

Evidence Based Prevention Surgical Site Infection (SSI)



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Purpose

- Epidemiology SSI
- Prevention principles
- Focus peri-operative bundles

Quality Improvement Benchmarks

- National Healthcare Safety Network
- 2006-2008
- 1545 Hospitals
- CDC based reporting

	Patients	% SSI
Laminectomy	40077	1.02%
Fusion	30310	1.9%
Revision fusion	989	3.1 %
Overall		1.5%

Quality Improvement Benchmarks

- National Healthcare Safety Network
- 2006-2008
- 1545 Hospitals
- CDC based reporting

	Patients	% SSI
THA	130,418	1.27%
TKA	171,186	0.89%

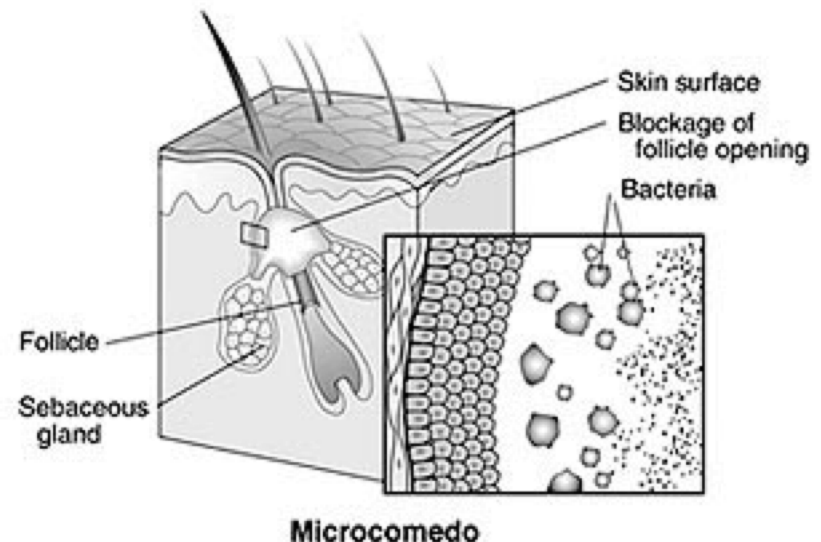
Pathogens (NSHN)

Pathogen	Orthopedic (n = 7,765)
<i>Staphylococcus aureus</i>	3,656 (47.1)
<i>Escherichia coli</i>	314 (4.0)
Coagulase-negative staphylococci	1,073 (13.8)
<i>Klebsiella (pneumoniae/oxytoca)</i>	159 (2.0)
<i>Pseudomonas aeruginosa</i>	341 (4.4)
<i>Enterococcus faecalis</i>	354 (4.6)
<i>Candida albicans</i>	22 (0.3)
<i>Enterobacter</i> spp.	238 (3.1)
Other <i>Candida</i> spp. or NOS	14 (0.2)
<i>Enterococcus faecium</i>	76 (1.0)
<i>Enterococcus</i> spp.	154 (2.0)
<i>Acinetobacter baumannii</i>	51 (0.7)
<i>Streptococcus</i> spp.	433 (5.6)
<i>Proteus</i> spp.	231 (3.0)
<i>Serratia</i> spp.	98 (1.3)
Other ^b	551 (7.1)
Total	7,765 (100)

Propionibacterium acnes

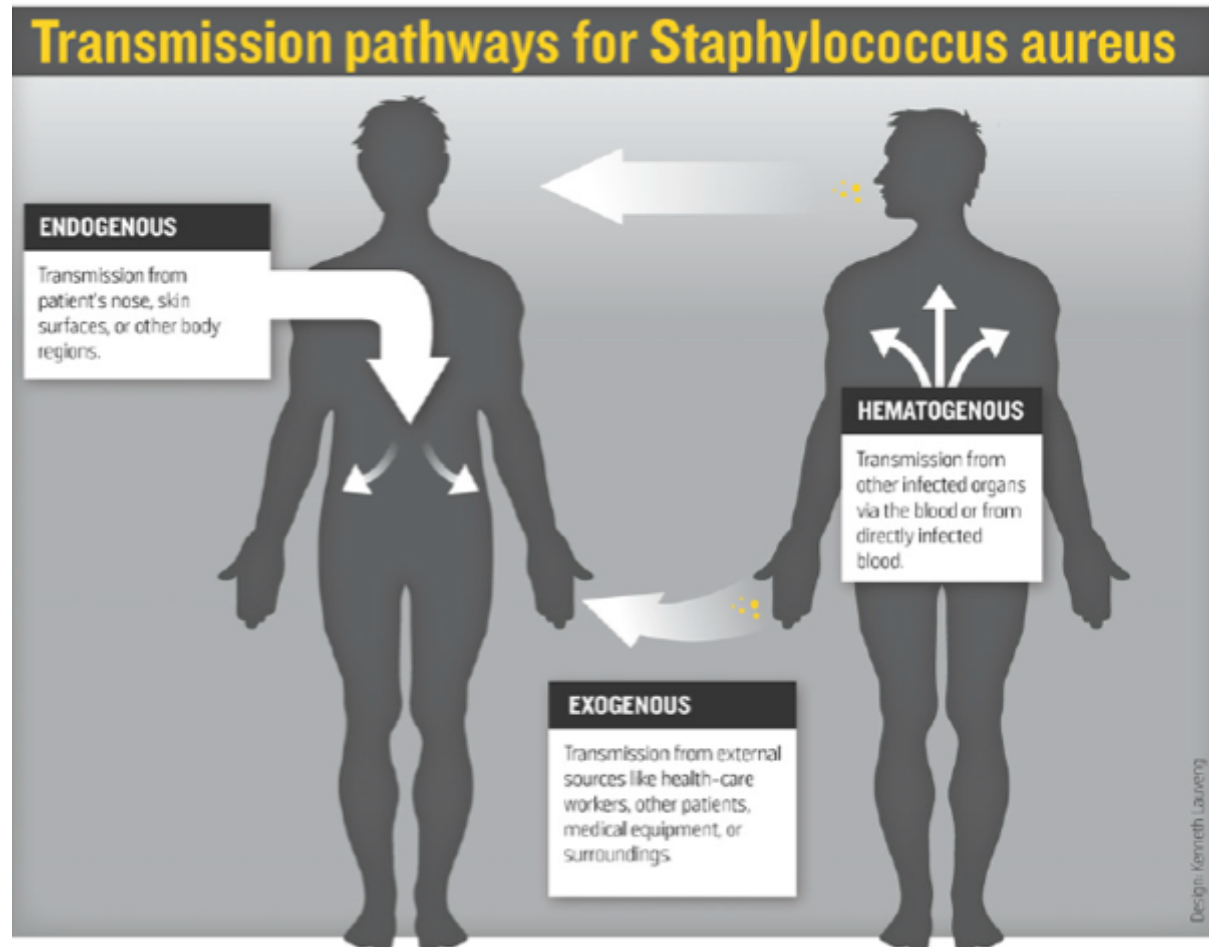
- Gram positive anaerobic rod
- Ubiquitous skin flora
- Acne
- Associated latent periprosthetic infection
- Neurosurgery shunt infections
- Shoulder surgery
 - Pilosebaceous gland
 - Ineffective skin prep and abx
 - 1/3 of patient culture + after prep

No effective means sterilize skin



What Are Source of Organisms?

- Endogenous
- Exogenous
- Hematogenous



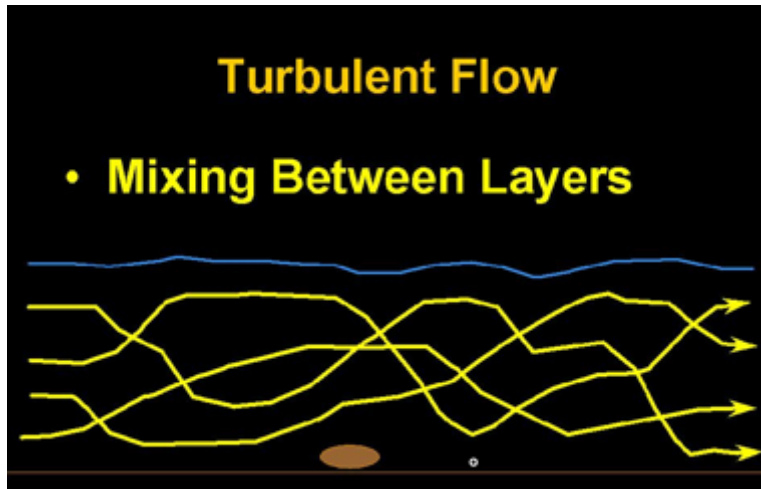
Endogenous Source

- MSSA, MRSA carriers
 - Nares
- Genetic typing
- Correlate to SSI organism
- Skramm JBS 2014
- Bode NEJM 2010

	% Endogenous
Skramm	86%
Bode	78%

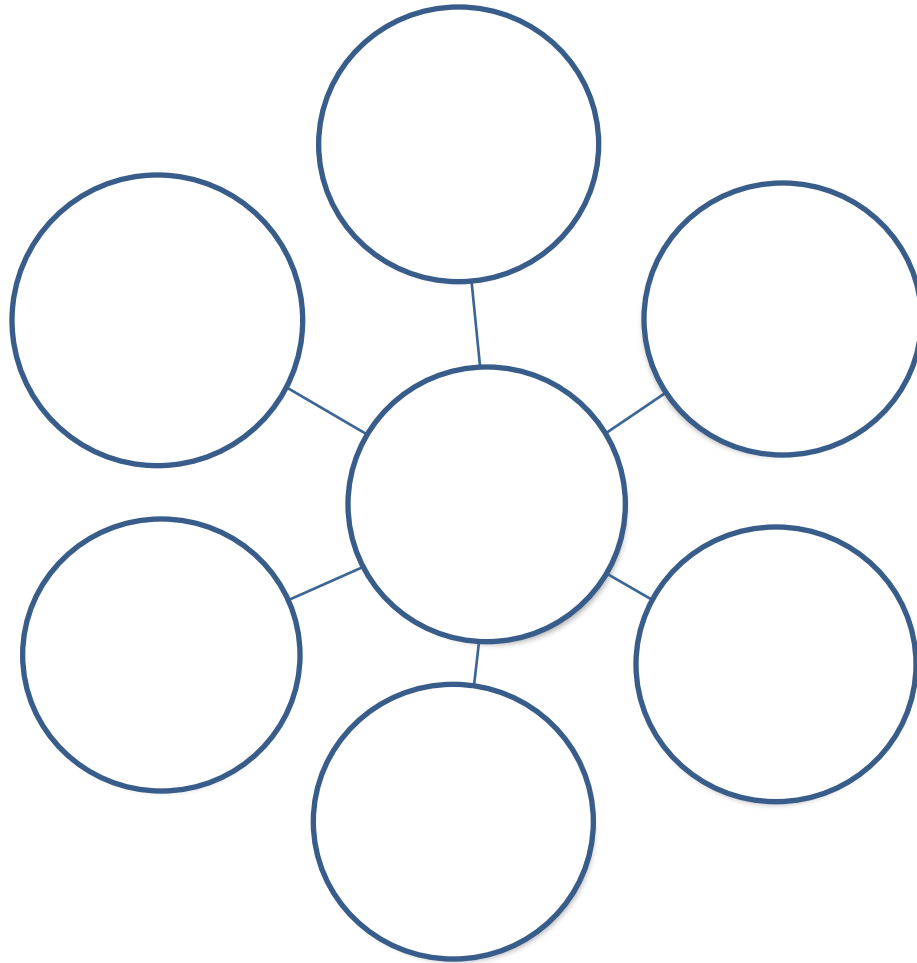
How Do They Get Spread Around?

- Hand contact
 - Health care workers
- Air quality
 - Room turbulence



Prevention Surgical Site Infection

- Systems approach
- Team effort
- Goal: >50% reduction



Safety Checklists

- Common use
- Aid communication
- Uniform care
- Reduce errors
- Improves compliance
- Reduce mortality and morbidity
- Reduce SSI



Safety Checklists

- Standards
 - SCIF
 - JACHO

Table 1 – SCIP *Inf* performance measures verbally addressed in the Scott and White surgical safety checklist.

SSC section	SCIP <i>Inf</i> performance measures	Verbal verification by surgical team
Check in	<i>Inf</i> -10 perioperative temperature management	Estimated time for procedure
Sign in	<i>Inf</i> -10 perioperative temperature management	Risk of hypothermia (operation >1 h)
Time out	<i>Inf</i> -2 antibiotic selection	Appropriate antibiotic ordered
Time out	<i>Inf</i> -1 antibiotic timing	Antibiotic given within 60 min of incision (except vancomycin)

Improved compliance
Near 96-99%
No change in SSI

Basic Principles Mangram 1999

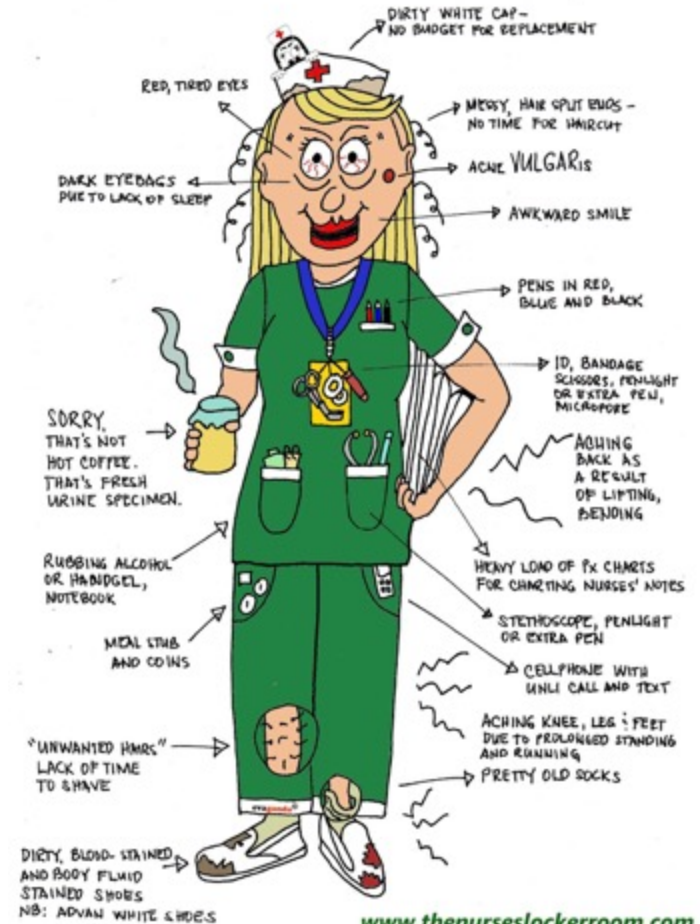
- Optimize pt health/ nutrition
- Sterilization equipment
- Positive pressure airflow
- Skin prep
- Antimicrobials
- Aseptic surgical technique

Bundled Effort to Reduce SSI

- The patient
- Surgical technique
- Surgical environment

Bundled Approach

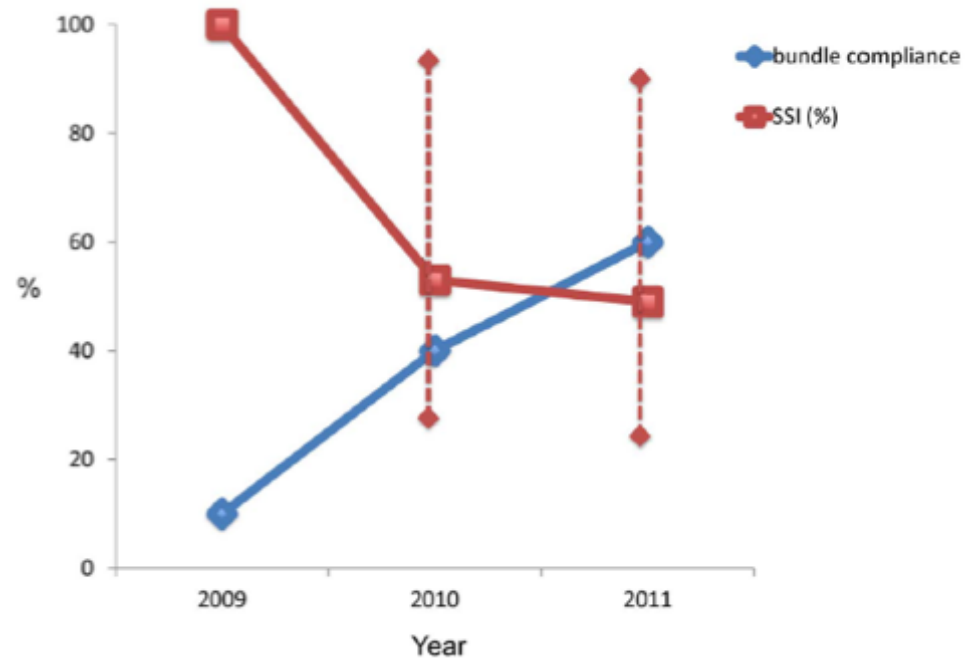
- Multiple interventions
- Team approach
- Include patient
- Safety becomes priority for everyone
- Evidence based
- Disadvantage – unknown which interventions work



Bundled Approaches

Van der Slegt PLOS One 2013

- Highly effective
- 40-60% reduction SSI
- Bundle
 - Normothermia
 - Hair removal preop
 - Antibiotics
 - Room discipline



Pre-admission Care

- Indications
- Optimize medical conditions
- Screening
- Decolonization

Pre-operative (Day of Surgery)

- Skin check
- Further decolonization
 - Skin wipes
- Preoperative antibiotics

Skin Assessment

- Ensure skin is epithelialized
- No active infections
- Dermatological conditions optimized



Do not be afraid to cancel surgery!

Local Skin Decolonization Sage Cloths

- 2% CHG
- Cloth dressing
- Towels for bath
- Soak surgical site
 - Night before surgery
 - Am in preop holding
- \$2.80/ pair

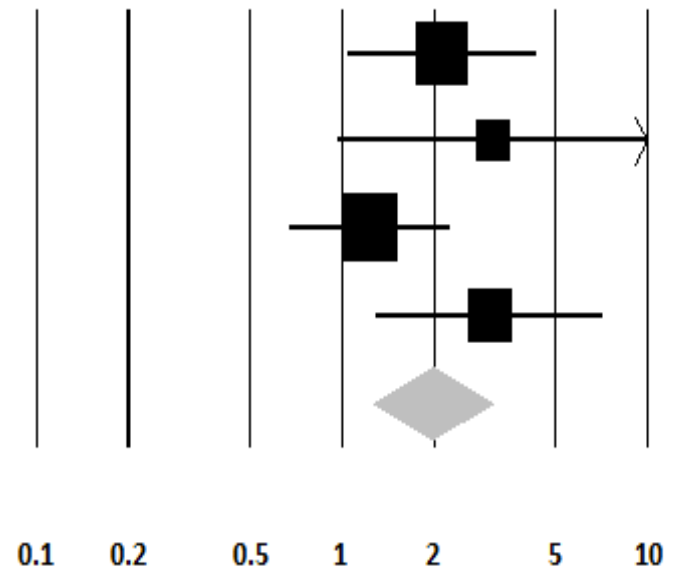


Sage Cloths

- 4 Historical cohort

	Risk ratio	Lower limit	Upper limit
Eislet, Ortho Nurs 2009	2.12	1.04	4.31
Kapadia, J Artho 2011	3.13	0.96	10.17
Farber CORR 2013	1.23	0.67	2.25
Grayling, AORN 2013	3.03	1.29	7.16
	1.98	1.26	3.10

Risk Ratio Ctrl/ Sage
RR 1.98



Reduces infection by 50%

Low Cost

Low risk

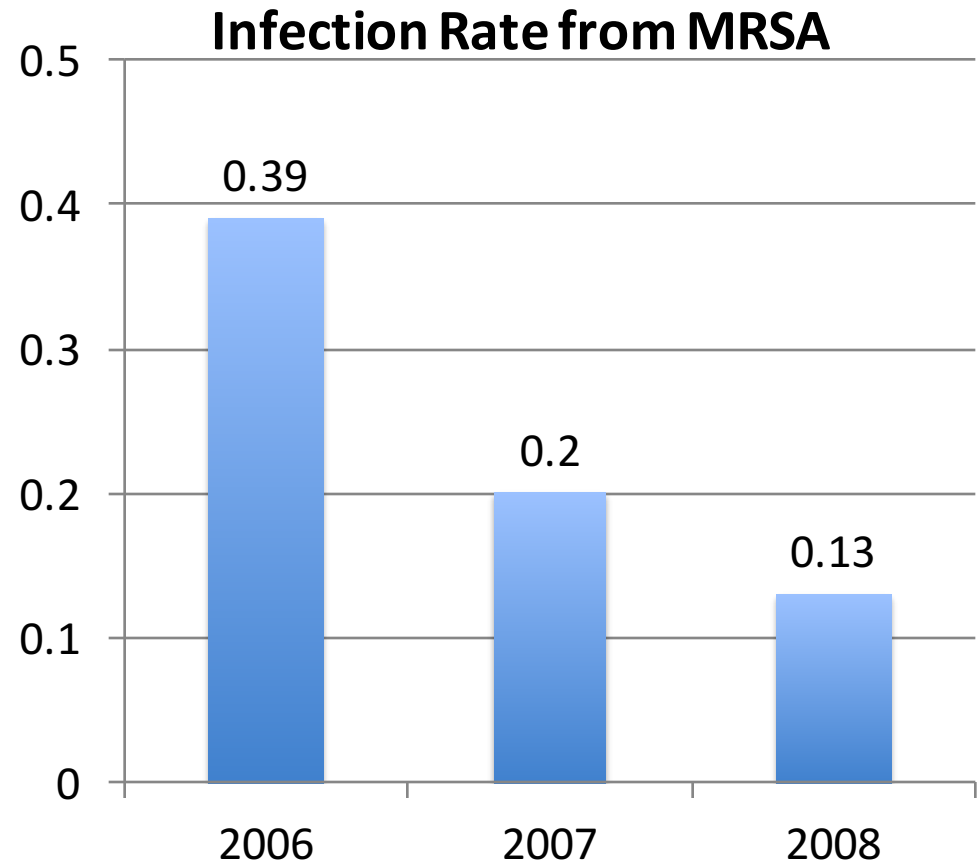
Favors
Control

Favors
Sage

Decreasing MRSA SSI

Thompson A, J Inf Cntr 2012

- 2007
- All surgical pts
 - CHC 2% cloths (non rinse)
 - Mupirocin nasal ointment
 - 5 days



Peri-operative Antibiotics

- Many guidelines
- Administer within 1 hour
- No more than 24 hrs
- Active against anticipated organisms
 - Staphylococcus

Clinical practice guidelines for antimicrobial prophylaxis in surgery

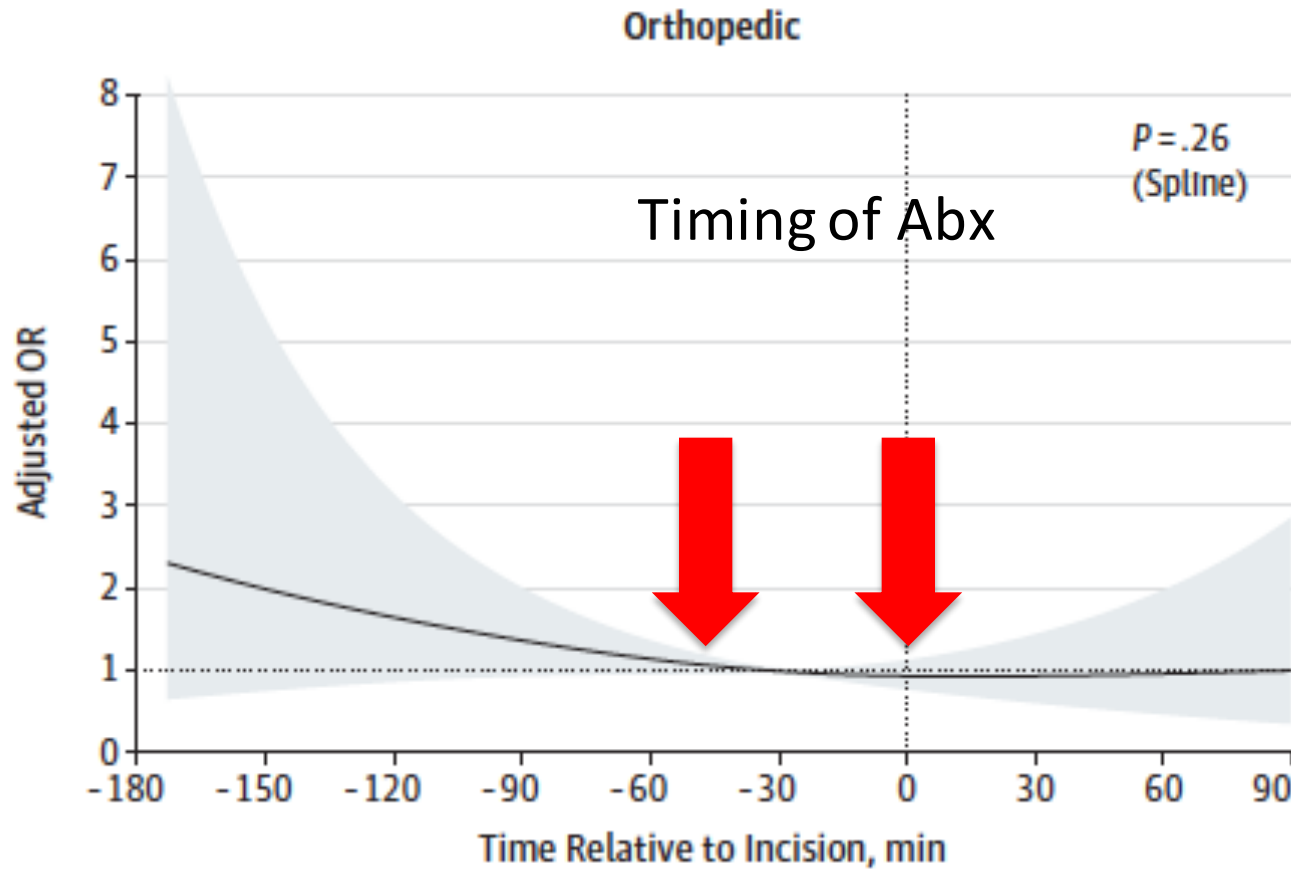
DALE W. BRATZLER, E. PATCHEN DELLINGER, KEITH M. OLSEN, TRISH M. PERL, PAUL G. AUWAERTER, MAUREEN K. BOLON, DOUGLAS N. FISH, LENA M. NAPOLITANO, ROBERT G. SAWYER, DOUGLAS SLAIN, JAMES P. STEINBERG, AND ROBERT A. WEINSTEIN

Am J Health-Syst Pharm. 2013; 70:195-283

	No allergy	β Lactum allergy	MRSA Carrier
	Cephazolin	Clindamycin	Vancomycin + cephalosporin
Weight < 120 kg	2 gm	900 mg	15 mg/kg 2 gm
Weight > 120 kg	3 gm	900 mg	15 mg/kg 3 gm
Re-dosing	4 hr	6 hrs	4 hrs
Alternatives	Cefuroxamine (1.5gm)	Vancomycin (15mg/kg)	

Type and Timing of Antibiotics

Hawn JAMA 2013

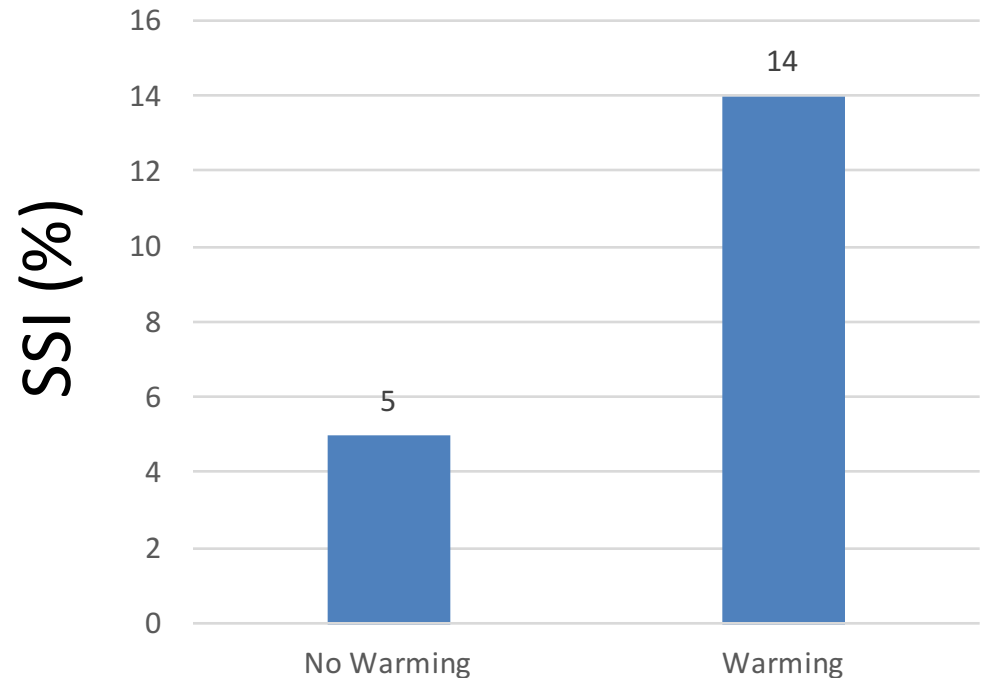


Within 1 hour of surgery optimal

Pre-operative Warming

Melling Lancert 2001

- Preop vs no preop warming
 - 30 min prior surgery
- RCT 421 patients
- Hernia, vein, breast
- Sig lower with preop warming



Intra-operative

- Many opportunities
- Bundled approach

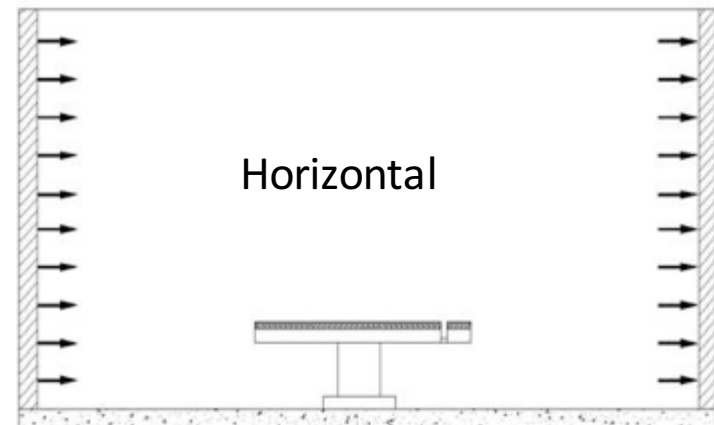
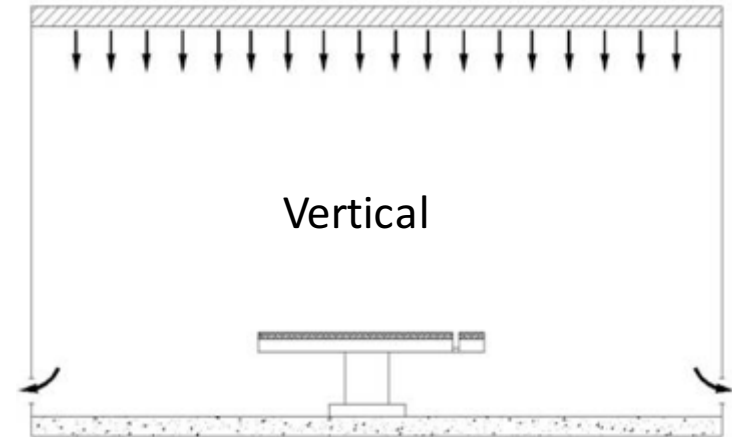
Hair Removal

- Multiple RCT's show
 - Lower SSI by clipping
 - Conjunction with surgery
- SCIP Measure



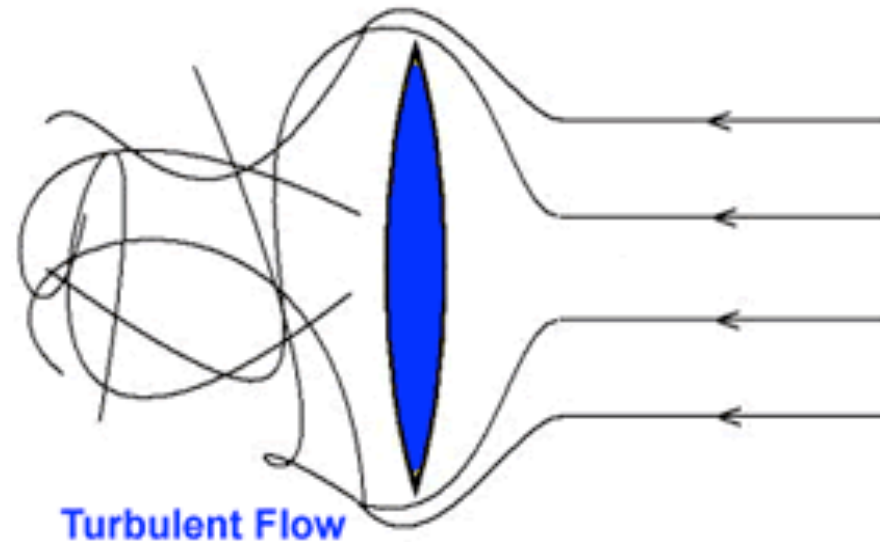
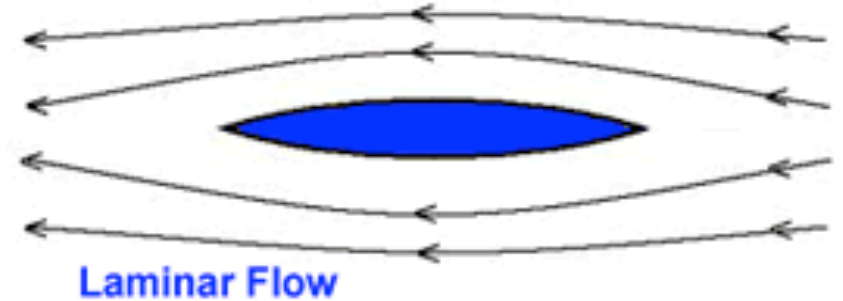
Air Quality

- 25 Air volume exchanges per hour
- Filtrated air
- Positive pressure
- Best from ceiling with exhaust just above floor



Fluid Dynamics

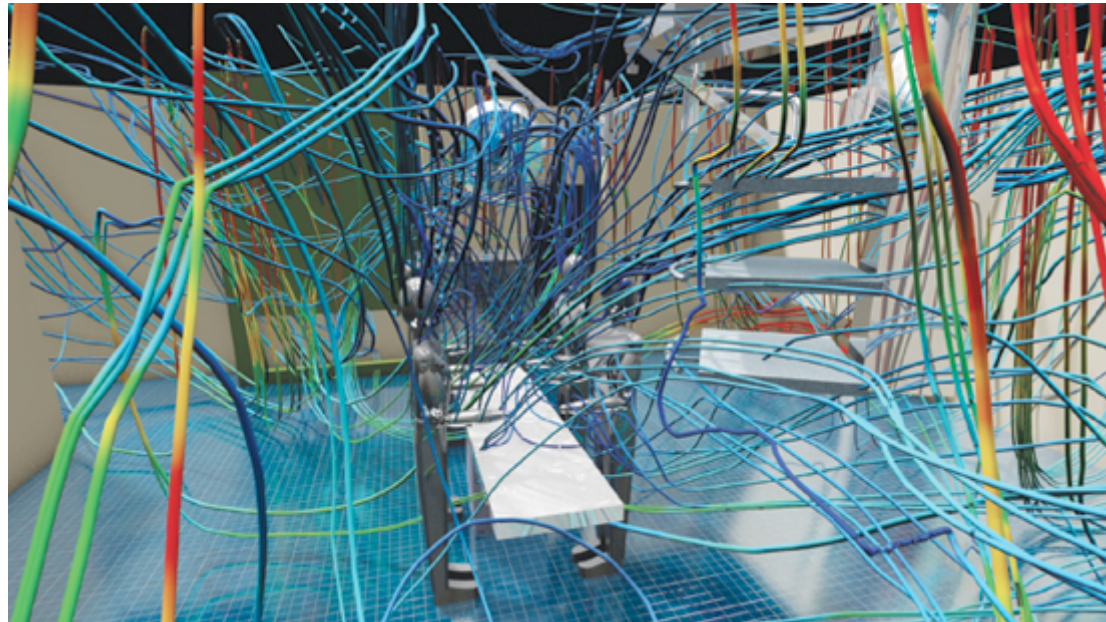
- Laminar flow
 - No mixing
 - Slower rate
- Turbulent flow
 - Mixing
 - Eddys
 - Higher flow rate



Laminar Flow



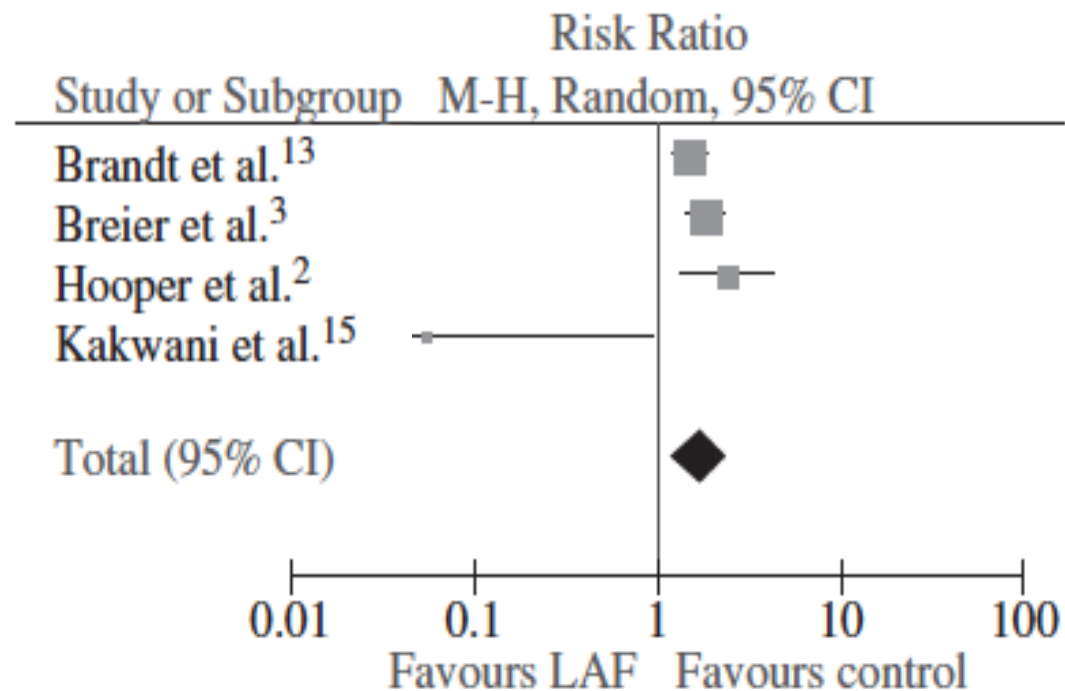
Turbulent Flow



Systematic Review - Laminar Flow

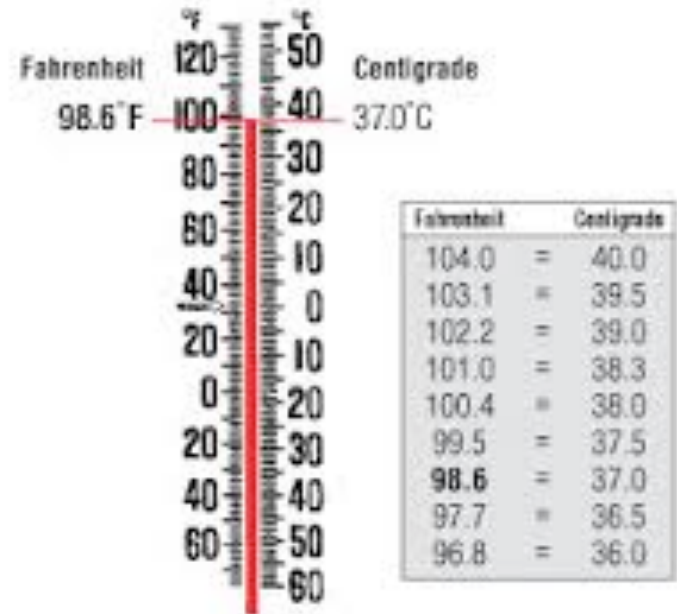
P. Gastmeier et al. / Journal of Hospital Infection 81 (2012) 73–78

- Four studies
- Risk ratio
 - 1.71 (1.21, 2.41)
 - $P < 0.001$
- Heterogeneity
 - I square 64%



Normothermia, $>36^{\circ}$

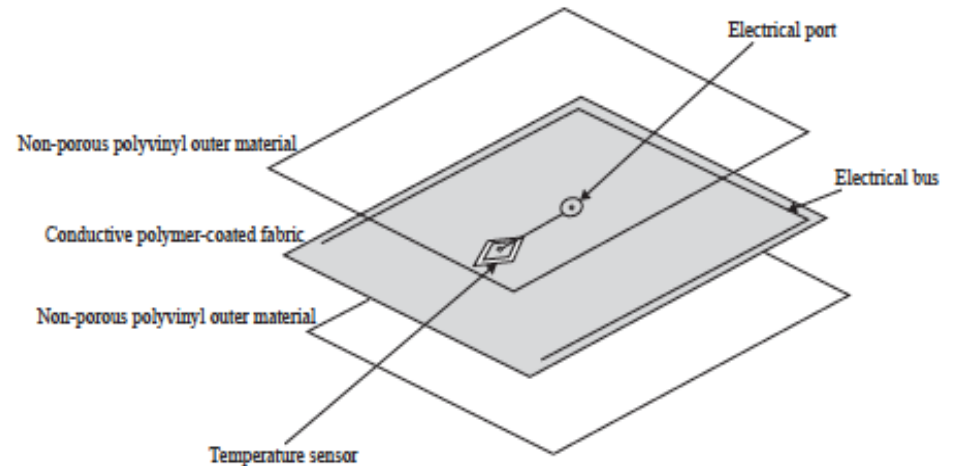
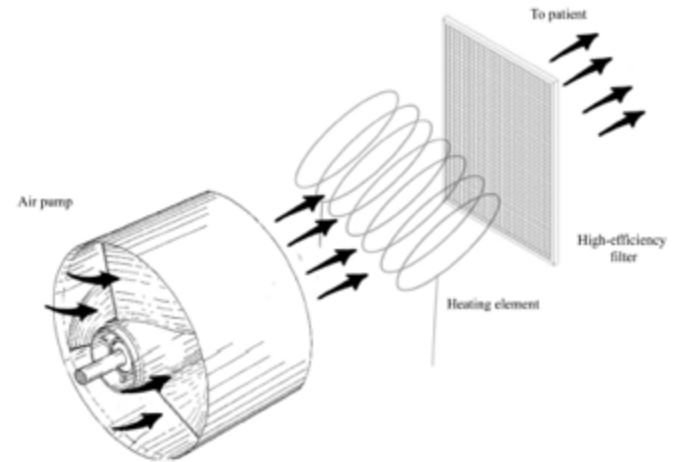
- Hypothermia 3 x risk SSI
 - Colorectal surgery
- SCIP measure
 - Colorectal surgery
 - Not orthopedic!



No standards for temperature in Orthopedic surgery

Warming Methods

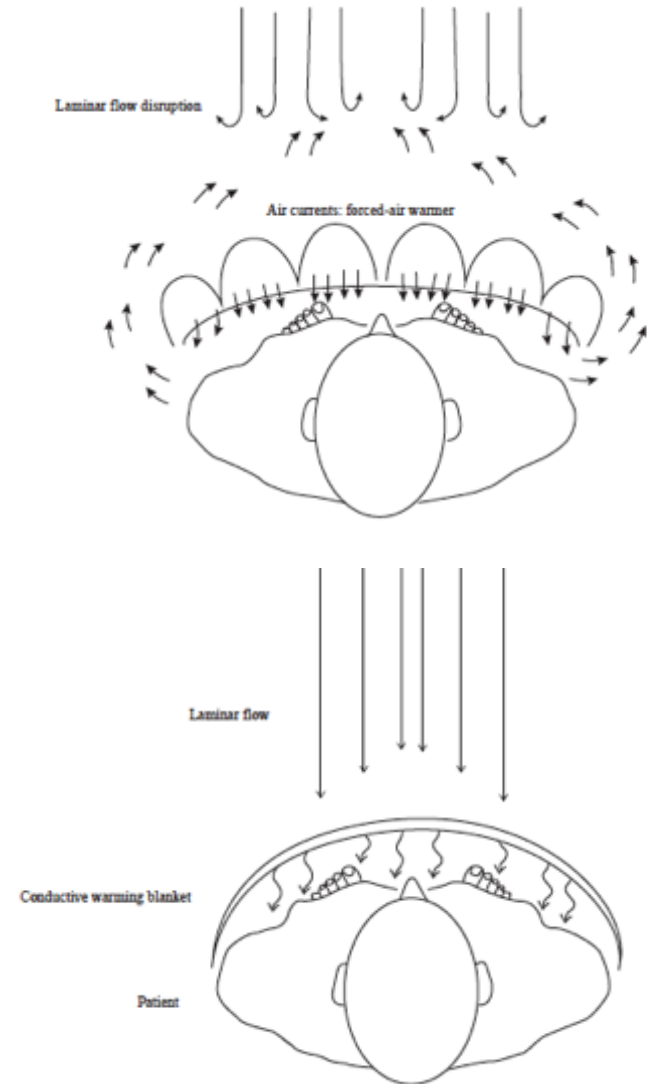
- Forced air warming
- Conductive polymer (electric)
- Circulation warming systems



Problems - Forced Air Systems

- Forced air eddys
- Thermal eddys
- Poor filtration
 - 63% effective
 - Coag neg staph
- Exhaust unfiltered

Surgical Site Infection
Conflicting results



Forced Air Warmer McGovern JBJS Br 2011

- 1037 Patients
 - Control Bear hugger
 - Warming fabric
- SSI rate

Need to consider alternatives

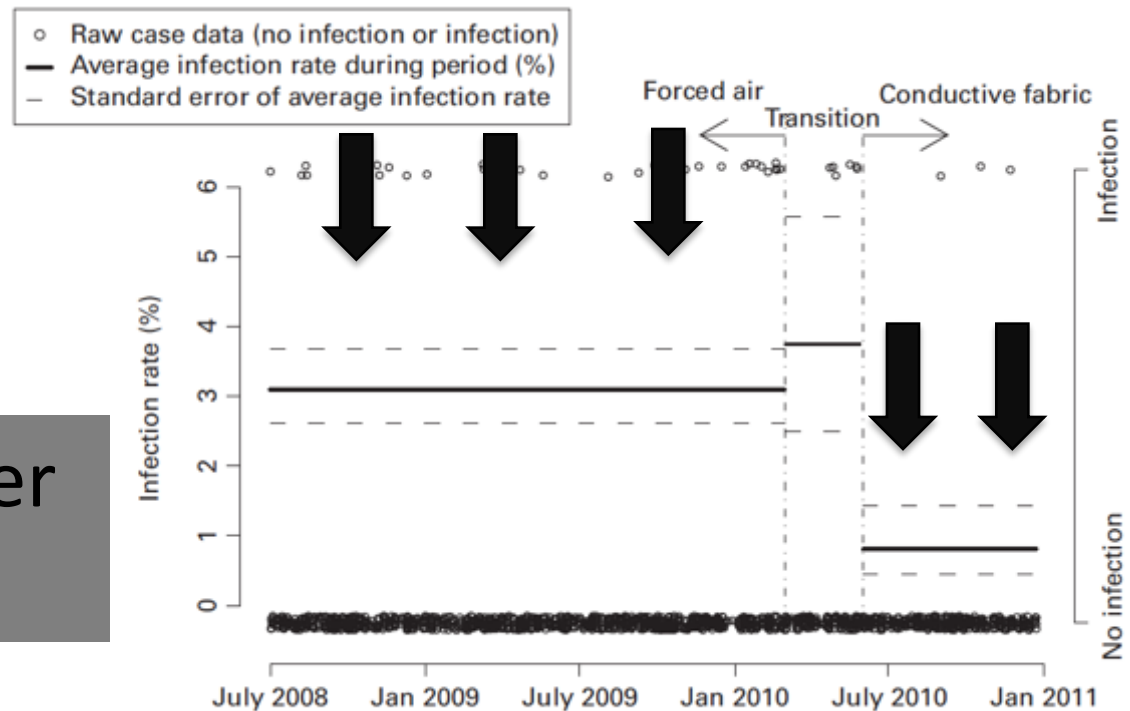


Fig 7

Space Suits

- Control air exchange from surgeon to pt
- Maintain laminar flow
- Widely used arthroplasty
- UWHC surgeons
 - Always use them
 - No evidence
 - “Protects themselves”





G. J. Hooper,
A. G. Rothwell,
C. Frampton,
M. C. Wyatt

Does the use of laminar flow and space suits reduce early deep infection after total hip and knee replacement?

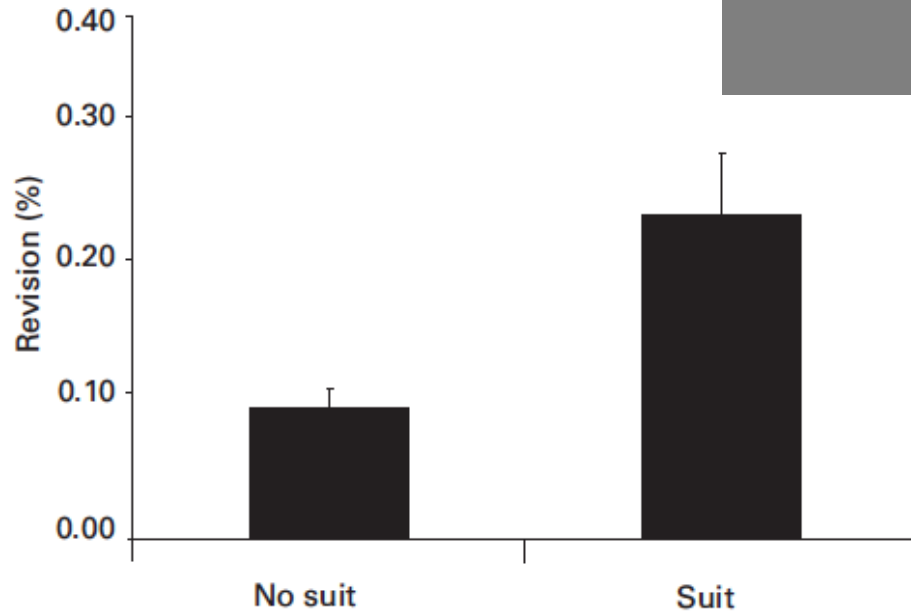
THE TEN-YEAR RESULTS OF THE NEW ZEALAND JOINT REGISTRY

- 88000 THA,TKA
- Registry
- 6 month Infection rates
- Laminar flow use 35%
- Space suits use 24%

Does the use of laminar flow and space suits reduce early deep infection after total hip and knee replacement?

THE TEN-YEAR RESULTS OF THE NEW ZEALAND JOINT REGISTRY

G. J. Hooper,
A. G. Rothwell,
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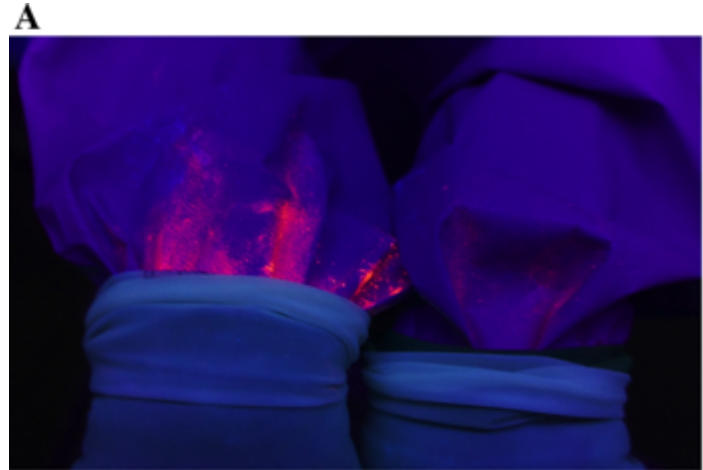


Fewer revisions without space suits

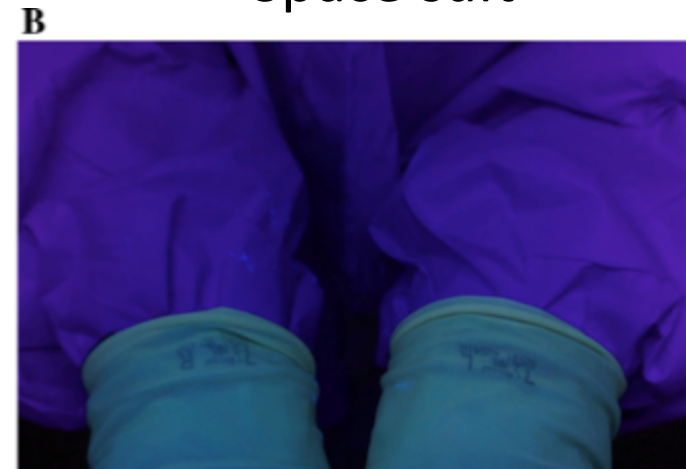
Adverse Effects of Space Suits

Young Eur J Orthop Surg Trauma 2014

- Powder migration
- Airflow forced out arms
- Dominant forearm flexor surface
- Rx Tape sleeve



Space suit



No space suit

Comparison between mixed and laminar airflow systems in operating rooms and the influence of human factors: Experiences from a Swedish orthopedic center

American Journal of Infection Control 42 (2014) 665-9

Annette Erichsen Andersson PhD, RN^{a,b,*}, Max Petzold PhD^c, Ingrid Bergh PhD, RN^d, Jón Karlsson MD, PhD^{e,f}, Bengt I. Eriksson MD, PhD^{e,f}, Kerstin Nilsson PhD, RN^a

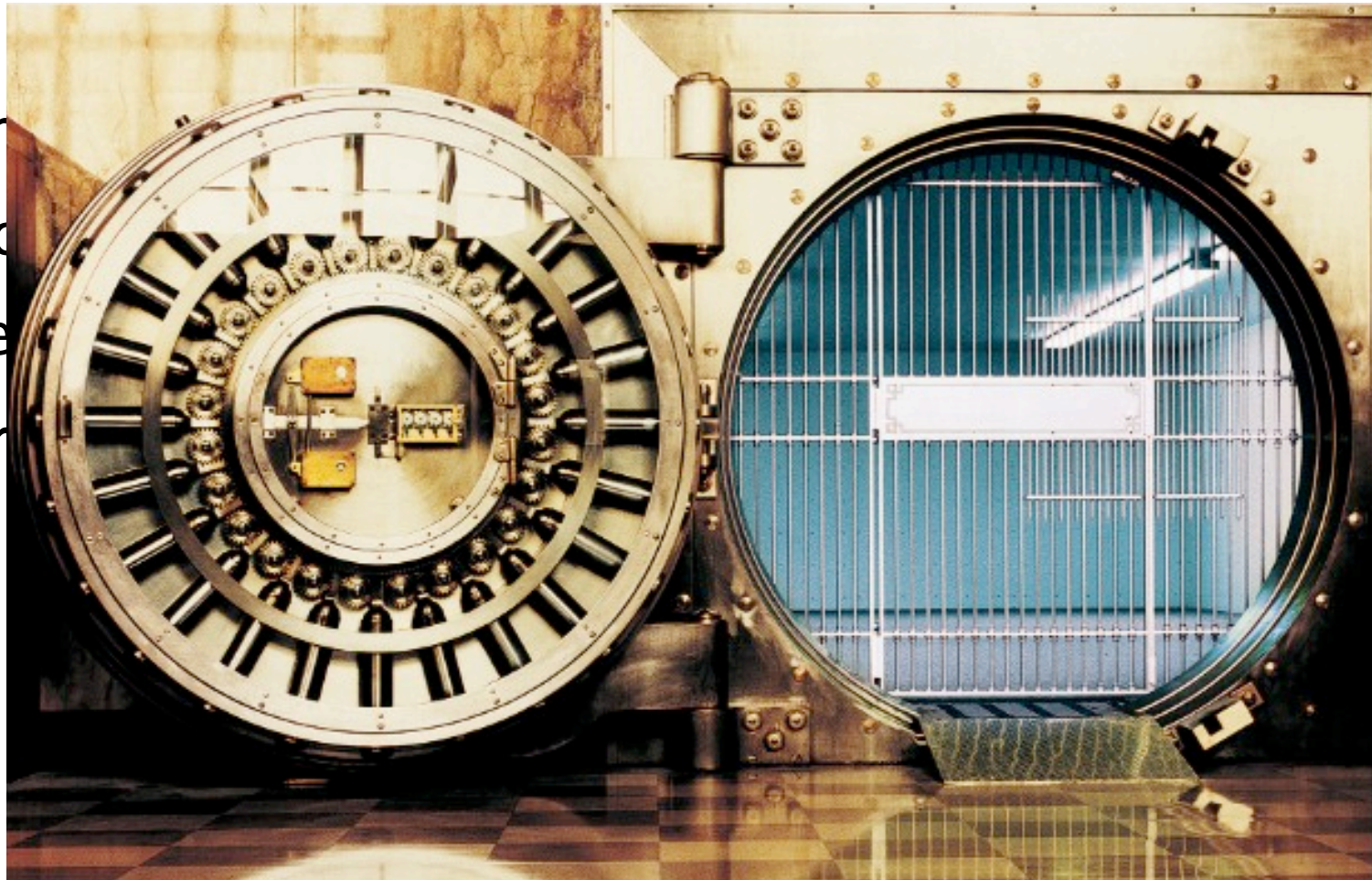


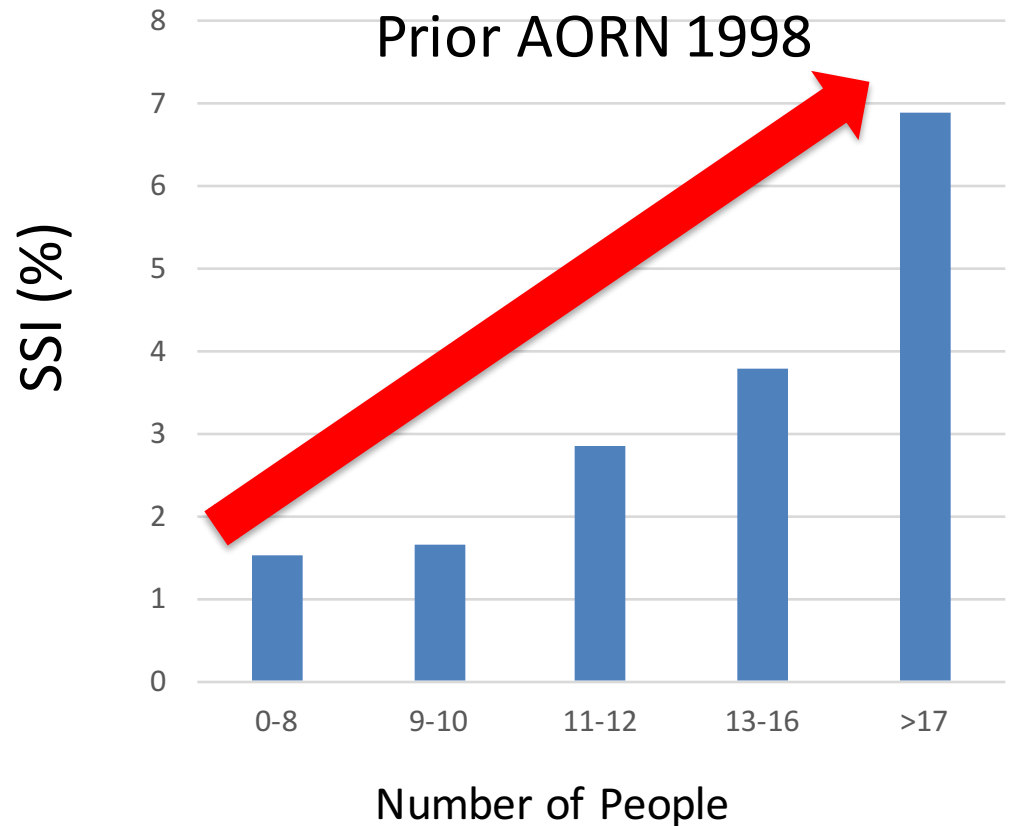
PHOTO: THINKSTOCK

- Hum
- Do
- Pe
- Regr

J's

Door Opening and Foot Traffic

- Interrupts laminar airflow
 - Creates eddy's
 - Recirculate bacteria
- Increases bacteria counts
- Modifiable risk factor for SSI

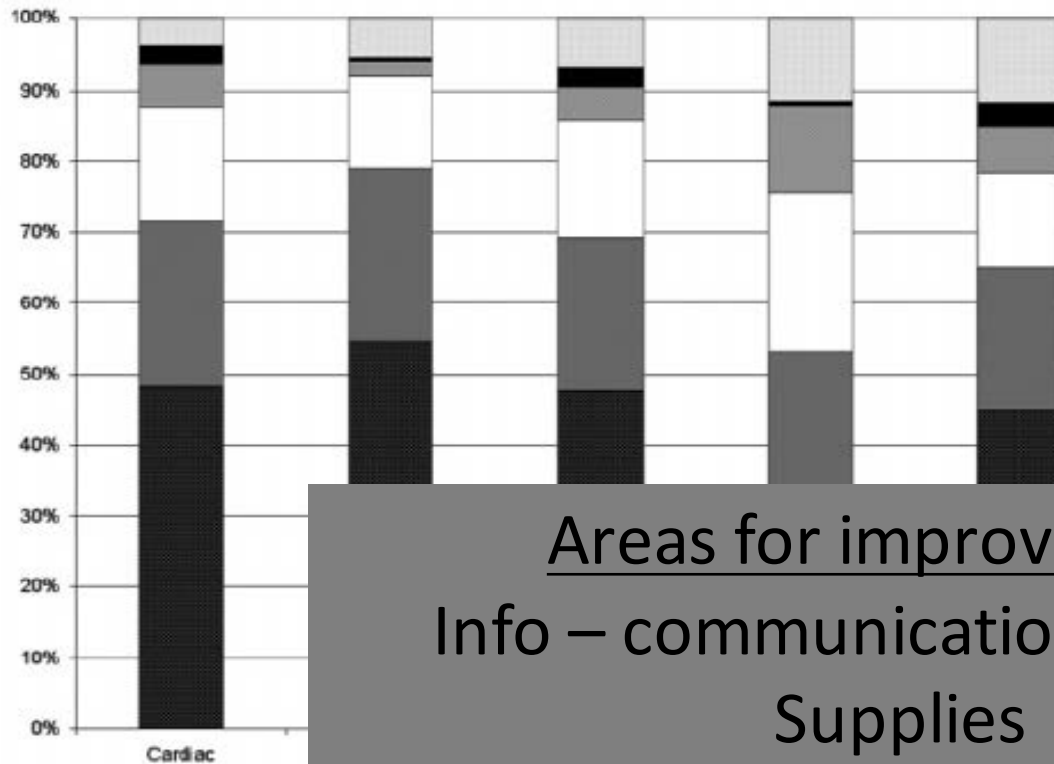


Door Openings Lynch AM J Med Qual 2009

- U of Michigan
- Monitored door openings
 - 28 cases
 - 3028 openings
- Ave length 20 sec
- Total 15 min/hr
- Assessed reasons

Service	Mean Door Openings per Hour
Cardiac	48
Neurosurgery	42
Orthopedic total joint	40
Orthopedic spinal fusion	50
Plastic surgery—breast reduction	25
General surgery	19
All specialties	37

Door Openings Lynch AM J Med Qual 2009



Supplies

break

Info

60-70%

Info

Areas for improvement

Info – communication systems

Supplies

Break schedules

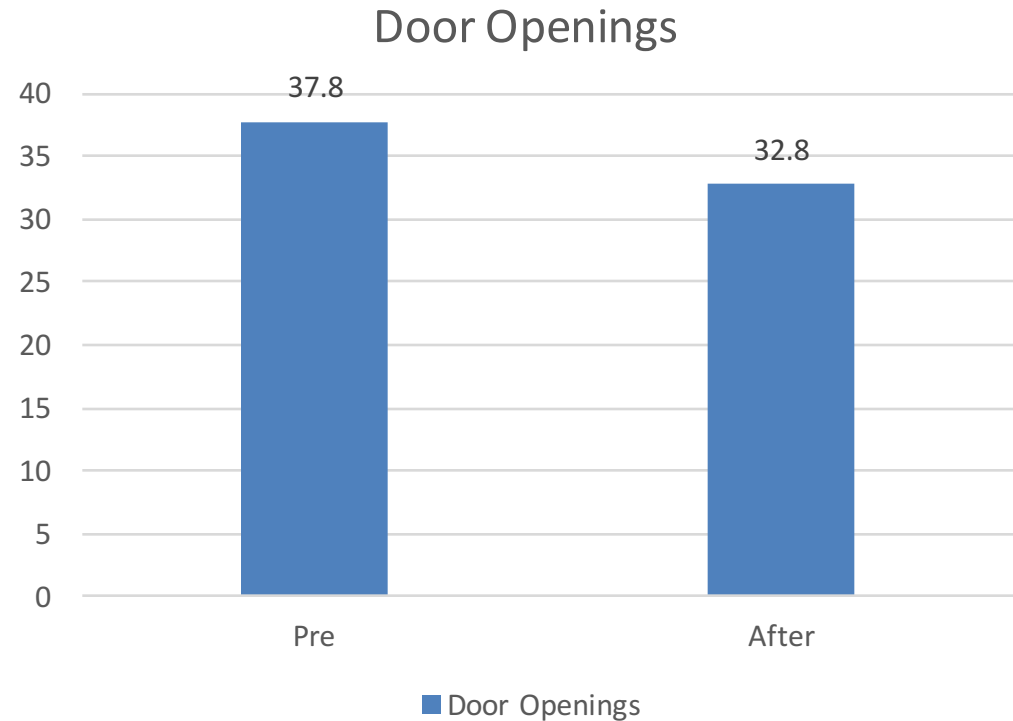
Communication Technology, Education and Policy Change Esser AORN 2016

- Process Changes
- Signage
- Wireless communication devices
- Eliminated observers



Communication Technology, Education and Policy Change Esser AORN 2016

- 305 surgeries
- 22 wsks each
- Multisurgical team
- Pediatric hospital
- High volume personal



The Effect of an Interdisciplinary QI Project to Reduce OR Foot Traffic

Rovaldi AORN 2015

- Informal trial
- Posted signs

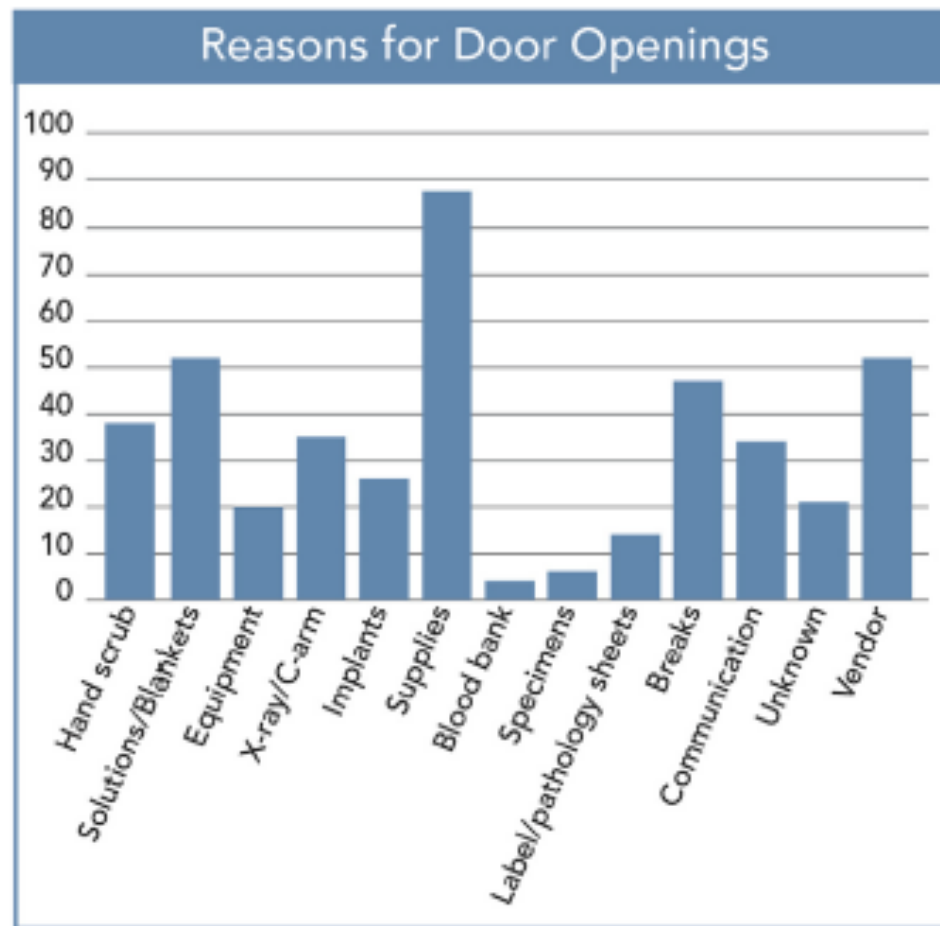


Not effective long term

The Effect of an Interdisciplinary QI Project to Reduce OR Foot Traffic

Rovaldi AORN 2015

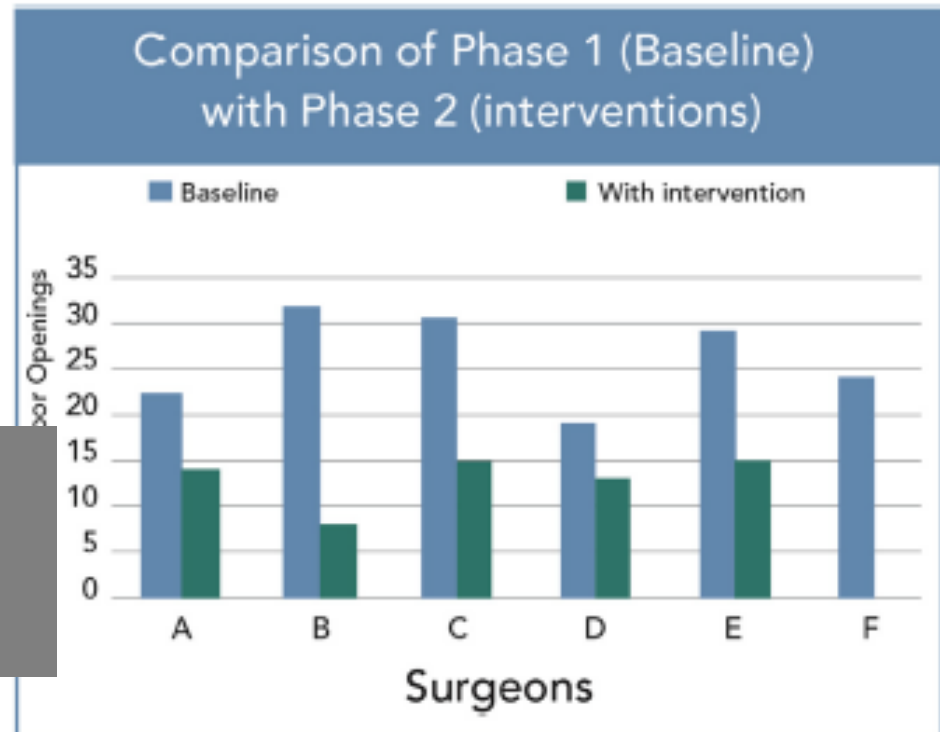
- Characterized reasons for openings
 - Supplies
 - Other equipment
 - Vendors !!!!!
 - Breaks



The Effect of an Interdisciplinary QI Project to Reduce OR Foot Traffic Rovaldi AORN 2015

- Shade – incision
- Caution tape
sterile core door

50 % sustained reduction



Goals of Surgical Hand Hygiene

- Reduce flora counts
- Prevent release bacteria
- Prevent growth under gloves
- Effectiveness varies among preparations
 - Technique
 - Drying
- CHG >> Iodinated longer effects

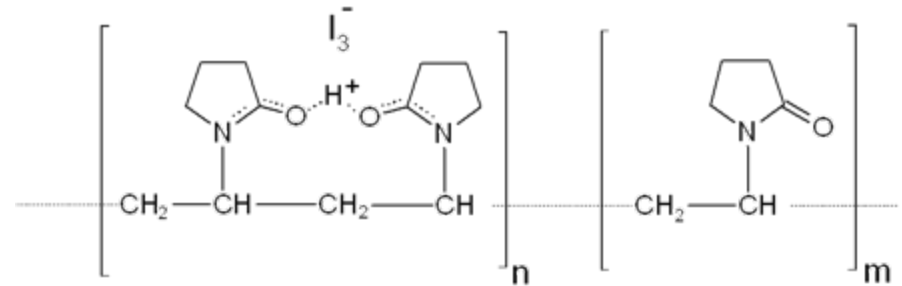
Surgical Hand Hygiene

- Recommendations:
 - First case
 - Wash CHG soap
 - 3 Mins
- Hand rub
 - 0.5% CHG + 70% alcohol
 - Let dry



Skin Antiseptics

- Duraprep
 - 0.7% Available iodine
 - 74% isopropyl alcohol
- Betadine
 - 1.0 % Available iodine
 - Water based
- Chlorprep
 - 2% CHG
 - 70% isopropyl alcohol



Preoperative skin antiseptics for preventing surgical wound infections after clean surgery (Review)

Dumville JC, McFarlane E, Edwards P, Lipp A, Holmes A

- Optimum skin prep

Alcohol based
High concentration
Acceptable
CHG
Provo-iodine



Adhesive Barriers

- Cochrane review
- No difference in SSI
 - With and without
 - Iodinated vs non iodinated



Plastic drapes >> Cloth drapes



Double gloving to reduce surgical cross-infection (Review)

Tanner J, Parkinson H

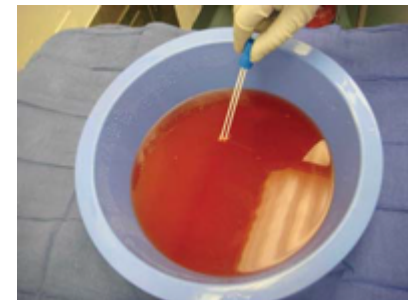


- 14 Studies
- Outcome perforations
 - None SSI

Double glove
Indicator
Latex >> latex free
Change q 2hrs

Instruments and Splash Basins

- Strong correlation to exposure time
- Pathologic organism
- Mitigation
 - Reduce by covering
 - Open as needed
 - Use new irrigation set up



C-arm and Microscope

- Instantly contaminated
- Change gloves
- Change drapes
- Minimize rotations



Topical Agents

- Antiseptics
 - Soaps (Castile)
 - Dilute betadine
- Antibiotics
 - Vancomycin
 - Gentamycin

Dilute Betadine Irrigation

DeValle J Arthrop 2012

- 0.35% Betadine
- 3 Min irrigation
- Joint arthroplasty
- Historical control

	Patients	% SSI
Pre-betadine	1852	0.97
Post-betadine	688	0.15

Shows potential

Unanswered questions: effect on polymer and cement

Vancomycin Powder

- Mixed with bone graft
- Mixed into muscles
- No systemic effect
- 10^{4-6} MIC concentration
- Not likely to have abx “pressure”
- ID docs have little concern



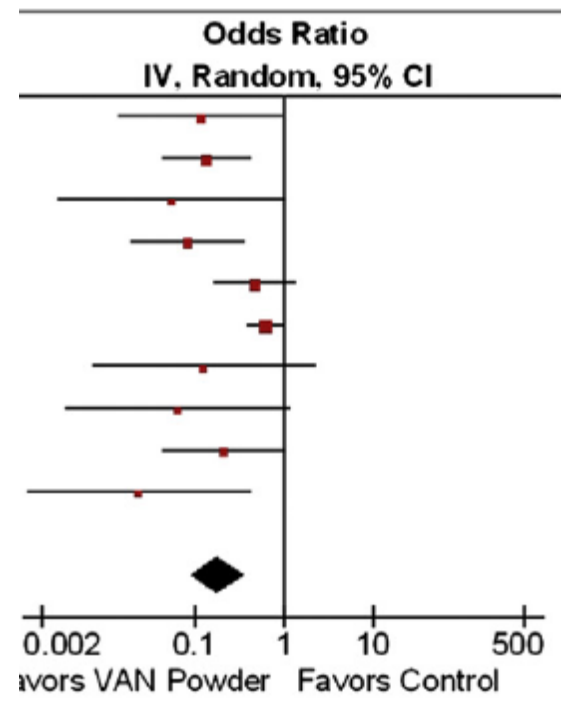
Effectiveness of local vancomycin powder to decrease surgical site infections: a meta-analysis

Hsiu-Yin Chiang, PhD^{a,*}, Loreen A. Herwaldt, MD^{a,b}, Amy E. Blevins, MALS^c,
Edward Cho, BS^a, Marin L. Schweizer, PhD^{a,b,d}

The Spine Journal 14 (2014) 397–407

- Meta-analysis
- 10 Studies
- Odds ratio
 - 0.19 with vanco

Vander Salm 1989
Rahman 2011
O'Neill 2011
Sweet 2011
Heller 2012
Mohammed 2013
Pahys 2013
Caroom 2013
Strom 2013 (1)
Strom 2013 (2)



80% Reduction in SSI

Antibiotic Sutures

- Triclosan
 - Polychloro phenoxy phenol
- Adhere to polymer sutures
- Active gram pos and neg bacteria



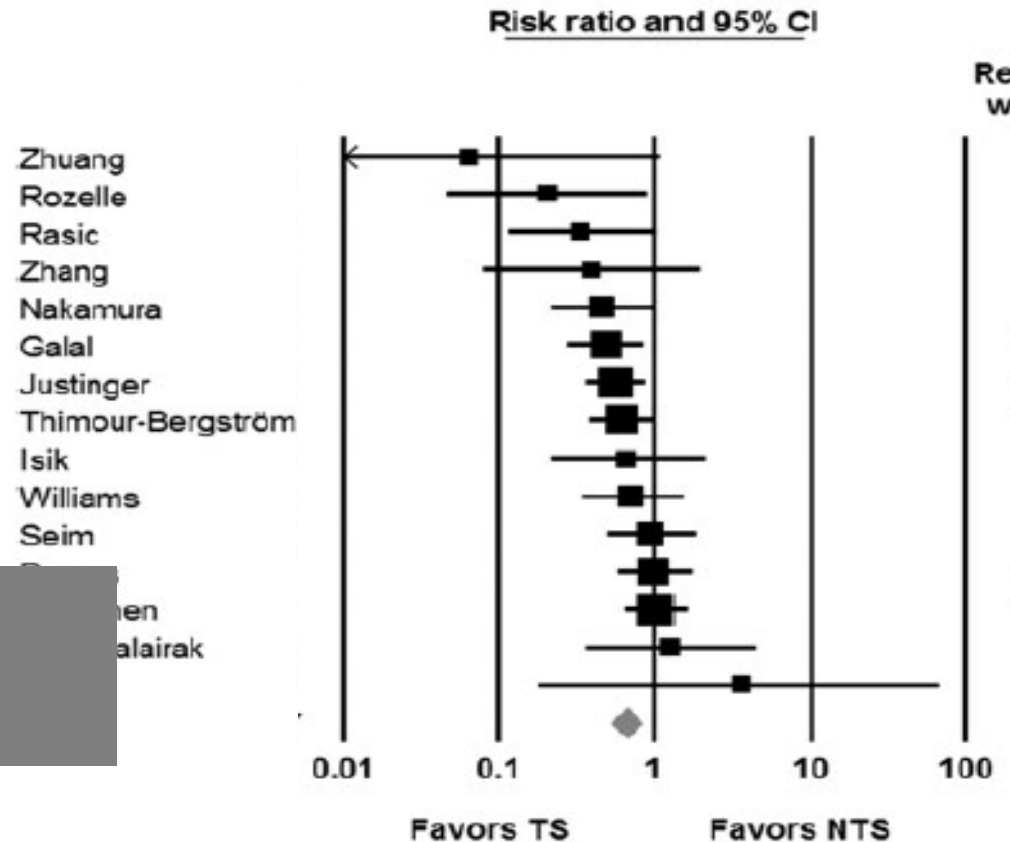
Antibiotic Sutures

Daoud Surg Inf 2014

- Meta-analysis
- 15 RCT
- Triclosan to standard suture

Relative risk – 0.67
Decreased SSI by 1/3

Ebay \$5 / suture
Standard vicril \$1-2



Dressings

- Cochrane review 2011
- 17 RCT's
- No difference among any type
- Silver impregnated not reported

Dressings for the prevention of surgical site infection (Review)

Dumville JC, Walter CJ, Sharp CA, Page T



Silver Dressing

Epstein Spine 2012

- Case controlled
- Lumbar spine fusion
- Routine
- Silverlon dressing

Similar results in joint arthroplasty
May control propionibacterium

	Routine	Deep
Number	129	109
Deep Infection	2.7%	0 %

Incisional Wound Vacuum Dressing

- Remove fluid
- Improve oxygenation
- Reduce bacterial propagation
- Very effective in open wound
- Unclear if helpful in closed wound
- ? Obese



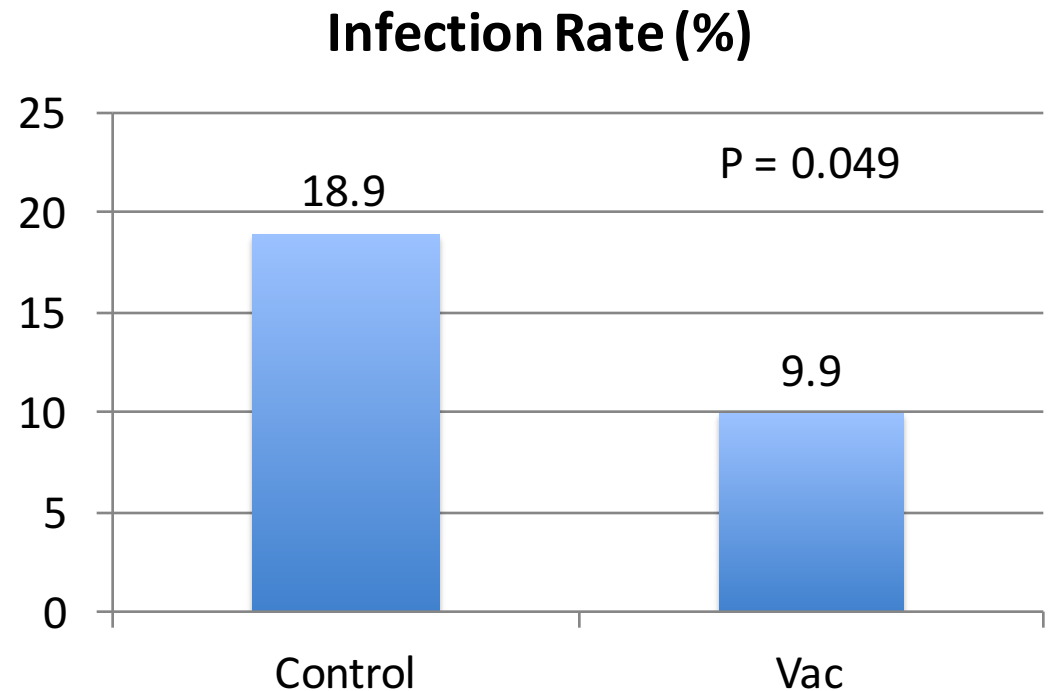
Incisional Wound Vacuum Assisted Dressing

Incisional Negative Pressure Wound Therapy After High-Risk Lower Extremity Fractures

James P. Stannard, MD, David A. Volgas, MD,† Gerald McGwin III, PhD,‡ Rena L. Stewart, MD,† William Obrebsky, MD,§ Thomas Moore, MD,|| and Jeffrey O. Anglen, MD¶*

J Orthop Trauma • Volume 26, Number 1, January 2012

- RCT
- Pilon, calcaneus, tibia fx
- 263 Patients
- Outcomes
 - Dehiscence
 - Infection



Silver Impregnated Dressings

- Strong antibacterial properties
- Antiquity
 - 4000 BC Silver lined vessels
 - Romans silver nitrate
- Water sterilization
- Burn dressings
- Incorporated into sterile dressings



Evidence of Reduction SSI

Colorectal

Neurological

Spine

Cardiovascular

Orthopedic

Post-Operative

- Antibiotics
 - 23 hours maximum
 - Decrease risk c-diff
 - Decrease risk of antibiotic pressure
- Discontinue drains, catheters, lines ASAP
- Occlusive dressings
 - No evidence

Conclusions

- Prevention SSI is everyone's responsibility
- Systematic approach
 - All stakeholders
 - Bundled approach
- Use best available evidence
- Nursing has critical role

Strategies: Prevention of Surgical Site Infection (SSI)

- Optimize patient
- Reduce bacterial burden
- Minimize contamination
- Leave healthy perfused tissue
- Assist with antibiotics