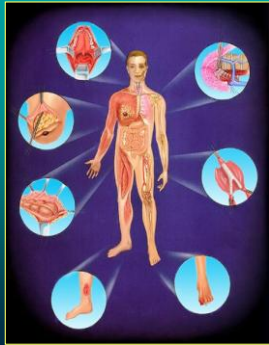


## CHG Irrigation, Skin Antisepsis and Patient Bathing: Is There a Risk Reduction Benefit?

Charles E. Edmiston Jr, PhD, CIC  
 Professor of Surgery & Hospital Epidemiologist -  
 Department of Surgery Medical College of Wisconsin  
 Milwaukee, Wisconsin USA  
 edmiston@mcm.edu



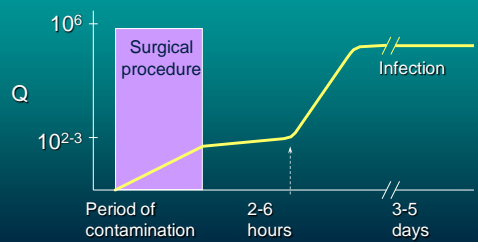
## "The Solution to Pollution is Dilution"



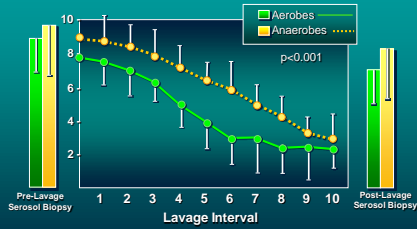
## Evidence-Based Hierarchy



## Kinetics of Bacterial Growth in a Surgical wound

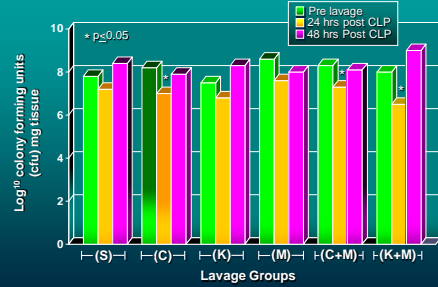


### Impact of Saline Lavage on Microbial Recovery from the Peritoneal Vault 24-Hours Post-Gut Injury

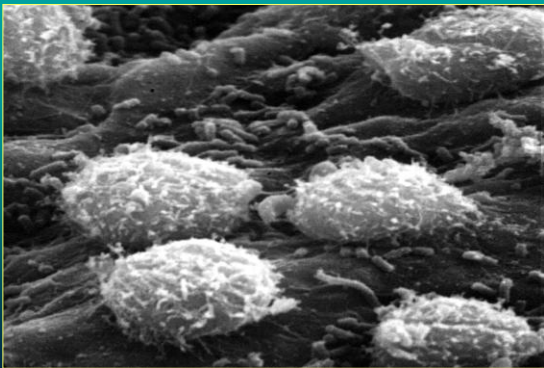


Edmston CE, et al. World J Surg 1990;14:176-183

### Impact of Antibiotic Lavage on Microbial Adherence to Serosal Mesothelium



Edmston CE, et al. World J Surg 1990;14:176-183



Edmston CE, et al. World J Surg 1990;14:176-183

### Topical Antibiotic Irrigation Literature by Service (1958-2009)

Ortho	3	2,736
Neuro	8	8,867
Gen	7	4,934
ENT	1	62
OB-GYN	2	394
Vasc	1	1,074
Transplant	1	354
Plastics	2	771
ER	1	260
Total	26	19,452

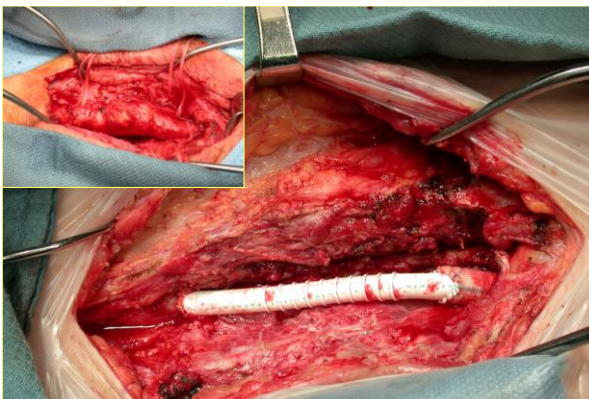
## Literature Review

- Several well designed trials demonstrated no benefit in infection rates with prophylactic local antibiotic
  - Simmons 2001- IV Abx same as IV+local Abx
  - Moesga 1989- IV Abx same as IV+local Abx
  - Anglen 2005- Local Abx same as saline

Strength of Analysis	Weak Study Design	Strong Study Design
<b>Total</b>	<b>23</b>	<b>3</b>
<b>Support Abx Irrigations</b>	<b>19</b>	<b>1</b>
<b>Oppose Abx Irrigations</b>	<b>4</b>	<b>2</b>

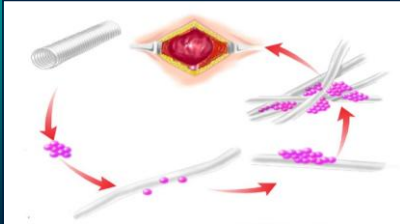
## Antiseptic Irrigation

- Takesue Y et al. Application of an electrolyzed strongly acidic aqueous solution before wound closure in colorectal surgery, *Dis Colon Rectum* 2011;54:826  
*Trend towards less SSI - Solution impairs wound healing*
- Mohd AR et al. Dermacyn irrigation in reducing infection of a median sternotomy wound. *Heart Surg Forum* 2010;13:E228  
*Dermacyn superior to povidone iodine irrigation*
- Rice DC. Intraoperative topical tetracycline sclerotherapy following mastectomy: A prospective, randomized trial. *J Surg Oncol* 2000;73:224  
*Tetracycline irrigation is not effective - similar to normal saline*
- White RR. Pharmacokinetics of topical and intravenous cefazolin in patients with clean surgical wounds. *Plast Reconstr Surg* 2008;122:1773  
*Higher tissue concentration of cefazolin irrigation and IV than IV alone*
- Tijerina J. Effectiveness of a systemic antibiotic followed by topical ionized solution as surgical site infection prophylaxis. *J Int Med Res* 2010;38:287  
*Trend towards less SSI in non perforated appendicitis*



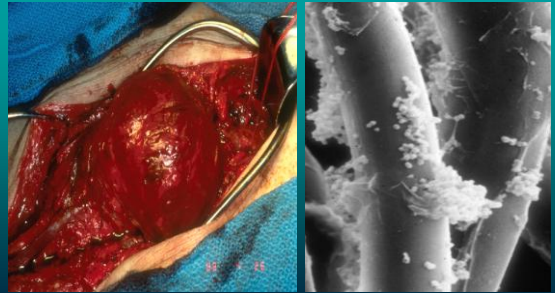
### Anastomotic femoral pseudoaneurysm: An investigation of occult infection as an etiologic factor

Gary R. Seabrook, MD, David D. Schmitt, MD, Dennis F. Bandyk, MD, Charles E. Edmiston, PhD, Candace J. Krepel, BS, M(ASCP), and Jonathan B. Towne, MD, Milwaukee, Wis.

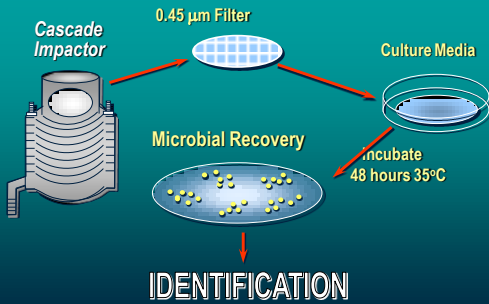


Seabrook & Edmiston, Critical Care Infectious Diseases 2001; 975-888

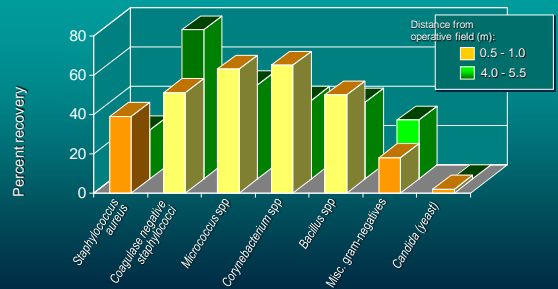
### Late-Onset Vascular Graft Infection



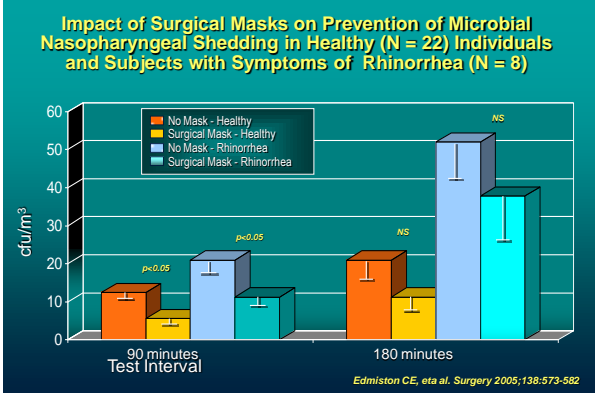
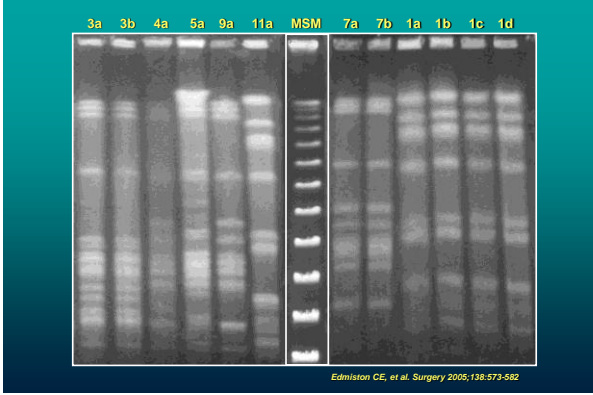
Slime-Forming *Staphylococcus epidermidis*



### Percent Intraoperative Recovery of Airborne Microbial Populations During Vascular Surgery (N=70)



Edmiston CE, et al. Surgery 2005;138:573-582



### The Surgical Wound

**Stage 1 (initial response)**  
 Coagulation proteins  
 Platelets  
 Mast cells  
 Complement  
 Bradykinins

↓  
 Increased vascular permeability  
 Mobilization of phagocytic cells

**Stage 2 (>24-hours)**  
 Monocytes (scenarios)  
 - wound healing  
 - proinflammatory  
 TNF- $\alpha$ , IL-1, IL-6  
 O<sub>2</sub> – intermediates  
 tissue injury

↓  
 Mobilization of phagocytic cells

### Impact of Intraoperative Irrigation on Resolution of Mesh Contaminated Animal Model

Study Group	Irrigation Fluid	Bacterial Isolates	Initial Challenge	Study Population, N = animals at 7 days
1	Saline (Control)	MRSA	-3.7 log <sub>10</sub> CFU	8
2	0.05% CHG*	MRSA	-3.7 log <sub>10</sub> CFU	8

Study Group	Positive Recovery at 7 days (log <sub>10</sub> CFU)	Negative Recovery at 7 day (log <sub>10</sub> CFU)	Biofilm Formation (log <sub>10</sub> CFU)
Saline	8/8, 4.26 log <sub>10</sub> CFU	No, 0/8	8/8, 6.3 log <sub>10</sub> CFU
0.05% CHG	1/8, 1.8 log <sub>10</sub> CFU p<0.001	Yes, 7/8	2/8, 2.6 log <sub>10</sub> CFU p<0.01

\* IriSept®

Edmiston CE, et al. ACS 2012

## Impact of 0.05% (Irrisept®) CHG to Inhibit Bacterial Adherence To Prosthetic Device Surfaces<sup>a</sup>

Materials	E. coli	Organisms (log <sub>10</sub> CFU/cm <sup>2</sup> )		
		RP 62 A <sup>b</sup>	MRSA <sup>c</sup>	MSSA <sup>d</sup>
Graft – PTFE	4.4 vs 0.8	6.8 vs 2.2	5.4 vs 1.9	5.6 vs 1.1
Graft – Dacron	6.0 vs 1.8	6.5 vs 1.6	6.4 vs 1.2	6.6 vs 1.3
Mesh – Polyester (s) <sup>e</sup>	6.3 vs 1.5	7.0 vs 2.1	6.8 vs 2.0	7.1 vs 2.2
Mesh – Polyester (r) <sup>f</sup>	6.1 vs 1.7	6.1 vs 2.2	7.1 vs 2.8	7.5 vs 2.6
Mesh – Polyester/absorbable hydrophilic film	6.0 vs 0	5.6 vs 0	6.8 vs 1.5	6.0 vs 1.4
Mesh – Polyester/polylactic acid	5.1 vs 1.8	6.1 vs 2.4	5.5 vs 1.0	5.9 vs 1.9

<sup>a</sup> bacterial suspension = 8.0 log<sub>10</sub> cfu/ml

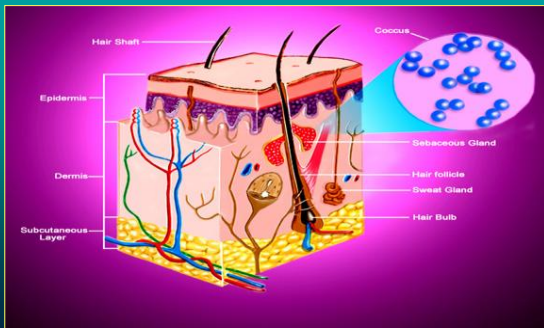
<sup>b,c,d</sup> RP 62A, *S. epidermidis*; MRSA, methicillin-resistant *S. aureus*; MSSA, methicillin-sensitive *S. aureus*

<sup>e,f</sup> s = soft; r = rigid

## Local Antibacterial Administration Clean Wounds

Author/Year	Study	Benefit Y/N
Praveen S -2009	Local antibiotics are equivalent to intravenous antibiotics in the prevention of superficial wound infection in inguinal hernioplasty.	N
Musella M -2001	Collagen tampons as aminoglycoside carriers to reduce postoperative infection rate in prosthetic repair of groin hernias.	Y
Bennett-Guerrero E -2010	Gentamicin-collagen sponge for infection prophylaxis on sternal wound infections following cardiac surgery: a randomized trial.	N
Eklund AM -2007	Prevention of sternal wound infections with locally administered gentamicin.	N
Friberg O -2007	Local collagen-gentamicin for prevention of sternal wound infections: The LOGIP trial.	Y
Almdahl SM -2011	Randomized prospective trial of saphenous vein harvest site infection after wound closure with and without topical application of autologous platelet-rich plasma	N
Yetim I - 2010	Effect of local gentamicin application on healing and wound infection in patients with modified radical mastectomy: A prospective randomized study.	Y

## Risk Reduction Begins on the Front End

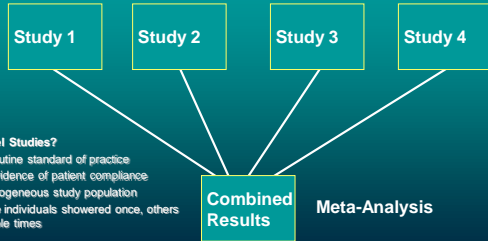


## Microbial Ecology of Skin Surface

- Scalp 6.0 Log<sub>10</sub> cfu/cm<sup>2</sup>
- Axilla 5.5 Log<sub>10</sub> cfu/cm<sup>2</sup>
- Abdomen 4.3 Log<sub>10</sub> cfu/cm<sup>2</sup>
- Forearm 4.0 Log<sub>10</sub> cfu/cm<sup>2</sup>
- Hands 4.0-6.6 Log<sub>10</sub> cfu/cm<sup>2</sup>
- Perineum 7.0-11.0 Log<sub>10</sub> cfu/cm<sup>2</sup>

Surgical Microbiology Research Laboratory 2008 – Medical College of Wisconsin

## Revisiting the Preadmission (Preoperative) Shower



### 7 Sentinel Studies?

- No routine standard of practice
- No evidence of patient compliance
- Heterogeneous study population
- Some individuals showered once, others multiple times

Webster J, Osborne S. *The Cochrane Collaboration. The Cochrane Library*, 2009;4:1-34.

## Mean Chlorhexidine Gluconate (CHG) Skin Surface Concentrations ( $\mu\text{g/ml} \pm \text{SD}$ ) Compared to $\text{MIC}_{90}$ (5 $\mu\text{g/ml}$ ) for Staphylococcal Surgical Isolates Including MRSA<sup>a</sup>

Groups	Subgroups (mean C, $\mu\text{g/ml}$ )			[C <sub>CHG</sub> /MIC <sub>90</sub> ]	p-value
	Pilot <sup>b</sup> (4%)	1 (4% Aqueous)	2 (2% Cloths)		
Group A (20) evening (1X)	3.7 $\pm$ 2.5	24.4 $\pm$ 5.9	436.1 $\pm$ 91.2	0.9 4.8 87.2	<0.001
Group B (20) morning (1X)	7.8 $\pm$ 5.6	79.2 $\pm$ 26.5	991.3 $\pm$ 58.2	1.9 15.8 198.2	<0.0001
Group C (20) both (2X)	9.9 $\pm$ 7.1	126.4 $\pm$ 19.4	1745.5 $\pm$ 204.3	2.5 25.3 349.1	<0.0001

<sup>a</sup> N = 90

<sup>b</sup> Pilot group N = 30

Edmiston et al. *J Am Coll Surg* 2008;207:233-239  
Edmiston et al. *AORNJ* 2010;92:509-518

## Presurgical Skin Preparations as a Pathway to Improving Surgical Outcomes

- Reducing the risk of SSI in orthopaedic surgery
  - Standardized precleansing initiative (CHG cloths) in total joint patients (night before/morning of surgery)
  - SSI rate prior to intervention – 3.2% (N=727)
  - SSI rate post intervention – 1.6% (N=824) 50% reduction  
*Elselt – Orthopaedic Nursing 2009;28:141-145*
- Bundling risk reduction strategies – Quality initiative
  - MRSA prescreening in orthopaedic, obstetric, bariatric patients – decolonization
  - Presurgical antiseptics (CHG cloths) prior to surgery
  - Preintervention SSI rate 1.6% (N=17/1,095) vs postintervention SSI rate 0.57% (N=7/1,225) >60% reduction
  - MRSA SSI rate 0.73% vs 0.16% >75% reduction  
*Lipke VL, Hyatt AS. AORNJ 2010;82:288-296*

## Institutional Prescreening for Detection and CHG Eradication of Methicillin Resistant *Staphylococcus aureus* in Patients Undergoing Elective Orthopaedic Surgery

	Study Period 6/2006-9/2007	Control Period 10/2005-6/2006	p value
N	7019	5293	
MRSA Infection	4 (0.06%)	10 (0.18%)	0.0315
MSSA Infection	9 (0.13%)	14 (0.26%)	0.0937
Total SSIs	13 (0.18%)	24 (0.46%)	0.0093

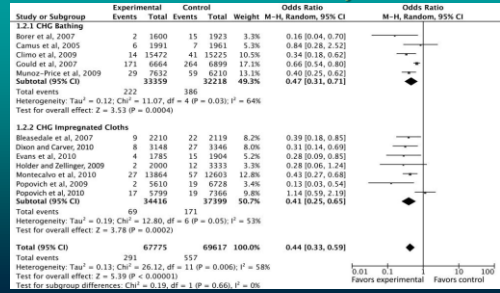
Kim DH, Spencer M, Davidson SM, et al. *J Bone Joint Surg Am* 2010;92:1820-1826

## Evidence Supporting Selected Uses of Chlorhexidine for Infection Control.

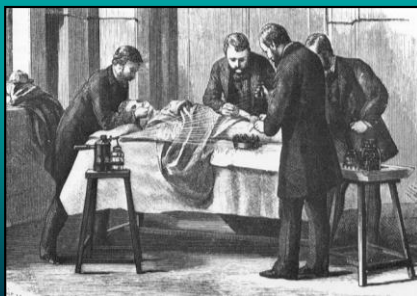
Intervention	Comparison or Outcome of Interest	Reference
Hand hygiene	Alcohol-based hand rub vs. Soap and water	1
Hand hygiene	Chlorhexidine hand rub vs. Soap and water	2
Hand hygiene	Chlorhexidine hand rub vs. Alcohol-based hand rub	3
Hand hygiene	Chlorhexidine hand rub vs. Soap and water	4
Hand hygiene	Chlorhexidine hand rub vs. Alcohol-based hand rub	5
Hand hygiene	Chlorhexidine hand rub vs. Soap and water	6
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Hand hygiene	Chlorhexidine hand rub vs. Alcohol-based hand rub	99
Hand hygiene	Chlorhexidine hand rub vs. Soap and water	100

Millstone AM, et al. Clin Infect Dis. 2008;46:274-281

## The Efficacy of Daily Bathing with Chlorhexidine for Reducing Healthcare-Associated Bloodstream Infections: A Meta-Analysis



O'Horo JC, et al. Infect Control Hosp Epidemiol 2012;33:257-267



LISTER CARBOLIC ACID SPRAY AS ANTISEPTIC PRECAUTION  
Wood Engraving - William Watson Cheyne, 1882 - National Library of Medicine

## Mechanism and Spectrum of Activity for Commonly Used Antiseptics

Agent	Mechanism of action	Gram positive bacteria	Gram negative bacteria	Rapidity of action	Residual activity
Alcohol	Denature proteins	Excellent	Excellent	Most rapid	None
Chlorhexidine	Disrupt cell wall	Excellent	Good	Intermediate	Excellent
Iodine/iodophors	Oxidation/substitution by free iodine	Excellent	Good	Intermediate	Minimal
PCMX	Disrupt cell wall	Good	Fair	Intermediate	Good
Triclosan	Disrupt cell wall	Good	Good	Intermediate	Excellent

Mangram AJ, et al. Am J Infect Control 1999;27:97-132



ORIGINAL ARTICLE  
 INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY  
**Effects of Preoperative Skin Preparation on Postoperative Wound Infection Rates: A Prospective Study of 3 Skin Preparation Protocols**  
 Brian R. Swenson, MD, MS; Traci L. Hedrick, MD; Rosemarie Metzger, MD; Hugo Bonatti, MD; Timothy L. Pruett, MD; Robert G. Sawyer, MD

- Single-center, non-randomized, unblinded Phase IV Study of 3 Antiseptic Preparations
- Sequential implementation design (6 month periods)
  - Period 1: Povidone-iodine scrub-paint combination (Betadine) with an isopropyl alcohol application between these steps
  - Period 2: 2% chlorhexidine/70% isopropyl alcohol (ChloroPrep)
  - Period 3: Iodine povacrylex in isopropyl alcohol (DuraPrep)
- SSIs tracked for 30 days
- Primary outcome was overall rate of SSIs by 6-month period performed in an intent-to-treat manner

Swenson BR, et al. *Infect Control Hosp Epidemiol.* 2009;30:964-971.

## SSIs and Wound Classifications by Antiseptic Preparation

N=3,209 General Surgical Cases

Variable	No. of SSIs	No. of surgical procedures	Povidone-iodine (n = 1,514 procedures)	Chlorhexidine (n = 827 procedures)	Iodine povacrylex (n = 794 procedures)	P*
<b>SSIs</b>						
All <sup>a</sup>	178	...	72 (4.8)	68 (8.2)	38 (4.8)	.001
Superficial	120	...	49 (3.2)	45 (5.4)	26 (3.3)	.019
Deep	11	...	6 (0.4)	4 (0.5)	1 (0.1)	.49
Organ/space	49	...	18 (1.2)	19 (2.3)	12 (1.5)	.12
<b>Wound classification</b>						
Clean	...	1,154	6/714 (0.84)	5/224 (2.2)	3/216 (1.4)	.21
Clean-contaminated	...	1,409	44/541 (8.1)	46/454 (10.1)	27/414 (6.5)	.15
Contaminated	...	204	9/82 (11.0)	5/65 (7.7)	6/57 (10.5)	.78
Dirty	...	278	13/150 (8.7)	12/77 (15.6)	2/51 (3.9)	.076

Swenson BR, et al. *Infect Control Hosp Epidemiol.* 2009;30:964-971.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

### Chlorhexidine-Alcohol versus Povidone-Iodine for Surgical-Site Antisepsis

Rabih O. Darouiche, M.D., Matthew J. Wall, Jr., M.D., Kamal M.F. Itani, M.D., Mary F. Otterson, M.D., Alexandra L. Webb, M.D., Matthew M. Carrick, M.D., Harold J. Miller, M.D., Samir S. Awad, M.D., Cynthia T. Crosby, B.S., Michael C. Mosier, Ph.D., Atef AlSharif, M.D., and David H. Berzler, M.D.

N ENGL J MED 362:1 NEJM.ORG JANUARY 7, 2010

#### DESIGN: A PROSPECTIVE, RANDOMIZED, MULTICENTER CLINICAL TRIAL OF 2% CHLORHEXIDINE GLUCONATE / 70% ISOPROPYL ALCOHOL (Alc-CHG) VS Povidone-IODINE (PI) FOR PREVENTION OF SSI

Multi Center: Michael E. DeBakey Veterans Affairs Medical Center, Ben Taub General Hospital, Houston, Veterans Affairs Medical Center, Boston, Medical College of Wisconsin, Milwaukee; Veterans Affairs Medical Center, Atlanta, Baylor College of Medicine, Houston

- Patients > 18 years, undergoing clean-contaminated procedures (gastrointestinal, thoracic, urologic and gynecologic)
- N = 849 surgical patients: 409 Alc-CHG vs 440 PI
- 1:1 randomization
- Patients monitored for 30 days post-op
- Overall rate of SSI was significantly reduced in Alc-CHG vs PI groups: 9.5% vs 16.1%,  $p=0.004$
- Significant difference for both superficial incisional site rate: 4.2% A-CHG vs 8.6% PI ( $p=0.008$ ) and deep incisional: 1% A-CHG vs 3% PI ( $p=0.05$ )
- No significant adverse events noted during the study in either group
- Alc-CHG superior to PI in reducing the risk of SSI in clean-contaminated procedures

New England Journal of Medicine 2010;362:18-26

## Antimicrobial Sealants

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*No benefit of applying cyanoacrylate prior to incision (N)*
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