Infection Control for the Surgeon

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Nosocomial Infections

- 5-10% of patients admitted to acute care hospitals acquire infections
  - 2 million patients/year
  - ¼ of nosocomial infections occur in ICUs
  - 90,000 deaths/year
  - Attributable annual cost: $4.5 – $5.7 billion
    - Cost is largely borne by the healthcare facility not 3rd party payors

Weinstein RA. Emerg Infect Dis 1998;4:416-420.
Jarvis WR. Emerg Infect Dis 2001;7:170-173.

Nosocomial Infections

- 70% are due to antibiotic-resistant organisms
- Invasive devices are more important than underlying diseases in determining susceptibility to nosocomial infection

Burke JP. New Engl J Med 2003;348:651-656.
Safdar N et al. Current Infect Dis Reports 2001;3:487-495.

Attributable Costs of Nosocomial Infections

	Cost per Infection
Wound infections	$3,000 - $27,000
Sternal wound infection	$20,000 - $80,000
Catheter-associated BSI	$5,000 - $34,000
Pneumonia	$10,000 - $29,000
Urinary tract infection	$700

Nettleman M. In: Wenzel RP, ed. Prevention and Control of Nosocomial Infections, 4th ed. 2003:36.

Shifting Vantage Points on Nosocomial Infections

Many infections are inevitable, although some can be prevented

→

Each infection is potentially preventable unless proven otherwise

Gerberding JL. Ann Intern Med 2002;137:665-670.

Major Sites of Nosocomial Infections

- Urinary tract infection
- Bloodstream infection
- Pneumonia (ventilator-associated)
- Surgical site infection

Nosocomial Urinary Tract Infections

Nosocomial Urinary Tract Infections

- Most common hospital-acquired infection (40% of all nosocomial infections)
  - 1 million cases of nosocomial UTI per year in the US
- Of nosocomial infections, lowest mortality & cost
- >80% associated with urinary catheter

Nosocomial Urinary Tract Infections

- 25% of hospitalized patients will have a urinary catheter for part of their stay
- 20-25 million urinary catheters sold per year in the US
- Incidence of nosocomial UTI is ~5% per catheterized day
- Virtually all patients develop bacteriuria by 30 days of catheterization
- Of patients who develop bacteriuria, 3% will develop bacteremia

Safdar N et al. Current Infect Dis Reports 2001;3:487-495.

Risk Factors for Nosocomial UTIs

- Female gender
- Diabetes mellitus
- Renal insufficiency
- Duration of catheterization
- Insertion of catheter late in hospitalization
- Presence of ureteral stent
- Using catheter to measure urine output
- Disconnection of catheter from drainage tube
- Retrograde flow of urine from drainage bag

Prevention of Nosocomial UTIs

- Avoid catheter when possible & discontinue ASAP
- Aseptic insertion by trained HCWs
- Maintain closed system of drainage
- Ensure dependent drainage
- Minimize manipulation of the system
- Condom or suprapubic catheter
- Silver coated catheters

Nosocomial Bloodstream Infections

Nosocomial Bloodstream Infections

- 12-25% attributable mortality
- Risk for bloodstream infection:

	BSI per 1,000 catheter/days
Subclavian or internal jugular CVC	5-7
PICC	0.2 - 2.2

Risk Factors for Nosocomial BSIs

- Heavy skin colonization at the insertion site
- Internal jugular or femoral vein sites
- Duration of placement
- Contamination of the catheter hub

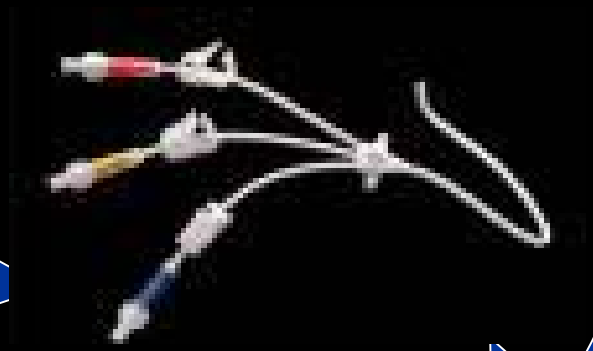
The importance of process of care measures in the reduction of nosocomial bloodstream infections

The risk factors interact in a dynamic fashion

The CVC is the greatest risk factor for Nosocomial BSI

Host

The CVC: Subclavian, Femoral and IJ sites



The intensity of the Catheter Manipulation

As the host cannot be altered, preventive measures are focused on risk factor modification of catheter use, duration, placement and manipulation

Prevention of Nosocomial BSIs

- Limit duration of use of intravascular catheters
  - No advantage to changing catheters routinely
- Maximal barrier precautions for insertion
  - Sterile gloves, gown, mask, cap, full-size drape
  - Moderately strong supporting evidence
- Chlorhexidine prep for catheter insertion
  - Significantly decreases catheter colonization
  - Disadvantages: possibility of skin sensitivity to chlorhexidine

Eliminating catheter-related bloodstream infections in the intensive care unit

- Purpose:
  - To determine whether a multifaceted systems intervention would eliminate catheter-related bloodstream infections (CR-BSIs)
- Method:
  - Prospective cohort study in a surgical intensive care unit (ICU) with a concurrent control ICU.
  - Patients:
  - All patients with a central venous catheter in the ICU

Pronovost et al. *Crit Care Med.* 2004 Oct;32(10):2014-20.

Eliminating catheter-related bloodstream infections in the intensive care unit

Interventions	Example
Staff Education	•All staff inserting central catheters were required to complete a web-based training program with post-test.
Creation of a catheter insertion cart	•Central catheter insertion cart that contains all equipment and supplies •Reduced the number of steps required for compliance

Pronovost et al. *Crit Care Med*. 2004 Oct;32(10):2014-20.

Eliminating catheter-related bloodstream infections in the intensive care unit

Promotion of daily catheter Removal	Asked daily during rounds whether catheters or tubes could be removed
Evidence based checklist CVC insertion and for BSI risk reduction	Hand hygiene prior to procedure Chlorhexidine skin preparation Full-barrier precautions during CVC insertion Subclavian vein as the preferred site Maintenance of sterile field during procedure
Nurse Empowerment	Procedure aborted if a violation in compliance with evidence-based guidelines was observed SICU attending physician notified

Pronovost et al. *Crit Care Med*. 2004 Oct;32(10):2014-20.

Eliminating catheter-related bloodstream infections in the intensive care unit

- Results:
  - During the first month nursing completed the checklist for 38 procedures:
    - Eight (24%) for new central venous access,
    - 30 (79%) for catheter exchanges over a wire,
    - Three (8%) were emergent.
  - Nursing intervention was required in 32% (12/38) of central venous catheter insertions

Pronovost et al. *Crit Care Med*. 2004 Oct;32(10):2014-20.

Eliminating catheter-related bloodstream infections in the intensive care unit

	BSI Rate 1st quarter 1998	BSI Rate 4th quarter 2002	January 2003-April 2004
Study ICU	11.3/1,000 catheter days	0/1,000 catheter days	0.54/1,000 catheter days No crBSI over 9 months
Control ICU	5.7/1,000 catheter days	1.6/1,000 catheter days	

Multifaceted, comprehensive program requiring CVC insertion education, with safety checks for proper hand hygiene, aseptic insertion procedure and operator responsibility can result in reduction of nosocomial BSI in an ICU setting.

Pronovost et al. *Crit Care Med*. 2004 Oct;32(10):2014-20.

Nosocomial Pneumonia

Nosocomial Pneumonia

- Cumulative incidence = 1-3% per day of intubation
- Early onset (first 3-4 days of mechanical ventilation)
  - Antibiotic sensitive, community organisms (*S. pneumoniae, H. influenzae, S. aureus*)
- Late onset
  - Antibiotic resistant, nosocomial organisms (MRSA, *Ps. aeruginosa*, *Acinetobacter* spp, *Enterobacter* spp)

Risk Factors for VAP

- Duration of mechanical ventilation
- Chronic lung disease
- Severity of illness
- Age
- Head trauma
- Elevated gastric pH
- Aspiration of gastric contents
- Reintubation
- Upper abdominal or thoracic surgery
- Supine head position
- NG tube

Prevention of VAP

- Semirecumbent position of ventilated patients (head of bed at 30-45°)
- Continuous oscillation: needs more study
- Continuous aspiration of subglottic secretions
  - Uses ETT with a dorsal lumen that opens into the subglottic region, allowing aspiration of pooled secretions with potential pathogens
  - Delays onset of VAP, conflicting evidence on incidence of VAP, no effect on mortality

Prevention of VAP

- Selective GI tract decontamination
  - Many studies
  - Complicated literature
    - Some studies used topical as well as IV antibiotics
  - Major concern: development of antibiotic resistance
- Sucralfate
  - Allows prophylaxis of stress ulcers without raising gastric pH (↑ pH leads to increased gastric colonization)
  - Mixed results in the literature
  - Disadvantages: requires NG tube, provides inferior prophylaxis for GI bleeding

Surgical Site Infections

Epidemiology of SSI in the US

- 30 million surgical procedures performed annually
- SSIs occur in 2-5% of clean, extra-abdominal procedures & up to 20% of patients undergoing intra-abdominal procedures
- CDC estimates that 500,000 SSIs occur annually
- Direct + indirect costs = $1-$10 billion
- 47-84% of SSIs occur after discharge

Sources of SSIs

- Endogenous: patient's skin or mucosal flora
  - Increased risk with devitalized tissue, fluid collection, edema, larger inocula
- Exogenous
  - Includes OR environment/instruments, OR air, personnel
- Hematogenous/lymphatic: seeding of surgical site from a distant focus of infection
  - May occur days to weeks following the procedure

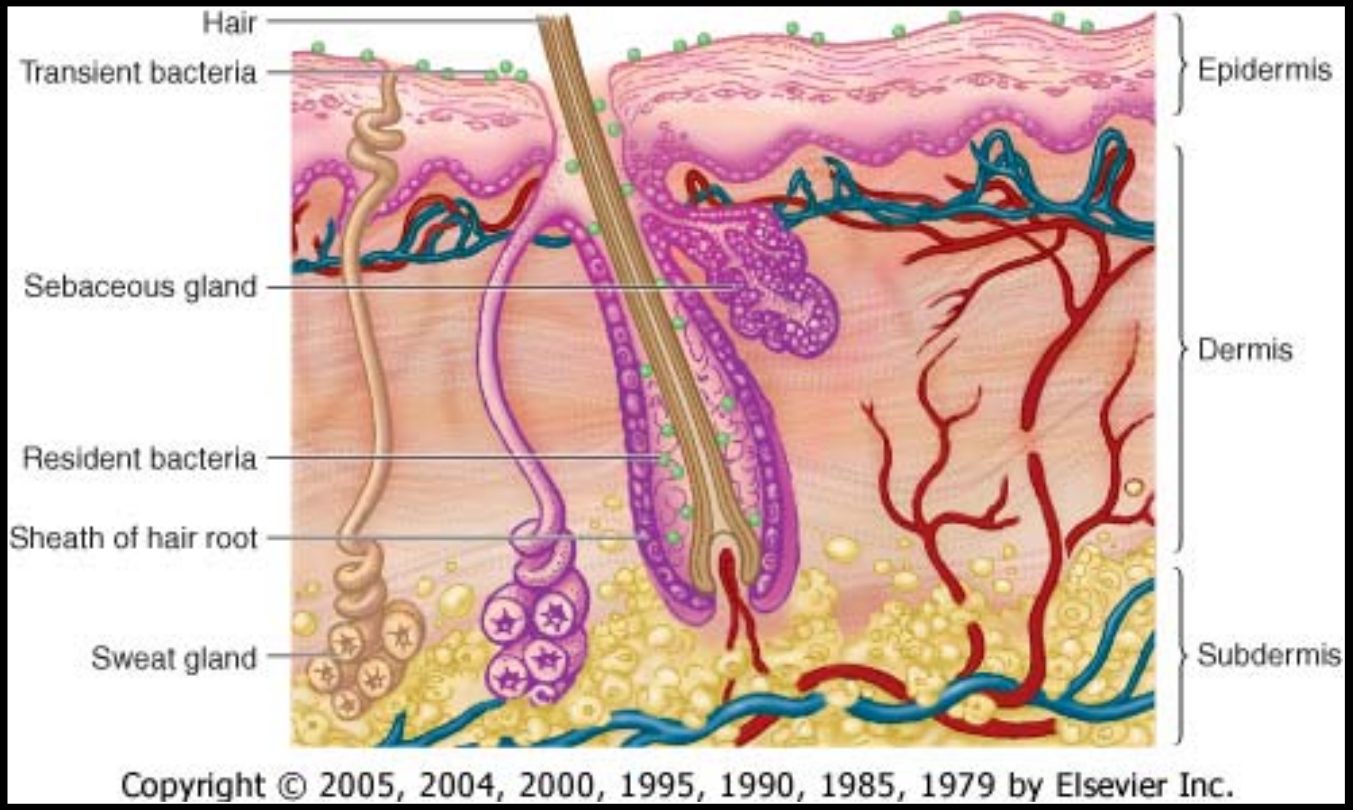
- **Most infections occur due to organisms implanted during the procedure**

Surgical Site Infections

Pathogens

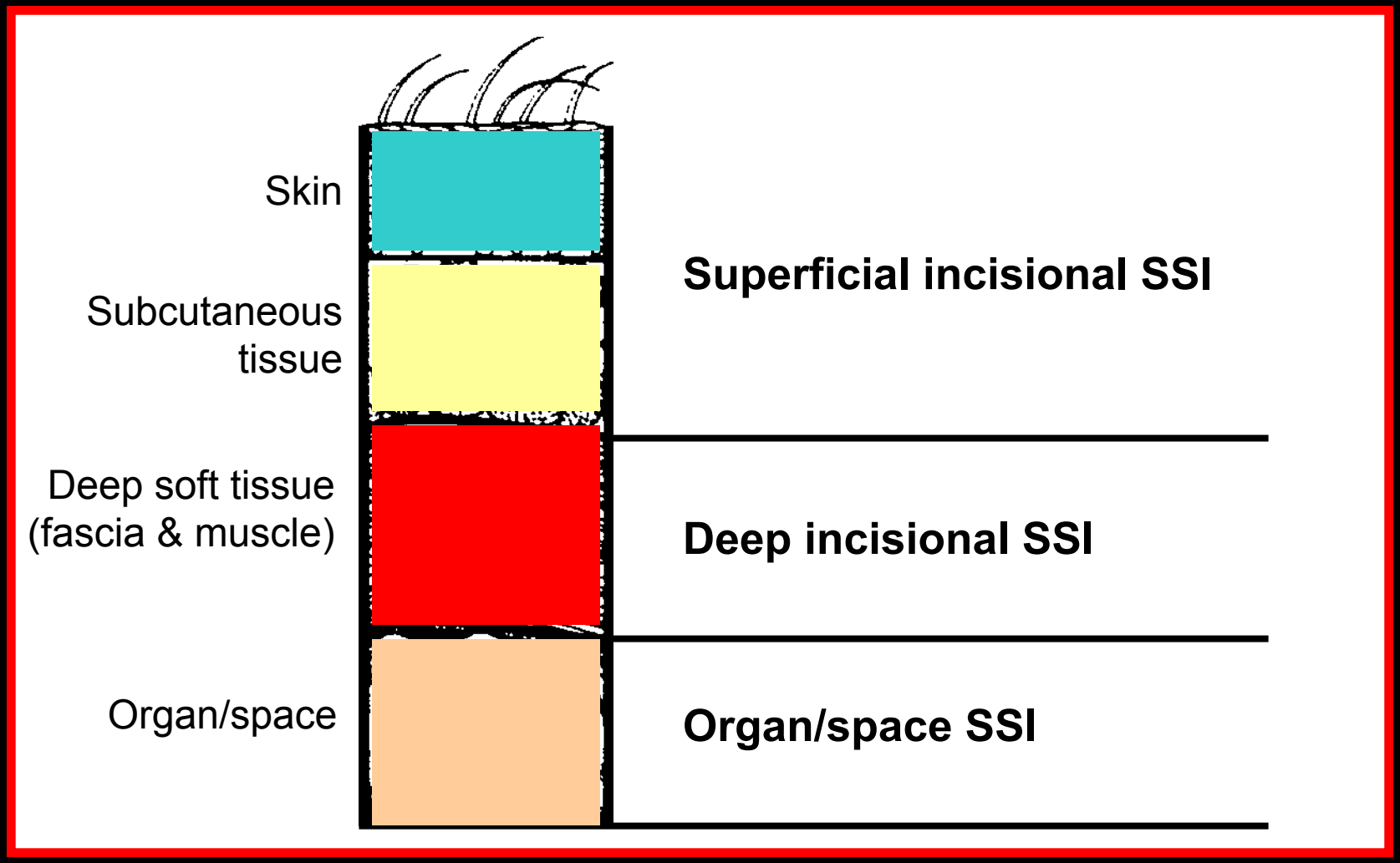
Rank	Pathogen	Percent
1	*S. aureus*	20%
2	Coagulase-negative Staph	14%
3	Enterococci	12%
4	*E. coli*	8%
4	*Pseudomonas aeruginosa*	8%
5	*Enterobacter* spp	7%

CDC. Am J Infect Control 1996;24:380-8.



Up to 20% of skin-associated bacteria in skin appendages (hair follicles, sebaceous glands) & are not eliminated by topical antisepsis. Transection of these skin structures by surgical incision may carry the patient's resident bacteria deep into the wound and set the stage for subsequent infection.

Definition of SSI



Horan C et al. Am J Infection Control 1992:20:271-74.

CDC Criteria for SSI

		Superficial incisional SSI	Deep incisional SSI	Organ/Space SSI
Anatomy		Skin & subcutaneous tissue	Deep soft tissues	Area other than incision
Timing		Within 30 days	Within 30 days if no implant; within 1 year if implant placed	
At least 1 of the following:	Purulent drainage	From superficial incision	From deep incision	From drain placed in organ/space
	Lab	Culture from fluid or tissue from incision	Abscess present on imaging or on reoperation	
	Signs/ symptoms	At least 1 (pain, tenderness, swelling, redness, heat) + MD opens incision	Deep incision dehisces or is opened + 1 (fever, pain, tenderness)	
	MD diagnosis			

Horan TC et al. Am J Infect Control 1992;20:271-4.

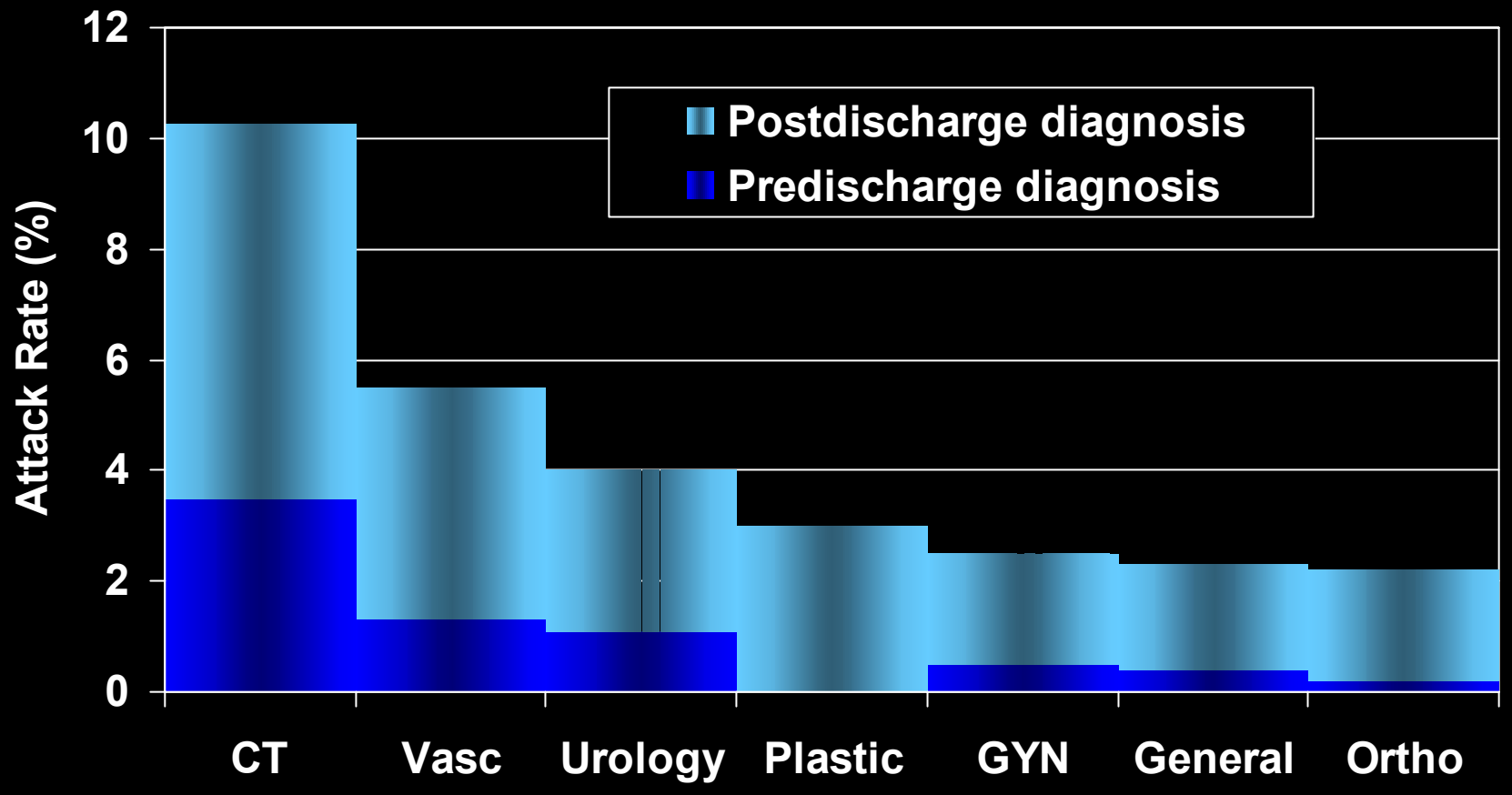
Surgical Site Infections (SSI)

- Clean wound
  - * elective, primarily closed, undrained
  - * nontraumatic, uninfected
- Clean-Contaminated wound
  - * GI, resp, GU tracts entered in a controlled manner
  - * oropharynx, vagina, biliary tract entered
- Contaminated wound
  - * open, fresh, traumatic wounds
  - * gross spillage from GI tract
  - * infected urine, bile

Surgical Site Infections

Wound Class	% of Operations	SSI Rate (%)
Clean	58	3.3
Clean-contaminated	36	10.8
Contaminated	4	16.3
Dirty-infected	2	28.6

Timing of SSI Diagnosis



Sands K et al. J Infect Dis 1996;173:963-70.

Risk Factors for SSI

- Age (extremes)
- Sex
  - * ♀post cardiac surgery
- Underlying disease
  - * obesity (fat layer < 3 cm 6.2%; >3.5 cm 20%)
  - * malnutrition
  - * malignancy
  - * remote infection

Risk Factors for SSI

- Duration of pre-op hospitalization
  - * increase in endogenous reservoir
- Pre-op hair removal
  - * esp if time before surgery > 12 hours
  - * shaving>>clipping>depilatories
- Duration of operation
  - * increased bacterial contamination
  - * tissue damage
  - * suppression of host defenses
  - * personnel fatigue

Prevention of SSI

Prevention of SSI

- Limit pre-op hospitalization
- Stabilize underlying diseases
- Avoid hair removal by shaving
  - Clipping of skin is preferred
- Skin decolonization of both patient and surgeon
  - Chlorhexidine
  - Intranasal mupirocin for *S. aureus* carriers
- Impermeable drapes
  - Maximum sterile barrier precautions
- Perioperative antibiotic prophylaxis
- Tight control of perioperative glucose

Consumer Advocacy Impacting Physician Practice- affect on SSI surveillance and process of care

- Direct education of the public
- Working with state legislatures to mandate public reporting of healthcare quality issues
- Pay for performance (P4P)

SCIP

- A national partnership of organizations to improve the safety of surgical care by reducing post-operative complications through a national campaign
- Goal: reduce the incidence of surgical complications by 25 percent by the year 2010
- Initiated in 2003 by the Centers for Medicare & Medicaid Services (CMS) & the Centers for Disease Control & Prevention (CDC)
  - Steering committee of 10 national organizations
  - More than 20 additional organizations provide technical expertise

SCIP Philosophy

- Surgeons, anesthesiologists, perioperative nurses, pharmacists, infection control professionals, & hospital executives work together to intensify their commitment to improving surgical care

SCIP Steering Committee Organizations

- Agency for Healthcare Research and Quality
- American College of Surgeons
- American Hospital Association
- American Society of Anesthesiologists
- Association of perioperative Registered Nurses
- Centers for Disease Control and Prevention
- Centers for Medicare & Medicaid Services
- Department of Veterans Affairs
- Institute for Healthcare Improvement
- Joint Commission on Accreditation of Healthcare Organizations

Monetary incentives for promoting quality and compliance with SSI risk reduction guidelines:

Richmond.com Reflecting Richmond

March 12, 2005

In recent years, the healthcare industry has placed a stronger emphasis on reducing medical errors, monitoring everything from how long doctors sleep to whether or not their handwriting is legible. Now one organization is not only recognizing the hospitals that follow patient safety and clinical guidelines, but rewarding them for doing so. ***Anthem Blue Cross and Blue Shield recently gave a total of $6 million to 16 Virginia hospitals as part of the company's new Quality-In-Sights Hospital Incentive Program (Q-HIP).***

http://www.richmond.com/health/output.aspx?Article_ID=3545364&Vertical_ID=15

SCIP Performance Measures

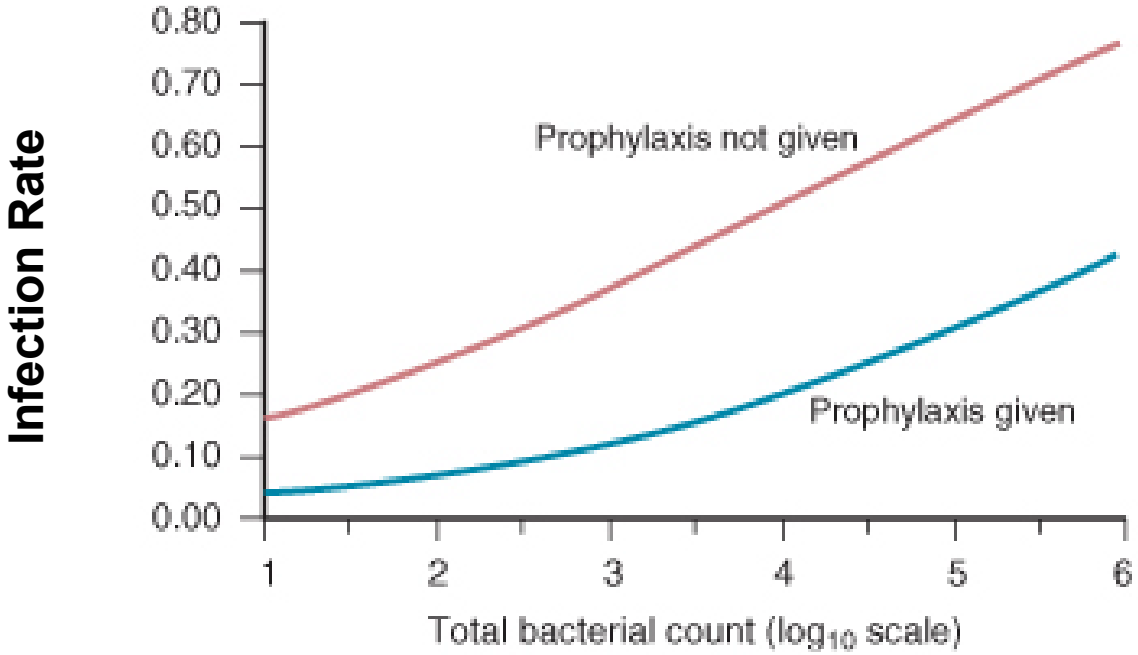
Surgical infection prevention	• SSI rates • Appropriate prophylactic antibiotic chosen • Antibiotic given within 1 hour before incision • Discontinuation of antibiotic within 24 hours of surgery • Glucose control • Proper hair removal • Normothermia in colorectal surgery patients

Perioperative Antibiotics

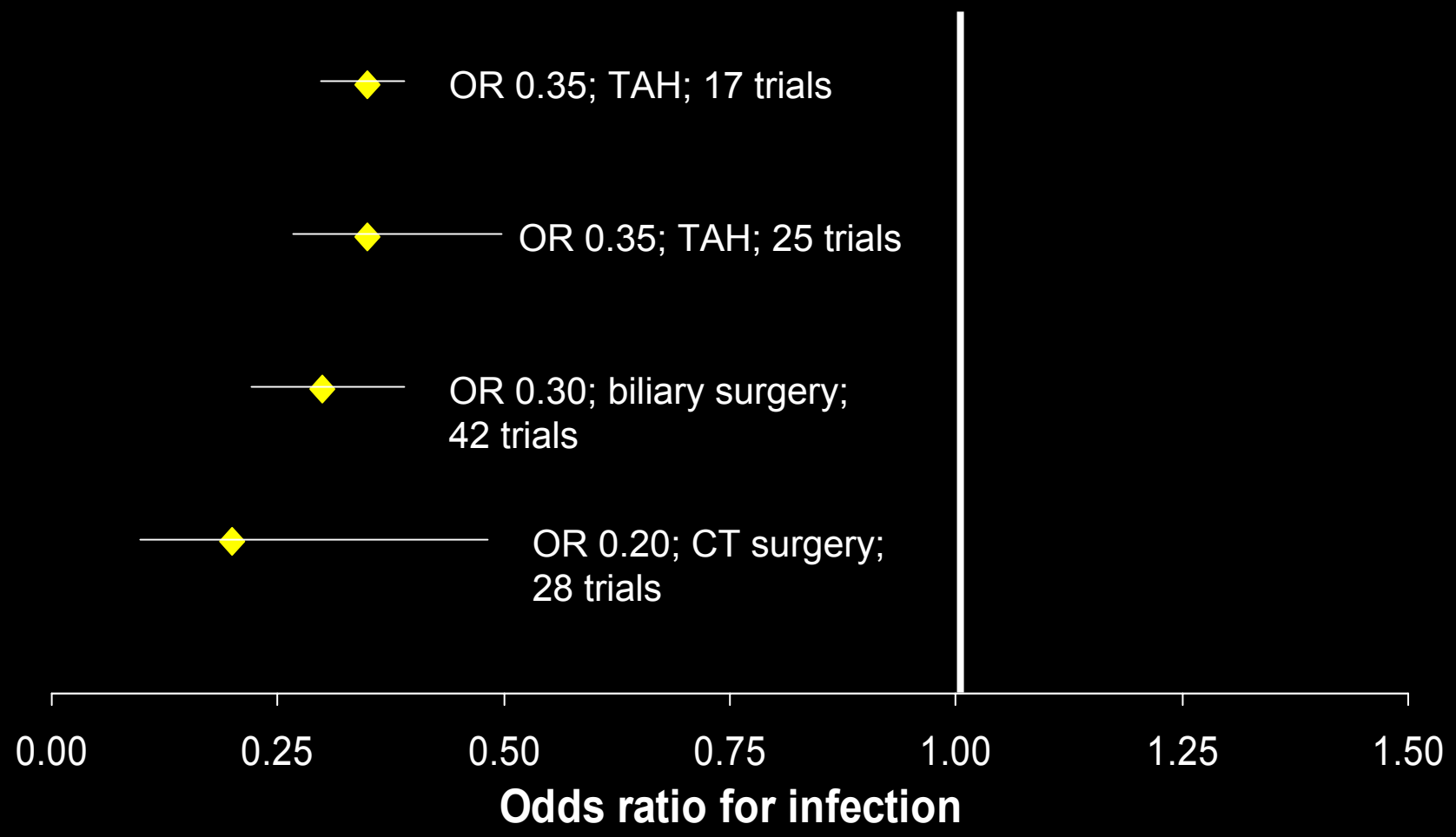
Antibiotic Prophylaxis for Surgery

- Goal: reduce intraoperative microbial contamination to a level that will not overwhelm host defenses & result in infection
- Characteristics of good prophylactic antimicrobials:
  - Safe
  - Inexpensive
  - Bactericidal
  - Spectrum of activity covers the most likely contaminants for the operation
- A bactericidal concentration should be present in serum & tissues at time of incision
- Therapeutic concentrations should be maintained until, at most, a few hours after the incision is closed

Auerbach AD. *Making Health Care Safer.* AHRQ, 2001:221.



Meta-analyses:
Antibiotic Prophylaxis vs Placebo



Auerbach AD. *Making Health Care Safer.* AHRQ, 2001:224-5.

Indications for Antibiotic Prophylaxis

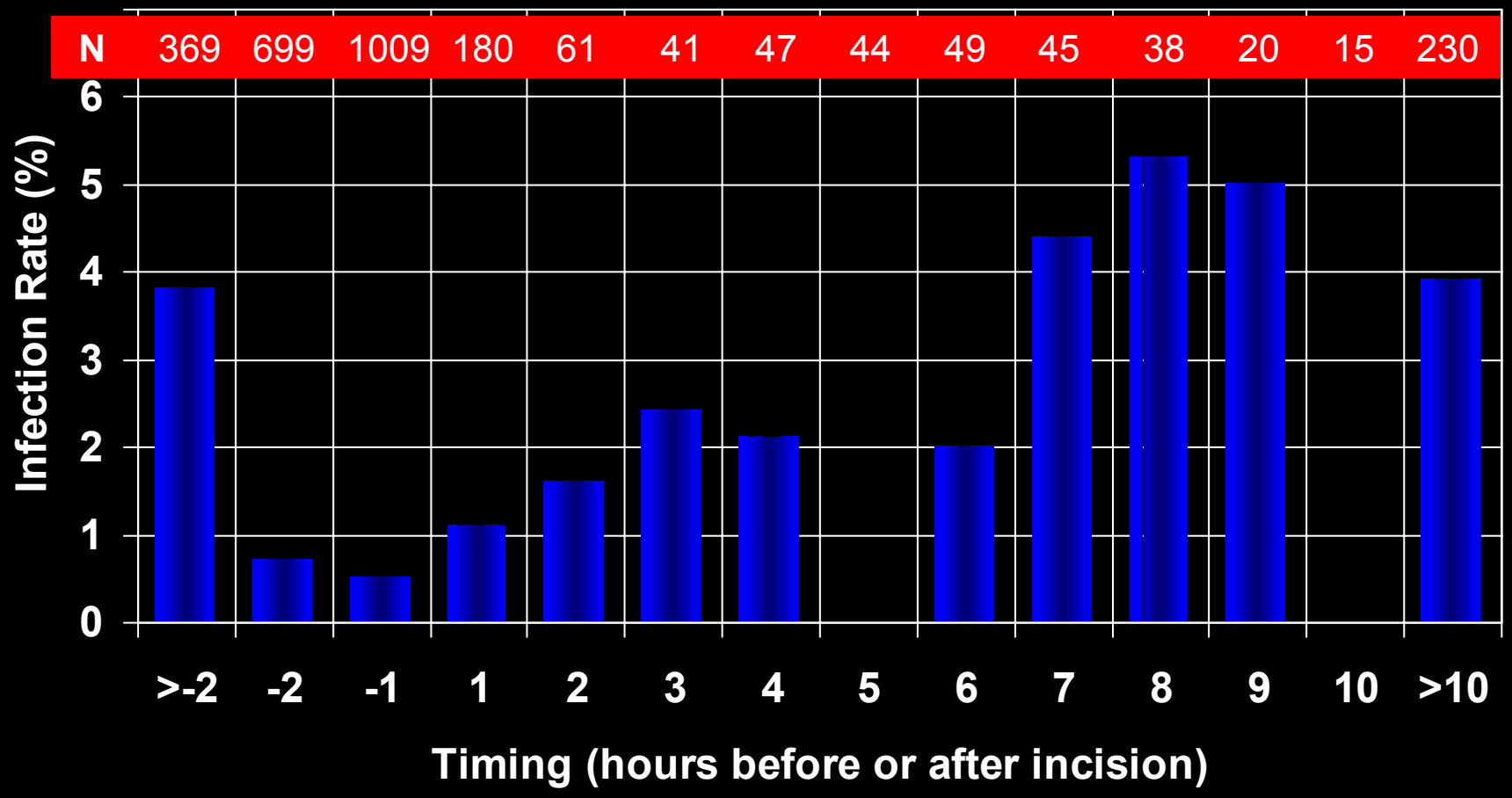
- Clean-contaminated procedures
- Clean procedures that require placement of prosthetic material
- Clean procedures in which infection would be catastrophic
- Contaminated procedures

Rates of SSI based on Timing of Antibiotic Administration

- Prospective study evaluating timing of antibiotic prophylaxis and incidence of surgical site infection
- Evaluated 2,847 patients undergoing clean or clean—contaminated procedures in a 540 bed teaching hospital

Classen DC et al. New Engl J Med 1992;326:281-6.

Rates of SSI based on Timing of Antibiotic Administration



Classen DC et al. New Engl J Med 1992;326:281-6.

Rates of SSI based on Timing of Antibiotic Administration

Timing (related to incision)	N	Infection rate (%)	RR	95% CI
2-24 hrs before	369	3.8	6.7	1.8-10.4
0-2 hrs before	1,708	0.6	1.0	
0-3 hrs after	282	1.4	2.4	0.6-7.4
3-24 hrs after	488	3.3	5.8	2.4-13.8
All	2,847	1.5		

Classen DC et al. New Engl J Med 1992;326:281-6.

Process Indicators:
Appropriate Antibiotic Prophylaxis

Procedure	Approved Antibiotics	Approved for β-lactam allergy
Cardiac	•Cefazolin	•Vancomycin •Clindamycin
Vascular		
Hip/Knee arthroplasty		
Colon	Oral: •Neomycin + erythromycin •Neomycin + metronidazole Parenteral: •Cefoxitin •Cefazolin + metronidazole	•Clindamycin + gentamicin •Clindamycin + levofloxacin •Metronidazole + gentamicin •Metronidazole + levofloxacin
Hysterectomy	•Cefazolin •Cefoxitin	•Clindamycin + gentamicin •Clindamycin + levofloxacin •Metronidazole + gentamicin •Metronidazole + levofloxacin •Clindamycin

Process Indicators:
Timing of First Antibiotic Dose

Infusion should begin within 60 minutes of the incision

- Little controversy regarding this indicator

Bratzler DW et al. Clin Infect Dis 2004;38:1706-15.

Process Indicators:

Duration of Antimicrobial Prophylaxis

Prophylactic antimicrobials should be discontinued within 24 hrs after the end of surgery

- Areas of controversy:
  - ASHP recommends continuing prophylaxis for CT surgery procedures for up to 72 hrs after the operation; Society of Thoracic Surgeons recommends 48 hrs

Bratzler DW et al. Clin Infect Dis 2004;38:1706-15.

Proper Hair Removal

Preoperative Hair Removal

Category I A: Strongly recommended for implementation; supported by well designed, experimental, clinical or epidemiologic studies.

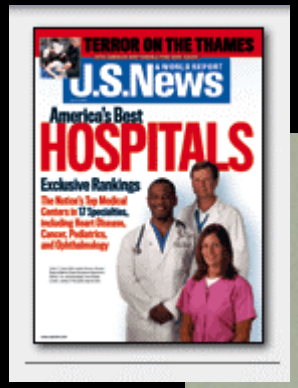
Not removing hair from the surgical site unless necessary to facilitate surgery.

If hair is to be removed, then this should be done immediately before surgery and preferably with *electric scissors and not by shaving.*

CDC Hospital Infection Control Practices Advisory Committee Guideline for Prevention of Surgical Site Infection.

AJIC 1999;27:97-134.

July 2000 Bulletin of the American College of Surgeons



Much Cleaner Cuts

PROBLEM: Infection related to surgery ● **PROPOSAL:** Better use of antibiotics, don't shave with razor prior to surgery, tighten control of blood sugar ● **POSSIBLE LIVES SAVED:** 8,000

A hospital is a risky place for people who have had surgery. No matter how much antibacterial solution is painted on before the first cut, opening the body invites lurking microbes. Infections at the surgery site complicate an estimated 780,000 operations a year, or more than 1 in every 40 procedures. For abdominal surgery, the likelihood is as high as 1 in 5. And the complications are tough to

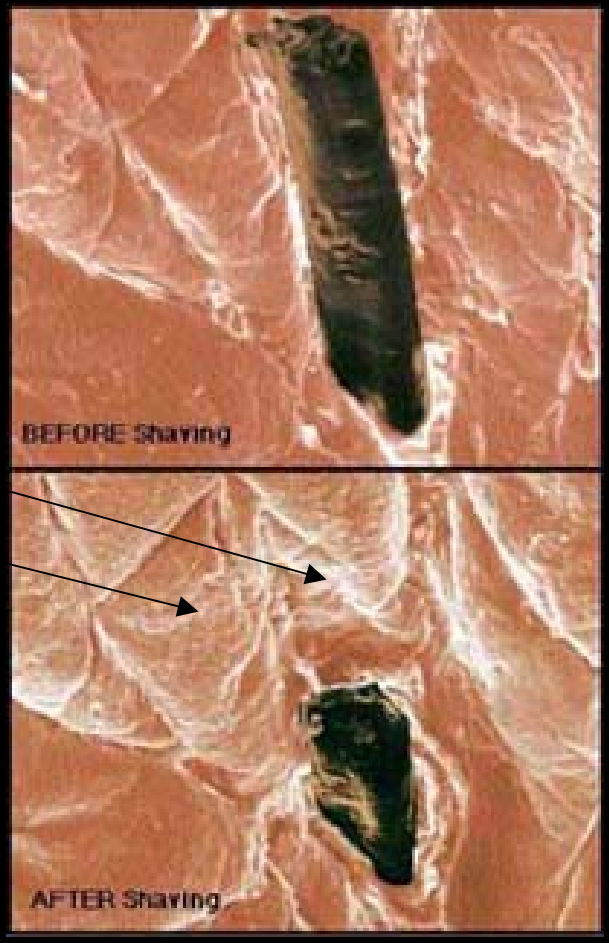
treat. Infected patients are two to three times more likely to die and are hospitalized an average of seven days longer than uninfected patients who had the same operation.

Even before the 100K campaign got underway, IHI had been working with a group of 56 hospitals on strategies to lower the rate of surgical-site infections. Results of the yearlong effort, published last month in the *American Journal of Surgery*, showed a re-

U.S. News and World Report, July 18, 2005.

Pathophysiology of Shaving & SSI

- Hair removal with a razor can disrupt skin integrity
- Microscopic exudative rashes and skin abrasions can occur during hair removal.
- These rashes and skin abrasions can provide a portal of entry for microorganisms



Preoperative Hair Removal: Summary of the Data

Study	Conclusion
Mishriki et al. ***Journal of Hospital infection (1990) 16;223-230.***	Prospective analysis of 702 consecutive surgical cases resulting in 51 infections. Age, preoperative stay, shaving and the surgeon were all statistically associated with SSI.
Moro et al. ***Ann Ital Chir LXVII 1,1996.13-19.***	Prospective analysis of 2,262 clean surgeries in eight general wards and one thoracic ward. 3.7% developed SSI Logistic regression analysis: 7 risk factors- advanced age,obesity, high risk procedures, OR duration>2 hours, preoperative shaving, open surgical drains > 3 days

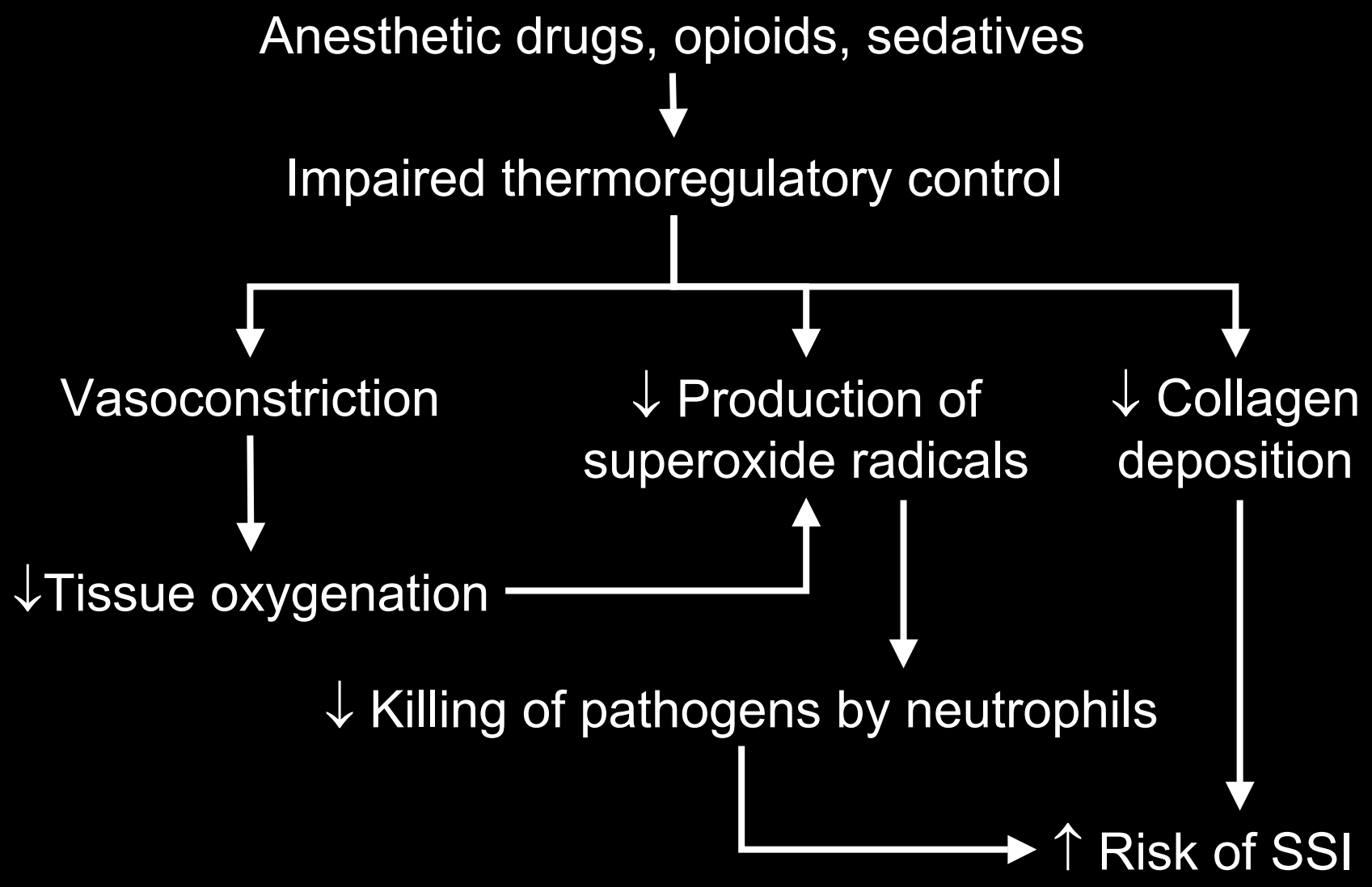
Pre-op Hair Removal

- Conclusions from a review of 20 studies:
  - several randomized & observational studies with controls show that either wet or dry shaving the evening before the procedure results in a significantly higher infection rate than depilation or electric clipping
  - there are no convincing differences in the incidence of postoperative SSIs between electric clipping, depilation, or no hair removal
  - If hair removal is anticipated, removal with clippers should be performed as close as possible to the time of the procedure

Kjonniksen I et al. AORN J 2002;75:928-36,938,940.

Perioperative Normothermia

Physiologic Effects of Hypothermia



Perioperative Normothermia

- Blinded, randomized trial of 421 patients undergoing clean surgery (breast, varicose vein or hernia) comparing routine preoperative care to systemic warming (forced air warming blanket 30 minutes preop) to local warming (30 minute preop warming of planned incision with a radiant dressing)

	Non-warmed	Local warming	Systemic warming	P
Infection rate	14%	4%	6%	
		5%		0.001

Melling AC et al. Lancet 2001;358:876-80.

Perioperative Normothermia

- Double-blinded, randomized trial of 200 patients undergoing colorectal surgery comparing routine intraoperative thermal care (34.5ºC) to normothermia (36.5ºC) using a forced air cover and heated fluids

	Hypothermia	Normothermia	P
Infection rate	19%	6%	0.009

Kurz A et al. New Engl J Med 1996;334:1209-15.

Perioperative Glycemic Control

Perioperative Glucose Control

- Poor glucose control has been shown to be an independent risk factor for SSI in multiple studies
- Risk is increased due to vascular disease, neutrophil dysfunction, impairment of complement & antibodies
- Intervention: maintain glucose at 151-200 mg/dL via a continuous insulin infusion

Perioperative Glucose Control

- **141** diabetic patients undergoing CABG were randomized to tight glycemic control (125-200 mg/dL) with GIK or standard therapy (<250 mg/dL) using SQ SSI beginning before anesthesia & continuing for 12 hours after surgery

	SSI	**GIK**	**P**
Infection (wound, pneumonia)	13%	0%	0.01
Post-op LOS	9.2 days	6.5 days	0.001
Mortality	0%	0%	0.99

Lazar HL et al. Circulation 2004;109:1497-1502.

Perioperative Glucose Control

- 2,467 diabetic patients undergoing cardiac surgery at a community hospital
  - 968 patients treated with sliding scale insulin (1987-91)
  - 1499 patients treated with CII to target glucose of 150-200 until POD 3 (1991-97)

	SSI	CII	P
Wound infection	1.9%	0.8%	0.01
LOS	10.7 days	8.5 days	<0.01
Mortality	6.1%	3.0%	0.03

Furnary AP et al. Ann Thorac Surg 1999;67:352-360.

Perioperative Glycemic Control

- An increasing body of evidence demonstrates that tight glycemic control of blood glucose improves overall outcomes for patients with DM.
- The best quality data currently available is in the CT surgical literature
- Data appear promising but quality studies in the non-cardiac surgical populations are not yet available.

Surgical Hand Antisepsis

Surgical Hand Antisepsis: 1999

"Surgical scrub of at least 2-5 minutes (up to elbow) using an appropriate antiseptic."

Category IB recommendation

1999-ACS/CDC/HICPAC

July 2000 Bulletin of the American College of Surgeons

Surgical Hand Antisepsis: 2002

Surgical hand antisepsis using either an antimicrobial soap (2-5 minute scrub) or an alcohol-based handrub with persistent activity is recommended before donning sterile gloves when performing surgical procedures.

Category I B recommendation

CDC MMWR- *Guideline For Hand Hygiene in Healthcare Setting*, October 25, 2002

Surgical Hand Antisepsis: 2002

Study:	Findings:
•Meers et al. ***Journal of Hygiene.*** 1978 •Kikuchi et al. ***Acta Derm Venereol.*** 1999.	Surgical hand preparation requiring scrubbing with a brush damages the skin and leads to increased shedding of bacteria and squamous epithelial cells
•Dineen,P. ***Surg Gynecol Obstet,*** 1973. •Bornside GH. ***Surgery,*** 1968.	Scrubbing with a disposable sponge or combination sponge-brush has reduced bacterial counts on the hands as effectively as scrubbing with a brush.
•Mulberry et al. ***Am J Infect Control***, 2001 •Loeb et al. ***Am J Infect Control,*** 1997	Neither brush nor sponge is necessary to reduce bacterial counts on the hands of surgical staff to acceptable levels

CDC MMWR- Guideline For Hand Hygiene in Healthcare Setting, October 25, 2002

Comparison of Different Regimens for Surgical Hand Preparation

- Prospective clinical trial
  - To compare the microbiology and skin condition of hands when using a traditional surgical scrub (TSS) with a detergent-based antiseptic containing 4% chlorhexidine gluconate (CHG) vs. a short application without scrub of a waterless hand preparation (HP) containing 61% ethyl alcohol, 1% CHG, and emollients.
- Endpoints:
  - antimicrobial effectiveness
  - effect on skin condition
  - time required

Comparison of Different Regimens for Surgical Hand Preparation

	Initial visit - Friday	Treatment periods											
		Hand preparation						Traditional surgical scrub					
		Week 1		Week 2		Week 3		Week 4		Week 5		Week 6	
		Mon	Fri	Mon	Fri	Mon	Fri	Mon	Fri	Mon	Fri	Mon	Fri
Sign consent and randomization	✓												
Inclusion/exclusion criteria	✓												
Entrance questionnaire	✓												
Product training, hand skin assessment (HSA) orientation	✓												
Visual scoring of skin (morning before first scrub)	✓	✓	✓		✓		✓	✓	✓		✓		✓
HSA (morning before first scrub)	✓	✓	✓		✓		✓	✓	✓		✓		✓
Prescrub hand culture	✓	✓	✓				✓	✓	✓				✓
Test scrub		✓	✓				✓	✓	✓				✓
Postscrub hand culture		✓	✓				✓	✓	✓				✓
Diary card (daily)													
Scrub observations (30 for each treatment during weeks 2, 3, 5, and 6)													
Exit questionnaire													✓

Larson et al. *AORN Journal*, February 2001

Comparison of Different Regimens for Surgical Hand Preparation

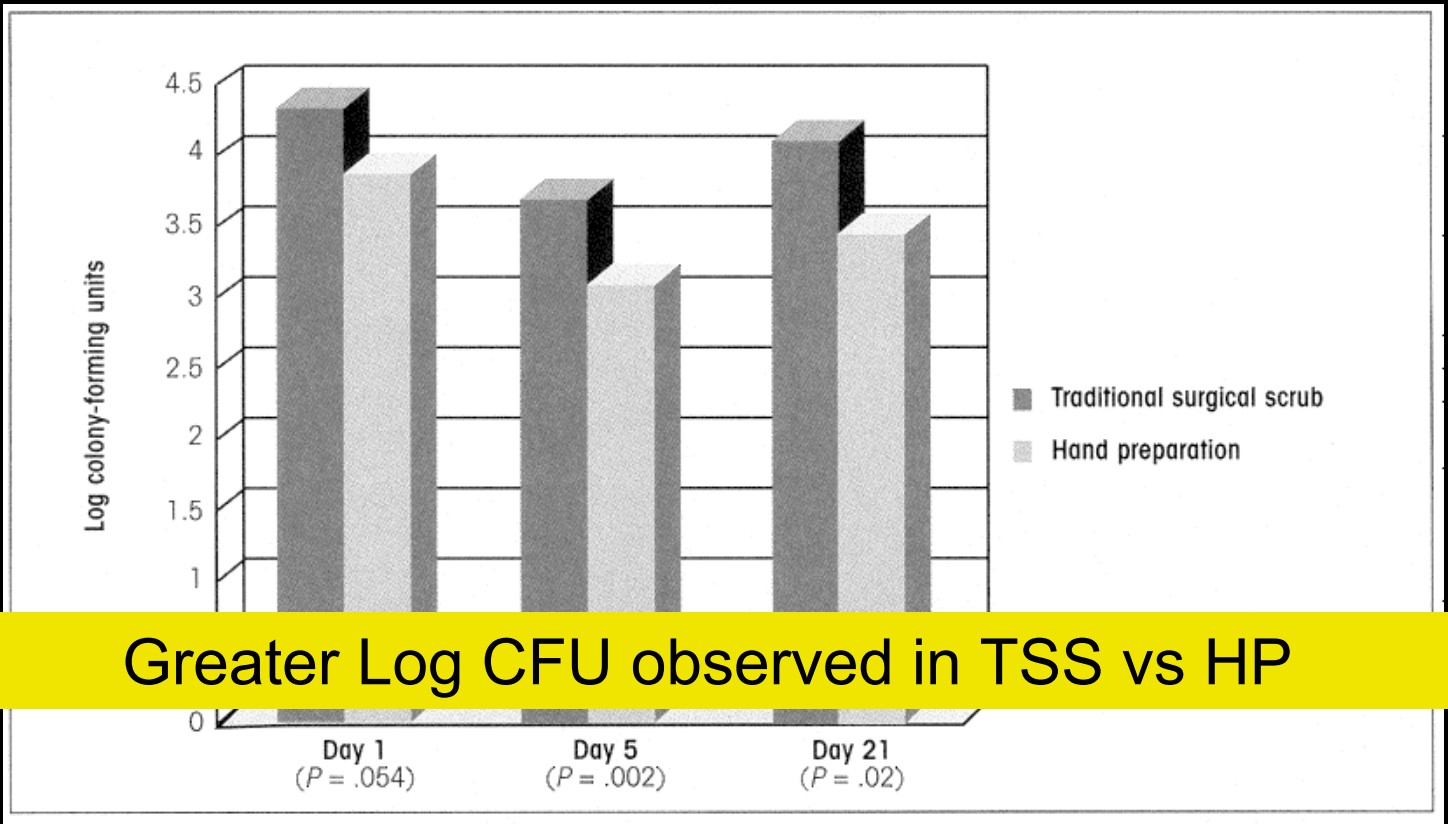
Time period	Visual scoring of skin change from baseline				*P* value (paired *t* tests)
	Hand preparation regimen		Traditional surgical scrub regimen		
	VSS	N	VSS	N	
Period baseline, week 1, day 1	4.7	22	5.1	19	.094
Day 5	-.2	20	-.8	18	.148
Day 12	-.4	19	-1.2	18	.011

Greater changes VSS observed in TSS vs HP

*Range: 0 = worst; -6 = best

Larson et al. *AORN Journal*, February 2001

Comparison of Different Regimens for Surgical Hand Preparation



Greater Log CFU observed in TSS vs HP

Larson et al. *AORN Journal*, February 2001

Comparison of Different Regimens for Surgical Hand Preparation

	Traditional surgical scrub	Hand preparation
Product		
• **Brush***		
Price per case of preloaded scrub brushes	$114 to $150	N/A
Number of brushes per case	300	N/A
Subtotal brush cost per scrub	$0.38 to $.050	N/A
• **Solution†**		
Price per case of solution‡	N/A	$256 to $333
Number of scrubs per case	N/A	1,600
Subtotal solution cost per scrub	N/A	$0.40 to $0.52
Staff member time		
Average length of scrub§ or application‖ (including drying time)	6 minutes	2 minutes
Average cost of OR minute¶	$10	$10
Subtotal cost of OR time per minute	$60	$20
Total cost of product per application time	$60.38 to $60.50	$20.40 to $20.52
Additional costs for consideration		
• **Weight of water waste per use**		
Empty 500 mL bottle	None	1.5 g#
Nail cleaner	0.6 g	0.6 g
Used scrub brush and packaging	38 g	None
Subtotal weight of waste per use	38.6 g	2.1 g
• **Additional waste**		
Water (2 gallons per minute flow rate)	12 gallons	none
Reusable sterile towel	used	none

Larson et al found the HP protocol less expensive

‡ *At time of study, the waterless product was under US Food and Drug Administration review and not for sale. The price is an estimate.*

§ *Manufacturers' directions for use for the chlorhexidine preloaded scrub brush require a total scrub time of six minutes.*

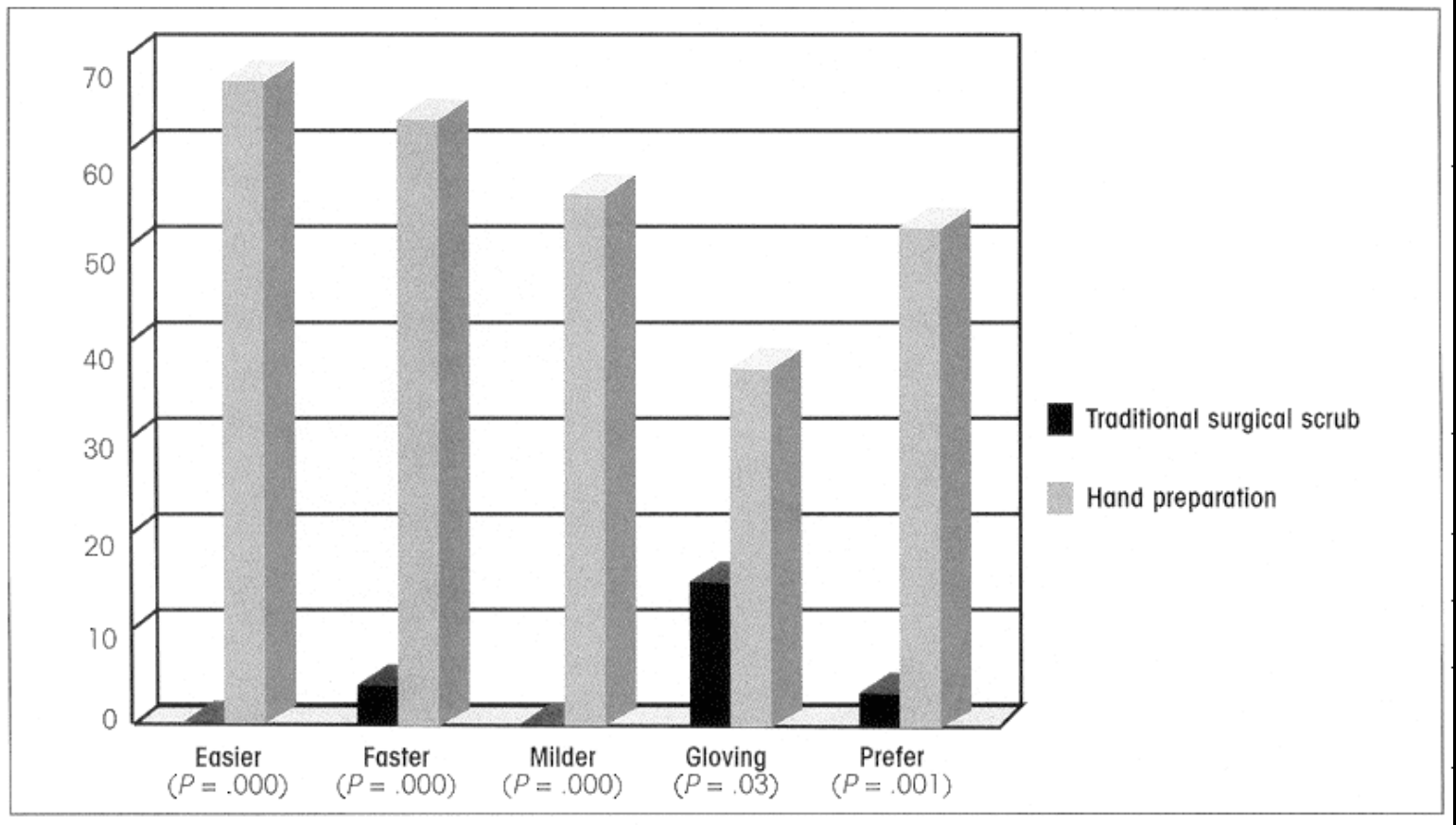
‖ *Application and dry time for the waterless product was observed to be approximately two minutes.*

¶ *Many institutions calculate the cost per minute for maintaining an active OR, including overhead and staff members. If available, this cost should be used.*

Figure provided is per use weight (ie, 125 g for empty bottle divided by 80 uses per bottle).

Larson et al. *AORN Journal*, February 2001

Comparison of Different Regimens for Surgical Hand Preparation



Larson et al. *AORN Journal*, February 2001

Comparison of Different Regimens for Surgical Hand Preparation

Conclusion:

- The HP was associated with less skin damage (P = .002) and lower microbial counts postscrub at days five (P = .002) and 19 (P = .02).
- The HP protocol had shorter contact time (HP mean [M] = 80.7 seconds; TSS M = 144.9 seconds; P < .0001), and more subjects preferred the HP regimen (P = .001).
- The HP performed better than the TSS, was less costly, and should be evaluated in larger trials and considered for widespread implementation.

Larson et al. *AORN Journal*, February 2001

Parienti et al; ***JAMA***, Aug 14 2002 Vol 288, No.6, 722-727

ORIGINAL CONTRIBUTION

Hand-Rubbing With an Aqueous Alcoholic Solution vs Traditional Surgical Hand-Scrubbing and 30-Day Surgical Site Infection Rates

A Randomized Equivalence Study

Study Overview

- Objective: to compare the effectiveness of hand-cleansing protocols to prevent SSI
- Design: prospective, randomized equivalence trial with crossover
- Setting: six surgical services from teaching and non-teaching hospitals is France
- Patients: A total of 4387 consecutive patients who underwent clean and clean contaminated surgery between January 1-May 1, 2001.

Parienti et al. *JAMA*. Vol 288,No.6. 2002

Study Overview

- Interventions
  - 2 hand-cleansing methods used alternately every other month
    - 75% aqueous alcohol solution:
      - Hand-rubbing involved a 75% AAS containing propanol-1, propanol-2, and mecetronium etilsulfate
      - Prior to the first procedure of the day, or if the hands were visibly soiled, the surgical team was instructed to use a nonantiseptic soap for a 1-minute hand wash
      - The hands and forearms were rinsed with nonsterile tap water and wiped carefully with nonsterile paper. The user was instructed to take enough AAS to fully cover the hands and forearms (at least 5 mL, which represents at least 4 pump strokes), and to apply it twice for 2 minutes 30 seconds (for a total of 5 minutes) without drying.
    - Hand scrubbing protocol with antiseptic preparation containing 4% povidone iodine or 4% chlorhexidine gluconate

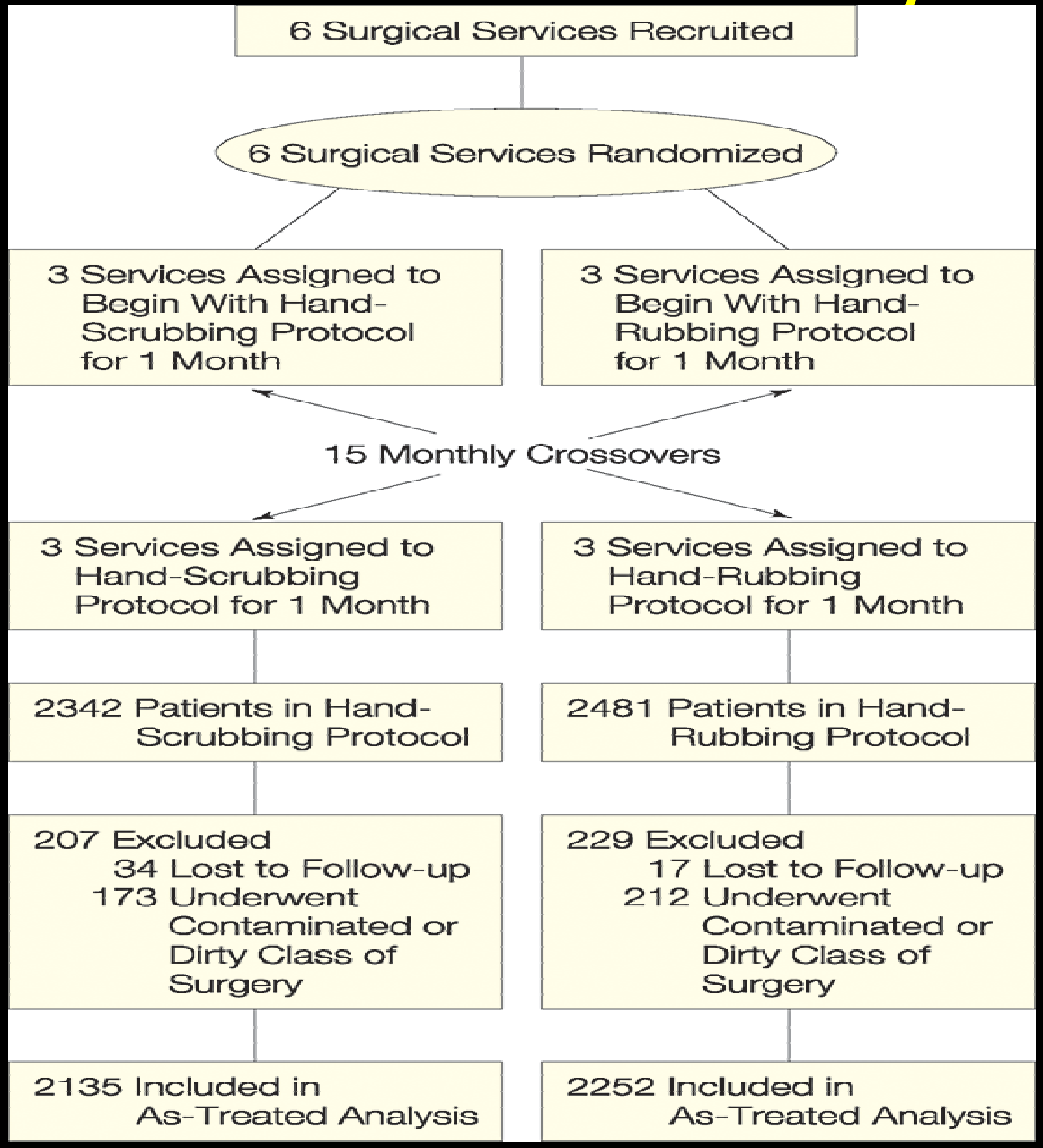
Parienti et al. *JAMA*. Vol 288,No.6. 2002

Data Analysis

- Primary endpoint- SSI at 30 days
  - Equivalence study
- Secondary endpoints- compliance and tolerance

Parienti et al. JAMA. Vol 288,No.6. 2002

Overview of Study



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Patient Characteristics

Table 1. Characteristics of the Patients According to the Hand-Hygiene Protocol*

Characteristic	Protocol, No. (%)	
	Hand-Scrubbing (n = 2135)	Hand-Rubbing (n = 2252)
Age, mean (SD), y	51.1 (17.6)	49.5 (17.4)
ASA physical status class		
1	948 (44.4)	1057 (46.9)
2	795 (37.2)	840 (37.3)
3	351 (16.4)	306 (13.6)
4 and 5	15 (0.7)	16 (0.7)
Unknown	26 (1.2)	33 (1.5)
Altemeier clean class	1485 (69.6)	1520 (67.5)
Duration of surgery, mean (SD), min	79.1 (73.6)	76.3 (71.6)
Emergency surgery	189 (8.9)	213 (9.5)
Type of surgery		
Gynecology	629 (29.5)	730 (32.4)
Urology	268 (12.6)	272 (12.1)

No differences in baseline characteristics between the 2 protocols

*ASA indicates American Society of Anesthesiologists. The ASA physical status classification indicates class 1, a healthy patient; class 2, a patient with mild systemic disease; class 3, a patient with severe systemic disease; class 4, a patient with severe systemic disease that is a constant threat; and class 5, a moribund patient who is not expected to survive without an operation.

Parienti et al. *JAMA*. Vol 288,No.6. 2002

SSI Rates

Table 2. Surgical Site Infection (SSI) Rates and Differences Between Hand-Scrubbing and Hand-Rubbing*

Altemeier Class of Contamination	No. SSI/No. Operations (%)		SSI Rate Difference (Hand-Scrubbing–Hand-Rubbing), % (95% Confidence Interval)	χ^2 Test of Equivalence (*P* Value)
	Hand-Scrubbing Protocol	Hand-Rubbing Protocol		
Clean	29/1485 (1.95)	32/1520 (2.11)	–0.15 (–1.16 to 0.85)	16.0 (<.001)
Clean-contaminated	24/650 (3.69)	23/732 (3.14)	0.55 (–1.36 to 2.46)	1.9 (.09)
All	53/2135 (2.48)	55/2252 (2.44)	0.04 (–0.88 to 0.96)	19.5 (<.001)

*The 95% confidence interval of the SSI rate difference was calculated according to Wallenstein18 and the χ^2 test was the

No differences in overall SSI rates observed

Parienti et al. JAMA. Vol 288,No.6. 2002

Compliance With Hand Antisepsis

Table 3. Compliance With the Recommended Duration of Hand Antisepsis During the First Procedure of the Day*

Operating Room Personnel	Hand-Scrubbing Protocol	Hand-Rubbing Protocol	*P* Value†
Duration of hand antisepsis, mean (range), s	287 (100-480)	313 (60-510)	.01‡
No. of hand antisepsis ≥5 min/total no. of hand antisepsis (%)			
Surgeon/assistant	20/83 (24)	51/133 (38)	.04
Scrub nurse	9/21 (42)	26/41 (63)	.18
All	29/104 (28)	77/174 (44)	.008

*Time required for the nonantiseptic hand wash prior to hand-rubbing with aqueous alcoholic solution has been excluded.

†

‡

Greater compliance observed with hand rubbing alcohol

Parienti et al. JAMA. Vol 288,No.6. 2002

Study Conclusions

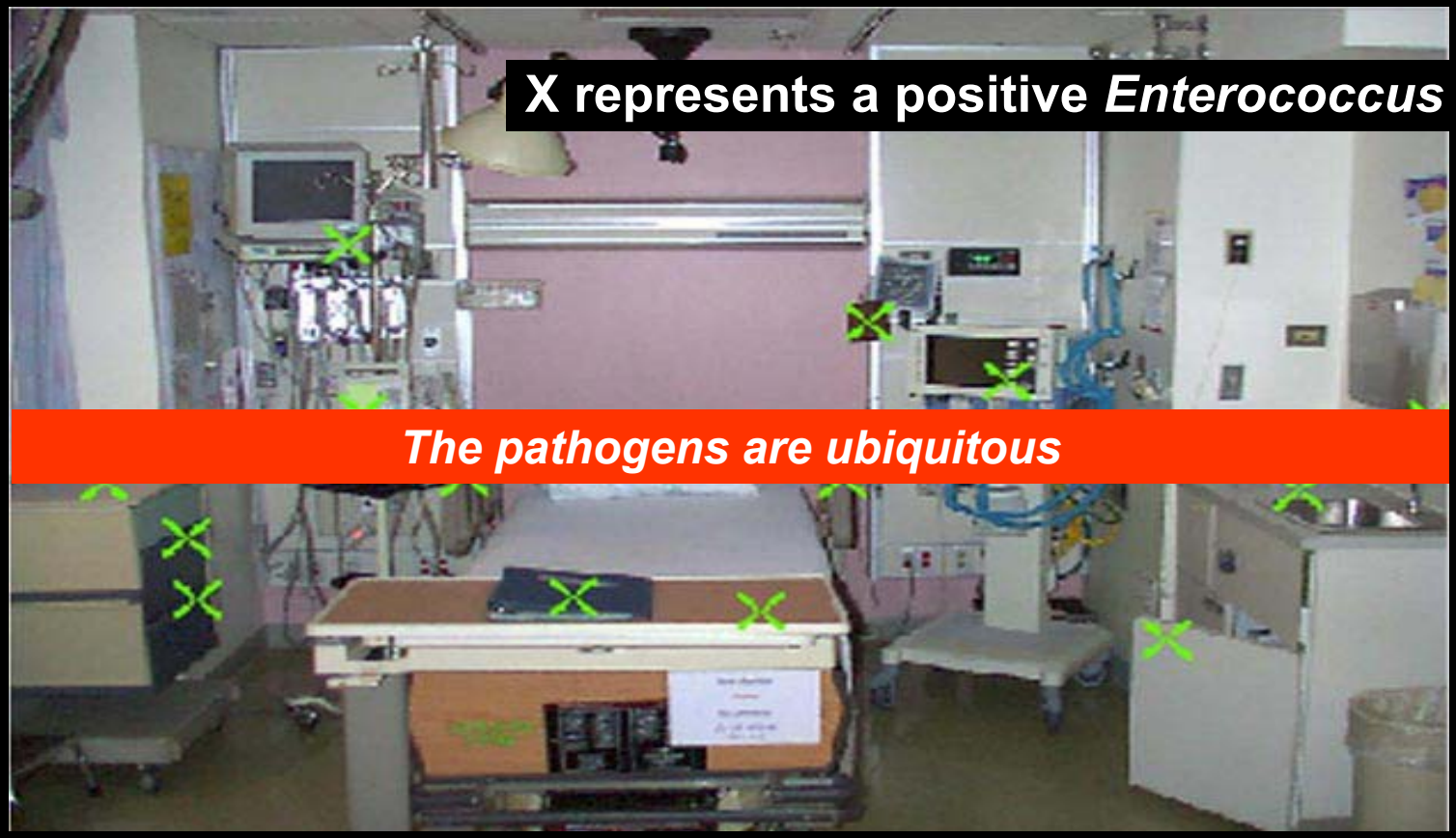
- Hand rubbing protocol with aqueous alcoholic solution was as effective as traditional hand scrubbing with antiseptic soap in preventing surgical site infections in a 30 day follow-up.
- Hand rubbing protocol with aqueous alcoholic solution was better tolerated by surgical teams and improved compliance with hygiene guidelines.
- Hand rubbing protocol with aqueous alcoholic solution can be safely used as an alternative to traditional surgical hand-scrubbing.

Parienti et al. *JAMA*. Vol 288,No.6. 2002

30%-40% of all Nosocomial Infections are Attributed to Cross Transmission:

The Importance of Hand Hygiene

The inanimate environment is a reservoir of pathogens



~ Contaminated surfaces increase cross-transmission ~

Abstract: The Risk of Hand and Glove Contamination after Contact with a VRE (+) Patient Environment. Hayden M, ICAAC, 2001, Chicago, IL.

The inanimate environment is a reservoir of pathogens

Recovery of MRSA, VRE, C.*diff,* CNS and GNR

Devine et al. *Journal of Hospital Infection.* 2001;43;72-75

Lemmen et al *Journal of Hospital Infection*. 2004; 56:191-197

Trick et al. *Arch Phy Med Rehabil* Vol 83, July 2002

Walther et al. *Biol Review,* 2004:849-869

Hand Hygiene

Single most effective method to limit cross transmission

Hand Hygiene	Comment
Typical Compliance	Observational studies of hand hygiene report compliance rates of 5-81%
Common Reported Barriers To Compliance	Insufficient time, understaffing, patient overcrowding, lack of knowledge of hand hygiene guidelines, skepticism about hand washing efficacy, inconvenient location of sinks and hand disinfectants and lack of hand hygiene promotion by the institution

HCWs' perceptions of compliance with infection control practices

		% of HCWs reporting compliance >80%		
Position	**N (%)**	**Handwashing**	**Contact isolation**	**Airborne isolation**
Registered nurses	118 (36)	77	59	74
Resident physicians	99 (31)	62	61	92
Attending physicians	33 (10)	62	72	82
LPNs, patient care assistants	29 (9)	59	72	76
Others	45 (14)	73	79	69
Total	**324 (100)**	**69**	**65**	**80**

Majority of respondents reported excellent compliance with IC practices

Berhe M, Edmond MB, G Bearman in ***AJIC*** 33;1 February 2005, 55-57

Alcohol Based Hand Sanitizers

- CDC/SHEA hand antiseptic agents of choice
  - Recommended by CDC based on strong experimental,clinical, epide microbiologic data
  - Antimicrobial superiority
    - Greater microbicidal effect
    - Prolonged residual effect
  - Ease of use and application

Alcohol based hand hygiene solutions

Quick: 5- 15 seconds

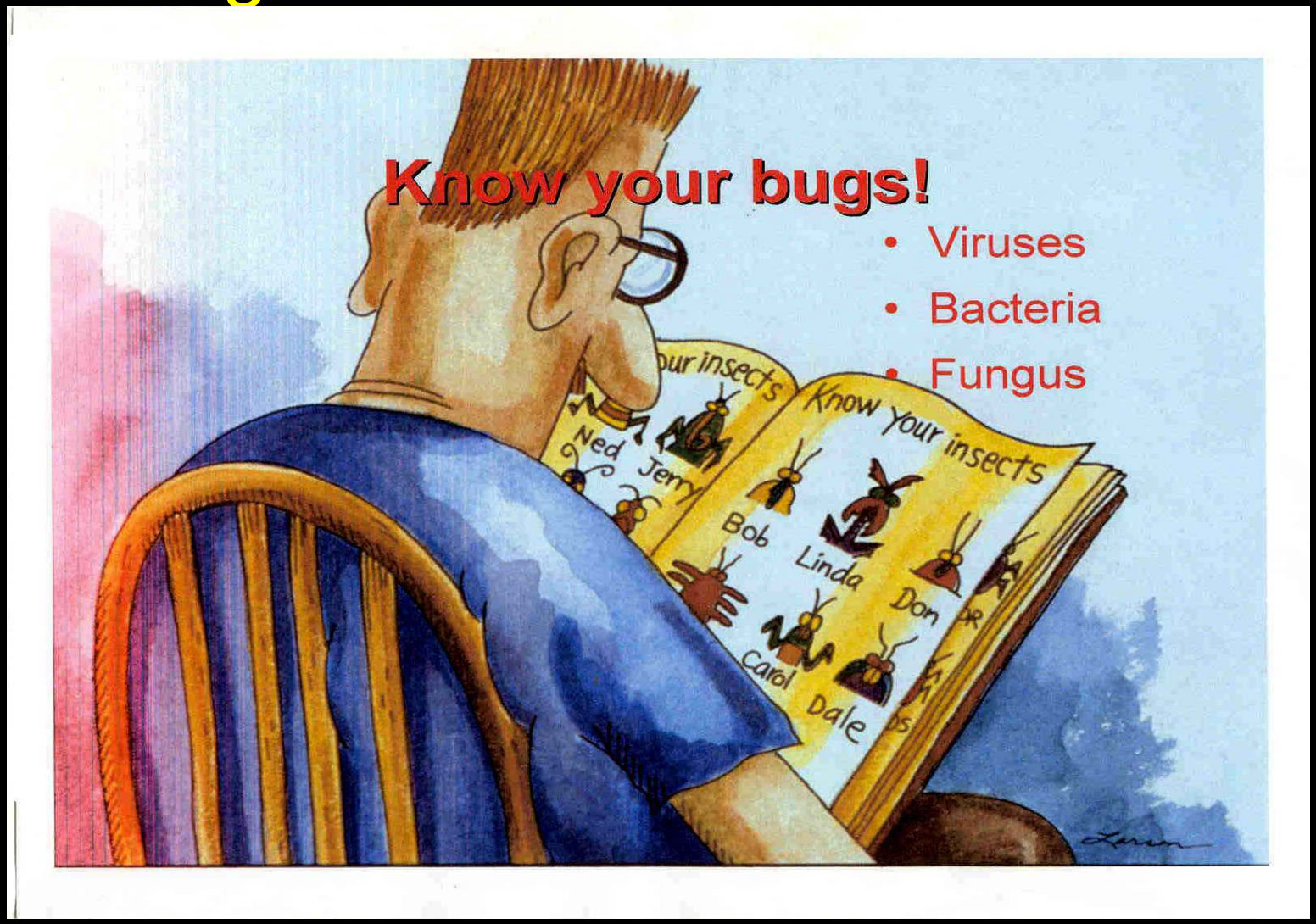
Easy to use

Very effective antisepsis due to bactericidal properties of alcohol

Conclusion

- Infection control is immediately relevant to surgical practice
- Research has led to well defined risk factors and risk reduction interventions for:
  - VAP,UTI,BSI, and SSI
- Sadly, implementation of risk reduction practices is frequently not uniform and poorly sustained
- Consumer advocacy groups, 3rd party payers, and regulatory agencies are increasingly mandating health system quality improvement through reporting of IC process of care measures

The Importance of Infection Control in Limiting the Cross Transmission of Pathogens



Supplemental Perioperative Oxygen

- Surgical wounds disrupt the local vascular supply as a result of injury & thrombosis of vessels, which cause wounds to be hypoxic as compared to normal tissue (often <30 mmHg)
- Increasing the PaO2 increases bactericidal superoxide radicals, but also cause endothelial cell damage, tissue necrosis, & impair the antibacterial function of macrophages

Supplemental Perioperative Oxygen

- 500 patients undergoing elective colorectal resection randomized to 30% O_2 vs. 80% O_2 during surgery & first 2 hours of recovery

	30% O_2	**80% O_2**	**P**
Wound infection	11.2%	5.2%	0.01
ICU admission	4.8%	2.0%	0.14
LOS after surgery	11.9 days	12.2 days	0.26
Mortality	2.4%	0.4%	0.13

Greif R et al. New Engl J Med 2000;342:161-7.

Supplemental Perioperative Oxygen

- 165 patients undergoing elective abdominal surgery randomized to 35% O_2 vs. 80% O_2 during surgery & first 2 hours of recovery

	35% O_2	**80% O_2**	**P**
Wound infection	11.3%	25.0%	0.02
ICU admission	8.8%	11.3%	0.60
LOS after surgery	6.4 days	8.3 days	0.07

Pryor KO et al. JAMA 2004;291:79-97.