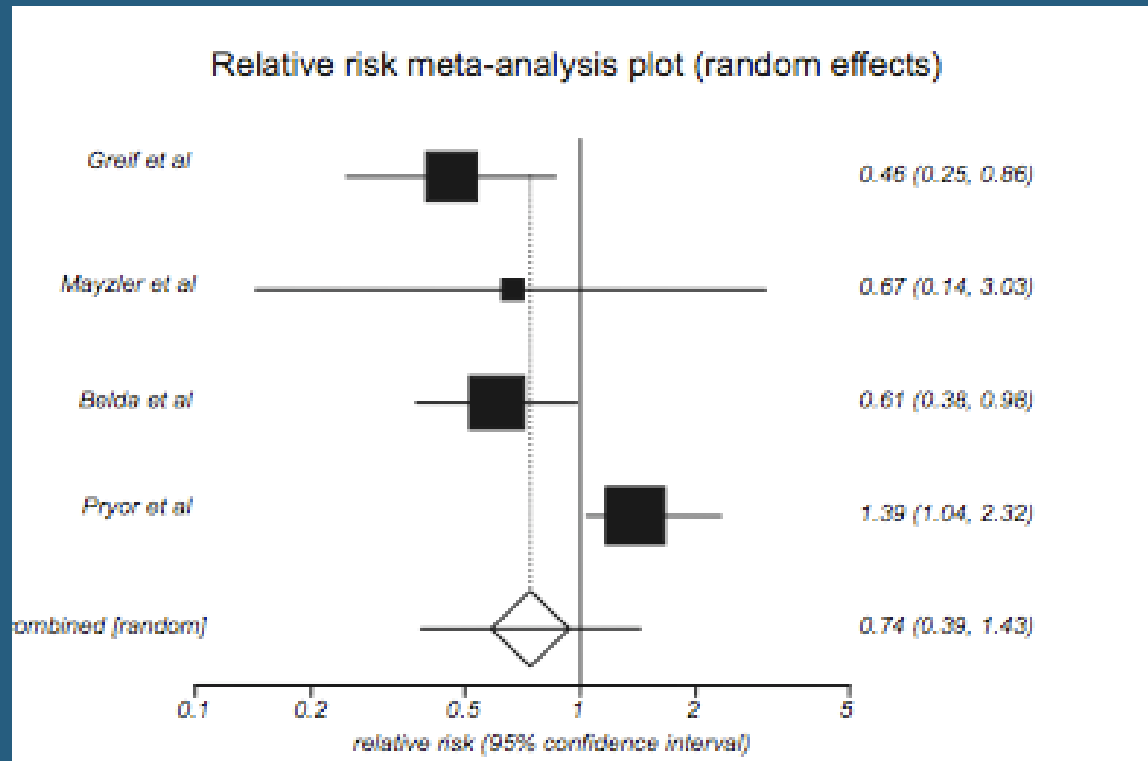


Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Active warming systems				
Infection and complications of the surgical wound	157 per 1000	57 per 1000 (31 to 104)	RR 0.36 (0.20 to 0.66)	589 (3 studies)	⊕⊕⊕⊕ low <sup>1</sup>	
Major cardiovascular complications (cardiovascular death, non-fatal myocardial infarction, non-fatal stroke, and non-fatal cardiac arrest)	63 per 1000	14 per 1000 (3 to 63)	RR 0.22 (0.05 to 1)	300 (1 study)	⊕⊕⊕⊕ low <sup>1</sup>	
All-cause mortality	16 per 1000	16 per 1000 (4 to 63)	RR 1.01 (0.26 to 4)	500 (2 studies)	⊕⊕⊕⊕ low <sup>1</sup>	
Participants transfused	291 per 1000	259 per 1000 (163 to 413)	RR 0.79 (0.50 to 1.23)	621 (8 studies)	⊕⊕⊕⊕ moderate <sup>2</sup>	
Chills/shivering	212 per 1000	83 per 1000 (59 to 115)	RR 0.39 (0.28 to 0.54)	1922 (29 studies)	⊕⊕⊕⊕ high <sup>3</sup>	

CDC, SHEA,  
APSIC (1B),  
HK, WHO

# Optimize Tissue Oxygenation

- Administer increased FIO<sub>2</sub> BOTH intra operatively and in the immediate post operative period (Category 1A). WHO explicitly advocates for 80% FIO<sub>2</sub>
- CDC, WHO, HK



# SSI: Impact of Supplemental O<sub>2</sub>

Study	FIO2-time/#	Control	High FIO2	Absolute RR	NNT
Greif	30-80; 2 hr/500	11.2	5.2	6.0	17
Pryor	35-80; 2 hr/160	11	25	14	7
Belda	30-80; 6 hr/300	24	14.9	9.1	11
All		15.2	11.5	3.7	27

# Additional Interventions to Prevent SSI

- Impervious plastic wound protectors (Category I)

Impervious plastic wound protector for GI/Biliary procedures



Use plastic wound protectors for GI and biliary surgery which can facilitate retraction of an incision during surgery

SHEA, WHO conditional recommendation and considers data low quality, APSIC suggests thought before use

- Clip, depilate or don't remove hair (Category II)

Hair removal



Do not remove hair from the operative site unless the presence of hair will interfere with the operation. Do not use razors. If hair removal is necessary remove hair outside of the OR using clippers or depilatory.

CDC, WHO, APSIC, HK








# Bottom Line on Hair Removal

- **Shaving vs no hair removal:** 17/177 (9.6%) vs 11/181 (6%), RR 1.59 (95% 0.77-3.27)
- **Shaving vs clipping:** 2.8% (46/1627) vs 1.4% (21/1566), RR=2.02 (95% 1.21,3.36)
- **Depilatory cream vs no hair removal:** 7.9% (10/126) vs 7.8% (11/141), RR 1.02 (0.45,2.31)

# Other Practices

- Category I B

Antimicrobial Solutions		Do not apply antimicrobial solutions to the surgical site (ointments, solutions, powders) CDC
Antimicrobial Sealants		Do not apply microbial sealant immediately after skin prep (not recommended by WHO; CDC Category II)
Antimicrobial Dressings		Uncertain evidence supporting antimicrobial dressings CDC-No recommendation
Dressings		There is no evidence supporting the use of advanced dressings for wounds closed primarily (WHO, APSIC)
Negative-pressure wound therapy		Uncertain evidence supporting antimicrobial dressings (WHO- Conditional recommendation; APSIC not recommended routinely)

# Interventions to Prevent SSI

## Category II-recommendations

?

- Do not use plastic adhesive drapes with or  without antimicrobial properties—WHO, CDC (Category II)

?

- Intra-operative irrigation of deep or subcutaneous tissues with aqueous iodophor in contaminated or dirty operations-CDC (II), APSIC (IIC)

?

- ✓ • Goal directed fluid therapy to reduce the risk of SSI (WHO, APSIC (IA))

# Normovolemia: New Data

**Table 3. Primary and Secondary Outcomes.\***

Outcome	Restrictive Fluid (N = 1490)	Liberal Fluid (N = 1493)	Hazard or Risk Ratio (95% CI) <sup>†</sup>	P Value
<b>Primary outcome</b>				
Disability-free survival at 1 yr — no. (%) <sup>‡</sup>	1223 (81.9)	1232 (82.3)	1.05 (0.88–1.24)	0.61
Death or persistent disability — no.	267	261		
Death	95	96		
Persistent disability	172	165		
<b>Secondary outcomes<sup>§</sup></b>				
Composite septic outcome or death — no./total no. (%) <sup>¶</sup>	323/1481 (21.8)	295/1487 (19.8)	1.10 (0.96–1.27)	0.19
Surgical-site infection — no./total no. (%)	245/1481 (16.5)	202/1487 (13.6)	1.22 (1.03–1.45)	0.02 <sup>  </sup>
Sepsis — no./total no. (%)	157/1481 (10.6)	129/1487 (8.7)	1.22 (0.98–1.52)	0.08
Anastomotic leak — no./total no. (%)	49/1481 (3.3)	35/1487 (2.4)	1.41 (0.92–2.16)	0.12
Pneumonia — no./total no. (%)	54/1481 (3.6)	57/1487 (3.8)	0.95 (0.66–1.37)	0.79
Acute kidney injury — no./total no. (%) <sup>**</sup>	124/1443 (8.6)	72/1439 (5.0)	1.71 (1.29–2.27)	<0.001
Renal-replacement therapy — no./total no. (%)	13/1460 (0.9)	4/1462 (0.3)	3.27 (1.01–13.8)	0.048 <sup>  </sup>
Pulmonary edema — no./total no. (%)	20/1481 (1.4)	32/1487 (2.2)	0.63 (0.36–1.09)	0.10
Unplanned admission to ICU — no./total no. (%)	161/1487 (10.8)	145/1491 (9.7)	1.11 (0.90–1.38)	0.32
Median peak serum lactate level (IQR) — mmol per liter <sup>††</sup>	1.6 (1.1–2.5)	1.6 (1.1–2.4)	NA	NA
Median C-reactive protein level on day 3 (IQR) — mg per liter <sup>‡‡</sup>	136 (82–198)	133 (80–200)	NA	0.66
Median duration of mechanical ventilation (IQR) — hr <sup>§§</sup>	17 (5–65)	14 (3–31)	NA	0.07
Median score on quality-of-recovery scale (IQR) <sup>¶¶</sup>	106 (89–121)	107 (90–122)	NA	0.31
Median duration of stay in HDU or ICU (IQR) — days <sup>  </sup>	1.8 (1.0–3.1)	1.4 (0.9–2.9)	NA	0.13
Median duration of hospital stay (IQR) — days	6.4 (3.6–10.6)	5.6 (3.6–10.5)	NA	0.26
<b>Death — no. (%)<sup>‡</sup></b>				
At 90 days	31 (2.1)	18 (1.2)	1.73 (0.97–3.10)	0.06
At 12 mo	95 (6.5)	96 (6.6)	1.03 (0.78–1.36)	0.86

# Interventions to Prevent SSI

## Category II-recommendations

- ① • Consider use of triclosan-coated sutures (CDC, WHO)
- ② • Consider the use of antimicrobial impregnated sutures (APSIC IIB in the setting of high SSI)
- ③ • Use plastic adhesive drapes with or without antimicrobial properties
- ④ • Intra-operative irrigation of deep or subcutaneous tissues with aqueous iodophor in contaminated or dirty operations



# What to Wear

## Naked Surgeons? The Debate About What to Wear in the Operating Room

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There has been recent controversy regarding recommendations and regulations concerning operating room attire. We performed a nonsystematic literature search regarding operating room attire and surgical site infection (SSI) risk. Much of the literature relies on air sampling and culture of operating room equipment but does not present evidence regarding effect on SSI risk. There is no evidence regarding SSI risk related to operating room attire except for sterile gowns and the use of gloves. Naked surgeons shed fewer bacteria into the operating room environment than ones wearing scrub suits.

**Keywords.** operating room; surgical site infection; attire; contamination; head gear.

Appropriate gloving	All members of the operative team should double glove and change gloves when perforations occur (SHEA-Category III, HK)
Surgical gowns	Use surgical gowns (reusable woven) (WHO-Category III; APSIC IIIC, HK)

# Facility Interventions to Prevent SSI

## Category II-recommendations

- Use of Laminar flow is NOT needed for THR/TKR (WHO; HK, APSIC IIC)

## Category III-recommendations

- Follow the AIA recommendations for proper air handling in the OR
- Minimize OR Traffic (HK, APSIC IIIC)
- Use approved hospital disinfectant



# Do Patient Care Pathways Work?

- Before (n=808) and after (n=674) evaluation of a QA/QI initiative to improve peri-incisional abx administration, tight glucose control and hair removal with clippers among patients undergoing CABG
- SSI decreased from 3.5% to 1.5% ( $p=0.001$ , OR=0.21)
- Predictors of infection included DM ( $p=0.001$ , OR=4.71), female gender ( $p=0.001$ , OR=2.83) and wound class II ( $p=0.04$ , OR=2.07)
- Limitation is the quasi experimental design without concurrent control groups

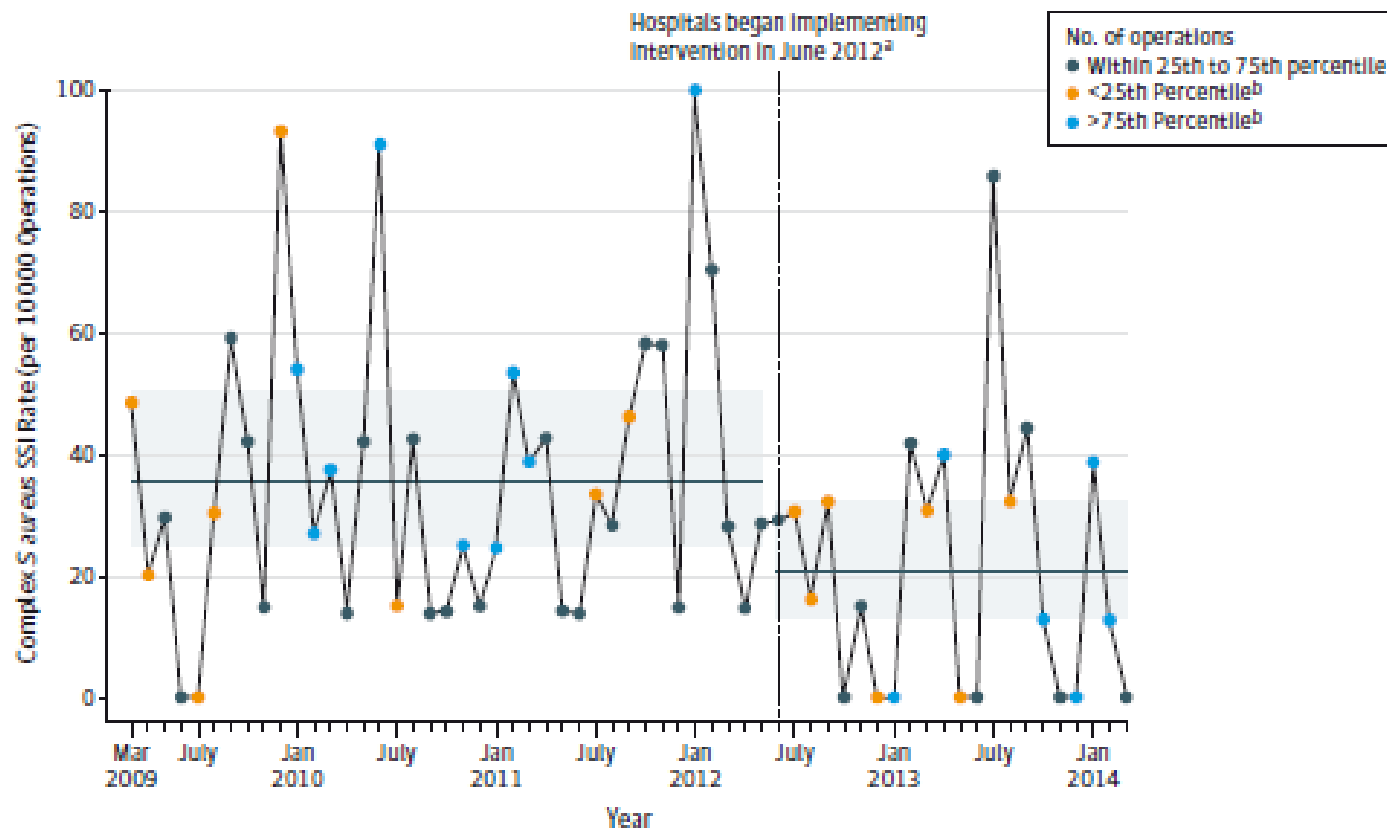
# Intervention

- Patients whose preoperative nares screens had MRSA or MSSA applied mupirocin intranasally BID for up to 5 days and to bathe daily with CHG for up to 5 days before their operations
- MRSA carriers received vancomycin and cefazolin or cefuroxime for perioperative prophylaxis; all others received cefazolin or cefuroxime.
- Patients who were MRSA-negative and MSSA-negative bathed with CHG the night before and morning of their operations.
- Patients were treated as MRSA-positive if screening results were unknown.

# Methods and Outcome

- 20 hospitals in 9 US states participated
- Rates of SSIs were collected for a median of 39 months (range, 39-43) during the pre-intervention period and a median of 21 months (range, 14-22) during the intervention period
- Outcome of interest: Complex (deep incisional or organ space) *S.aureus* SSIs.

Figure 1. Pooled Rate of Complex *Staphylococcus aureus* Surgical Site Infections (SSIs) by Admission Month

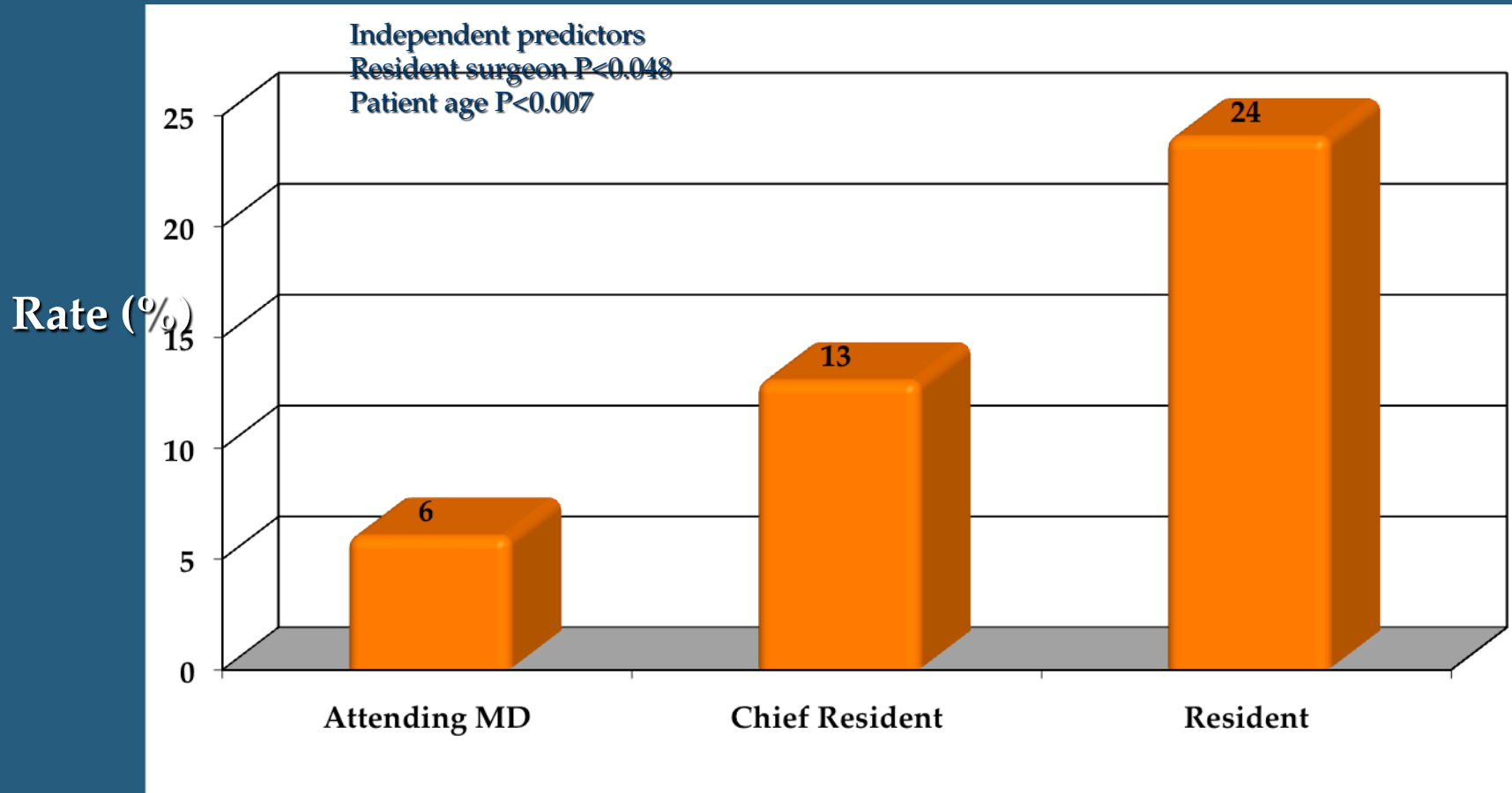


# Closing Thoughts

- SSI are associated with significant morbidity and costs
- Risk factors for infection can drive evidence based practice which will require measurement of outcomes and processes
- Surveillance and checklists work!
- Evidence based best practice should be implemented.
  - Reduce the risk of contamination-appropriate use of perioperative antimicrobial prophylaxis and use appropriate skin prophylaxis.
  - Prevent hyperglycemia--Glucose control
  - Reduce Hypothermia--Temperature control
  - ? Oxygenation
  - Decrease endogenous colonization--Decolonization
- “Bundled” interventions work!

# Extra Slides

# Endometritis: Surgeon Experience

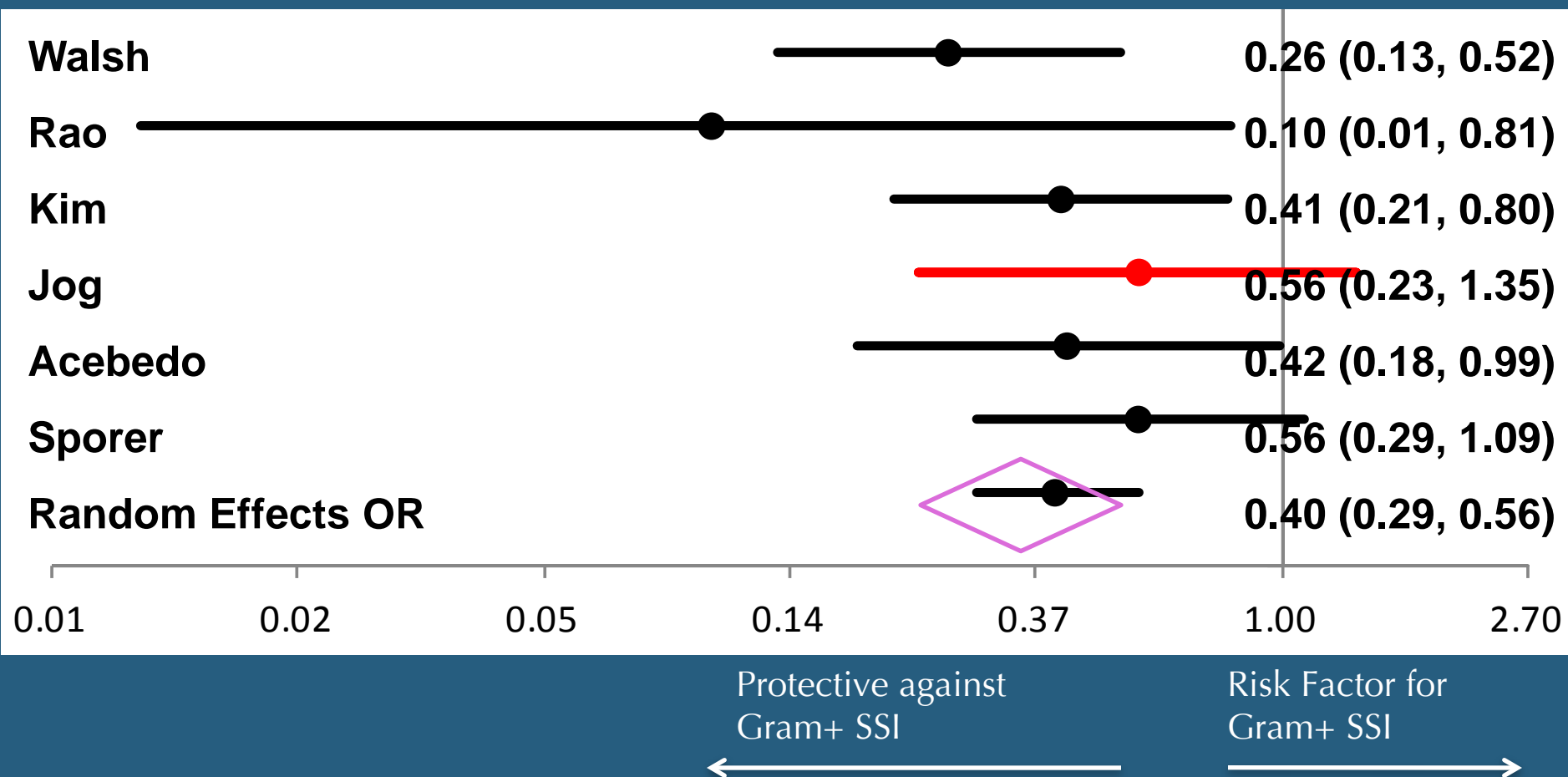


Miller et al  
SGO 1987

Primary surgeon



# Decolonization + Glycopeptide for MRSA Carriers



# Selective Decolonization

Research

## Original Investigation

### Association of a Bundled Intervention With Surgical Site Infections Among Patients Undergoing Cardiac, Hip, or Knee Surgery

Marin L. Schweizer, PhD; Hsiu-Yin Chiang, MS, PhD; Edward Septimus, MD; Julia Moody, MS; Barbara Braun, PhD; Joanne Hafner, RN, MS; Melissa A. Ward, MS; Jason Hickok, MBA, RN; Eli N. Perencevich, MD, MS; Daniel J. Diekema, MD; Cheryl L. Richards, MJ, LPN, LMT; Joseph E. Cavanaugh, PhD; Jonathan B. Perlin, MD, PhD; Loreen A. Herwaldt, MD

Schweizer et al. *JAMA*. 2015;313(21):2162-2171

# Results

Table 2. Poisson Regression Analysis of Monthly Rates of Complex *Staphylococcus aureus* Surgical Site Infections per 10 000 Operations

	Preintervention Period		Intervention Period		Rate Ratio for Bundled Intervention (95% CI)	P Value
	No. of Operations	Mean Rate (95% CI)	No. of Operations	Mean Rate (95% CI)		
All operations	28 218	36 (25-51)	14 316	21 (13-32)	0.58 (0.37-0.92) <sup>a</sup>	.02
Urgent/emergent			1189	37 (15-88)	1.03 (0.41-2.57) <sup>a</sup>	.95
Scheduled			13 127	20 (13-30)	0.55 (0.35-0.86) <sup>a</sup>	.009
Cardiac operations	7576	46 (26-82)	3257	40 (23-70)	0.86 (0.47-1.57) <sup>b</sup>	.63
Urgent/emergent			571	67 (32-137)	1.44 (0.53-3.91) <sup>b</sup>	.48
Scheduled			2686	33 (18-62)	0.72 (0.45-1.15) <sup>b</sup>	.17
Hip or knee arthroplasties	20 642	32 (21-48)	11 059	15 (10-24)	0.48 (0.29-0.80) <sup>c</sup>	.005
Urgent/emergent			618	14 (3-75)	0.44 (0.07-2.72) <sup>c</sup>	.38
Scheduled			10 441	16 (10-26)	0.51 (0.30-0.85) <sup>c</sup>	.009

Abbreviations: SSI, surgical site infection.

<sup>a</sup> Compared with the monthly rates of complex *S aureus* SSIs after all operations performed during the preintervention period.

<sup>b</sup> Compared with the monthly rates of complex *S aureus* SSIs after all cardiac operations performed during the preintervention period.

<sup>c</sup> Compared with the monthly rates of complex *S aureus* SSIs after all hip or knee arthroplasties performed during preintervention period.