# Update on the Prevention of Surgical Site Infections

Scientific Seminar on Infection Control
May 9, 2012

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# DISCLAIMERS

- I am not a surgeon
- I do not believe that SSIs and lapses in practices are necessarily intentional/of malicious intent

# Background: SSI

- 24 million surgeries/year in US
- 2.7% develop SSI
- **#2** healthcare-associated infection

- Expanding issues:
  - Novel techniques
  - Move to outpatient arena
  - ↑ Immunosuppressed pts

# Risk Factors for SSI

- **Patient Factors:**
  - Diabetes
  - Periop hyperglycemia
  - Tobacco use (current)
  - Malnutrition
  - Prolonged pre-op stay
  - ? Age
  - Irradiation
  - ? Corticosteroid use
  - Obesity
- **Operative Factors:**
  - Surgical technique
  - Poor skin prep
  - Incorrect Abx prophylaxis
  - Use of razor
  - Shaving night before
  - Break aseptic technique
  - No pre-op antiseptic shower
  - Prolonged procedure

# *Staphylococcus aureus* Carriage: Screening and Decolonization

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# *Staph. aureus* Colonization as a Risk for Infection

- RCT of mupirocin in general, gynecologic, neurosurgical, and CT procedures
  - OR of *S. aureus* SSI in colonized vs. non-colonized placebo recipients = **4.5** (2.5-8.2)
- Cardiac surgery patients:
  - Carriers **9.6** times more likely to have SSI than non-colonized patients
- Harvest site infections:
  - RR of *S. aureus* SSI in colonized vs. non-colonized patients = **7.1** (2.2-23.0)

**Perl TM et al NEJM 2002;346:1871+**
**Kluytmans JA et al L Infect Dis 1995;171:216+**

# Carriage Eradication

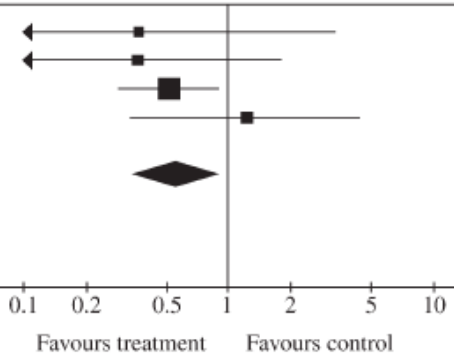
- Elimination led to:
  - ↓ carriage
  - ↓ SSI in cardiothoracic pts.
  - ↓ SSI in orthopedic pts.
  - ↓ *S. aureus* infection in dialysis pts.
  - ↓ *S. aureus* bacteremia
  - ↓ catheter exit-site infections in dialysis pts.

# RCTs of Mupirocin Decolonization

## Nosocomial *S. aureus* infections among surgical pts with SA carriage

| Study or subcategory | Mupirocin *n/N* | Control *n/N* | RR (random) 95% CI | Weight % | RR (random) 95% CI |
|---|---|---|---|---|---|
| Garcia | 1/31 | 3/34 | | 4.76 | 0.37 [0.04, 3.33] |
| Kalmeijer | 2/95 | 5/86 | | 8.93 | 0.36 [0.07, 1.82] |
| Perl | 17/430 | 34/439 | | 72.38 | 0.51 [0.29, 0.90] |
| Konvalinka | 5/130 | 4/127 | | 13.93 | 1.22 [0.34, 4.44] |
| Total (95% CI) | 686 | 686 | | 100.00 | 0.55 [0.34, 0.89] |

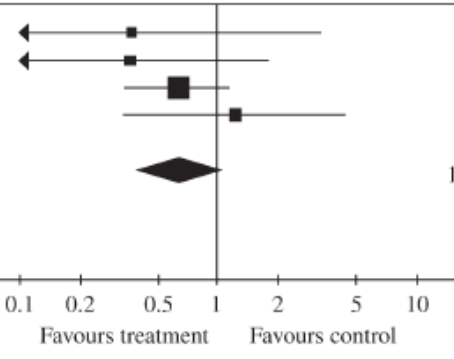
Total events: 25 (mupirocin), 46 (control)
Test for heterogeneity: $x^2=1.92$, df=3 ($P=0.59$), $I^2=0\%$
Test for overall effect: $Z=2.43$ ($P=0.02$)




## *S. aureus* SSIs among surgical pts with SA carriage

| Study or subcategory | Mupirocin *n/N* | Control *n/N* | RR (random) 95% CI | Weight % | RR (random) 95% CI |
|---|---|---|---|---|---|
| Garcia | 1/31 | 3/34 | | 5.26 | 0.37 [0.04, 3.33] |
| Kalmeijer | 2/95 | 5/86 | | 9.87 | 0.36 [0.07, 1.82] |
| Perl | 16/432 | 26/439 | | 69.46 | 0.63 [0.34, 1.15] |
| Konvalinka | 5/130 | 4/127 | | 15.41 | 1.22 [0.34, 4.44] |
| Total (95% CI) | 688 | 686 | | 100.00 | 0.64 [0.38, 1.06] |

Total events: 24 (treatment), 38 (control)
Test for heterogeneity: $x^2=1.69$, df=3 ($P=0.64$), $I^2=0\%$
Test for overall effect: $Z=1.73$ ($P=0.08$)




**van Rijen MM et al J Antimicrob Chemother 2008;61:254+**

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# Preventing Surgical-Site Infections in Nasal Carriers of *Staphylococcus aureus*

Lonneke G.M. Bode, M.D., Jan A.J.W. Kluytmans, M.D., Ph.D., Heiman F.L. Wertheim, M.D., Ph.D., Diana Bogaers, I.C.P., Christina M.J.E. Vandenbroucke-Grauls, M.D., Ph.D., Robert Roosendaal, Ph.D., Annet Troelstra, M.D., Ph.D., Adrienne T.A. Box, B.A.Sc., Andreas Voss, M.D., Ph.D., Ingeborg van der Tweel, Ph.D., Alex van Belkum, Ph.D., Henri A. Verbrugh, M.D., Ph.D., and Margreet C. Vos, M.D., Ph.D.

- RCT in Netherlands
- Adult patients admitted to departments of surgery and internal medicine screened for SA carriage (PCR)
- Carriers randomized to mupirocin-CHG decolonization vs. placebo soap & ointment
- Mupirocin: BID for 5 days
- CHG: Daily for 5 days
- Reapplication at 3 weeks and 6 weeks if still hospitalized

**Bode LGM et al NEJM 2010;362:9+**

- N = 6771 screened → 1251 SA+ (18.5%) → 918 randomized
- Placebo group with signif. more immunocompromised pts.
- No data on compliance w/ other SSI prevention measures

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

| Variable | Mupirocin–Chlorhexidine (N=504) | Placebo (N=413) | Relative Risk (95% CI)* |
|---|---|---|---|
| | *no. (%)* | | |
| *S. aureus* 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.

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**Bode LGM et al NEJM 2010;362:9+**

# Screening + Decolonization

- **Benefits:**
  - It's cheap (*maybe*)
  - It's easy (*maybe*)
  - It works (*in some pts*)
- **Risks:**
  - Increased infections due to other pathogens?
  - Resistance development
- **Questions:**
  - Does effect last?
  - Use in all populations?
  - Costs of screening?
  - Which screening test?
  - Impact of mupirocin resistance

# Skin Antisepsis

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# Skin Preparation: Which Agent?

- Quasi-experimental study of preps
- 3 periods:


- Adult general surgical pts
- N = 3209 operations
- SSI Rates:


Swenson BR et al Infect Control Hosp Epidemiol 2009;30:964+

# 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. Berger, M.D.

- RCT adults undergoing clean-contaminated GI/GU/GYN/Thoracic surgery at 6 sites
- Chlorhexidine-alcohol vs. povidone-iodine
- Outcome: Any SSI within 30 days
- N = 849
- Overall SSI Rate:
  - P-I group: 16.1%
  - CHG-alcohol group: 9.5%

RR: 0.59 (95% CI: 0.41-0.85)

Darouiche RO et al NEJM 2010;362:18+

**NNT to prevent 1 SSI = 17**

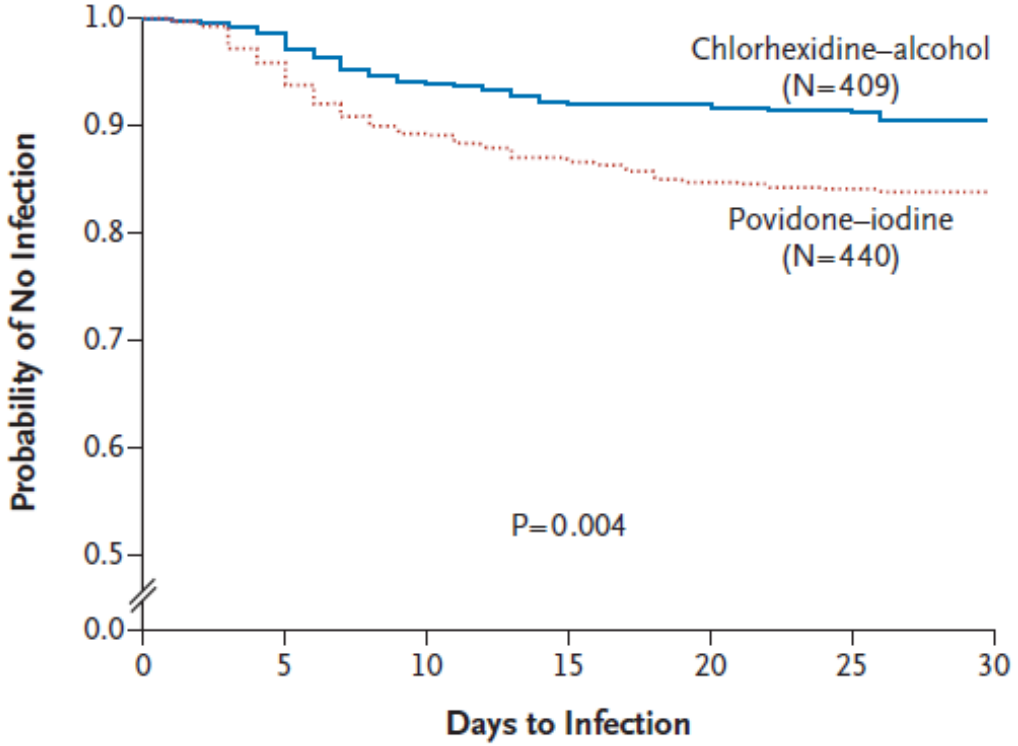


**Figure 2. Kaplan–Meier Curves for Freedom from Surgical-Site Infection (Intention-to-Treat Population).**

Patients who received chlorhexidine–alcohol were significantly more likely to remain free from surgical-site infection than were those who received povidone–iodine (P=0.004 by the log-rank test). In the chlorhexidine–alcohol group, 39 patients had events (9.5%) and data from 370 patients (90.5%) were censored; in the povidone–iodine group, 71 patients had events (16.1%) and data from 369 patients (83.9%) were censored.

Darouiche RO et al NEJM 2010;362:18+

**Table 2. Proportion of Patients with Surgical-Site Infection, According to Type of Infection (Intention-to-Treat Population).**

| Type of Infection | Chlorhexidine–Alcohol (N = 409) | Povidone–Iodine (N = 440) | Relative Risk (95% CI)* | P Value† |
|---|---|---|---|---|
| | *no. (%)* | | | |
| Any surgical-site infection | 39 (9.5) | 71 (16.1) | 0.59 (0.41–0.85) | 0.004 |
| Superficial incisional infection | 17 (4.2) | 38 (8.6) | 0.48 (0.28–0.84) | 0.008 |
| Deep incisional infection | 4 (1.0) | 13 (3.0) | 0.33 (0.11–1.01) | 0.05 |
| Organ-space infection | 18 (4.4) | 20 (4.5) | 0.97 (0.52–1.80) | >0.99 |
| Sepsis from surgical-site infection | 11 (2.7) | 19 (4.3) | 0.62 (0.30–1.29) | 0.26 |

* Relative risks are for chlorhexidine–alcohol as compared with povidone–iodine. The 95% confidence intervals were calculated with the use of asymptotic standard-error estimates.
† P values are based on Fisher's exact test.

Impact noted with superficial and deep SSI, NOT organ space SSI

*"The weight of evidence suggests that chlorhexidine-alcohol should replace povidone-iodine as the standard for preoperative surgical scrubs."*

Common criticism: No comparison with povidone + alcohol – was benefit due to combination with alcohol??

Darouiche RO et al NEJM 2010;362:18+
Wenzel RP NEJM 2010;362:75+

# Surgical Skin Antisepsis

- CHG-based prep appears to be best
- Avoid use with:
  - < 2 month old
  - Mucous membranes
  - Contact with meninges**

***Warnings***

**For external use only. Flammable: keep away from fire or flame.**

Do not use with electrocautery procedures

**Do not use**

- in children less than 2 months of age because of the potential for excessive skin irritation and increased drug absorption
- on patients with known allergies to chlorhexidine gluconate or isopropyl alcohol
- for lumbar puncture or in contact with the meninges
- on open skin wounds or as a general skin cleanser

**When using this product** keep out of eyes, ears, and mouth. May cause serious or permanent injury if permitted to enter and remain. If contact occurs, rinse with cold water right away and contact a doctor.

# Antibiotic Prophylaxis

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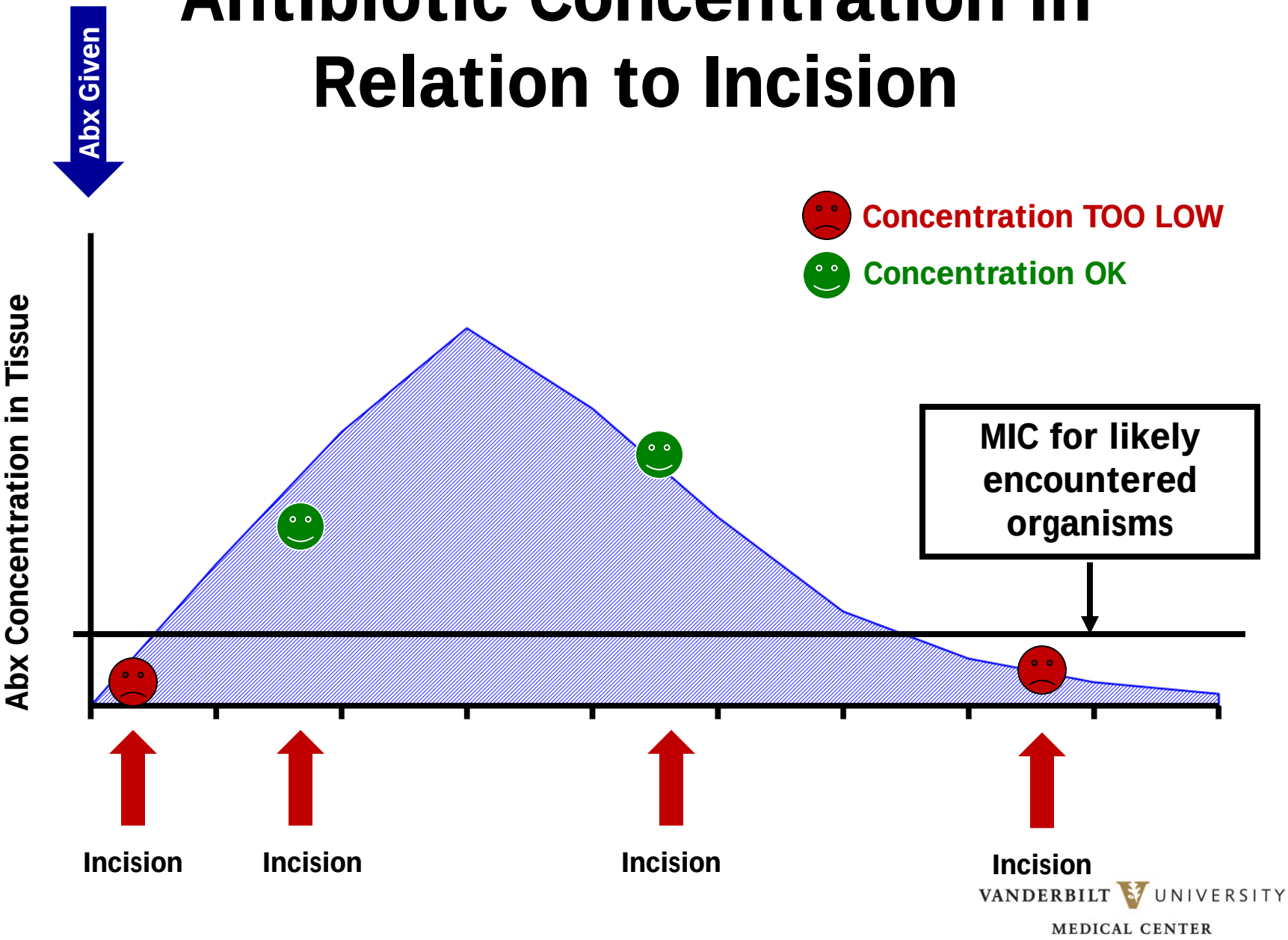
# Who Needs Surgical Prophylaxis?

- Recommended for **all** clean contaminated procedures
  - e.g. colon, small bowel, GYN
- Recommended for clean procedures:
  a) involving insertion of intravascular prosthetic material or a prosthetic joint ***or***
  b) in which an SSI would pose catastrophic risk (e.g. cardiac surgery)
- Contaminated/dirty procedures:
  - Assume already on abx
  - Should also ensure Staph coverage

# Key Principles of Surgical Prophylaxis

- Tissue concentration of antimicrobial needs to be above the mean inhibitory concentration (MIC) of that drug for the organisms of concern **AT THE TIME OF THE INCISION**
- **Get the D's right:**
  - **Right Drug**
  - **Right Dose**
  - **Right Delivery (i.e. timing)**
  - **Right Duration**

# Antibiotic Concentration in Relation to Incision

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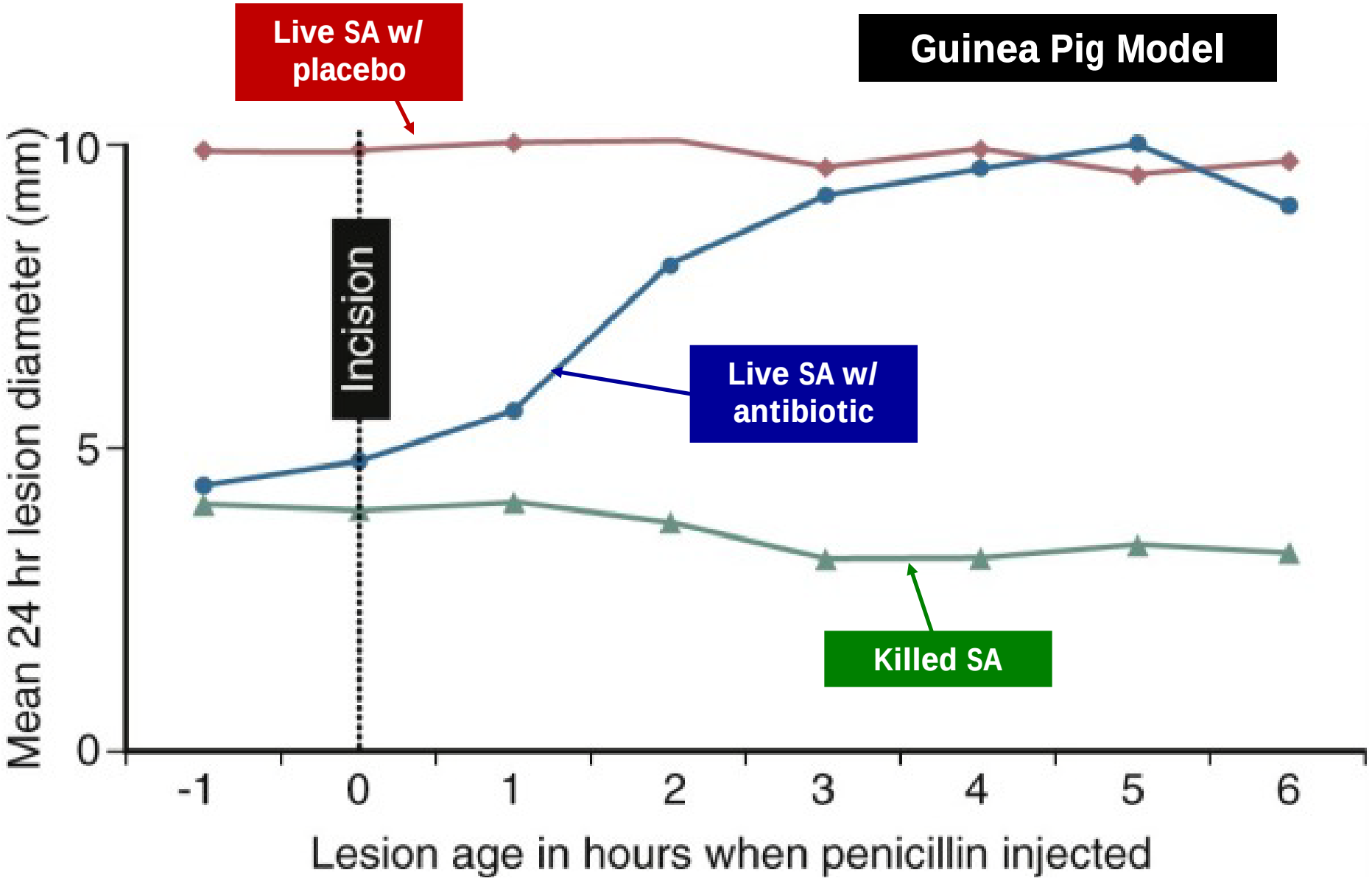
# Guinea Pig Model




Burke JF Surgery 1961;50:161+

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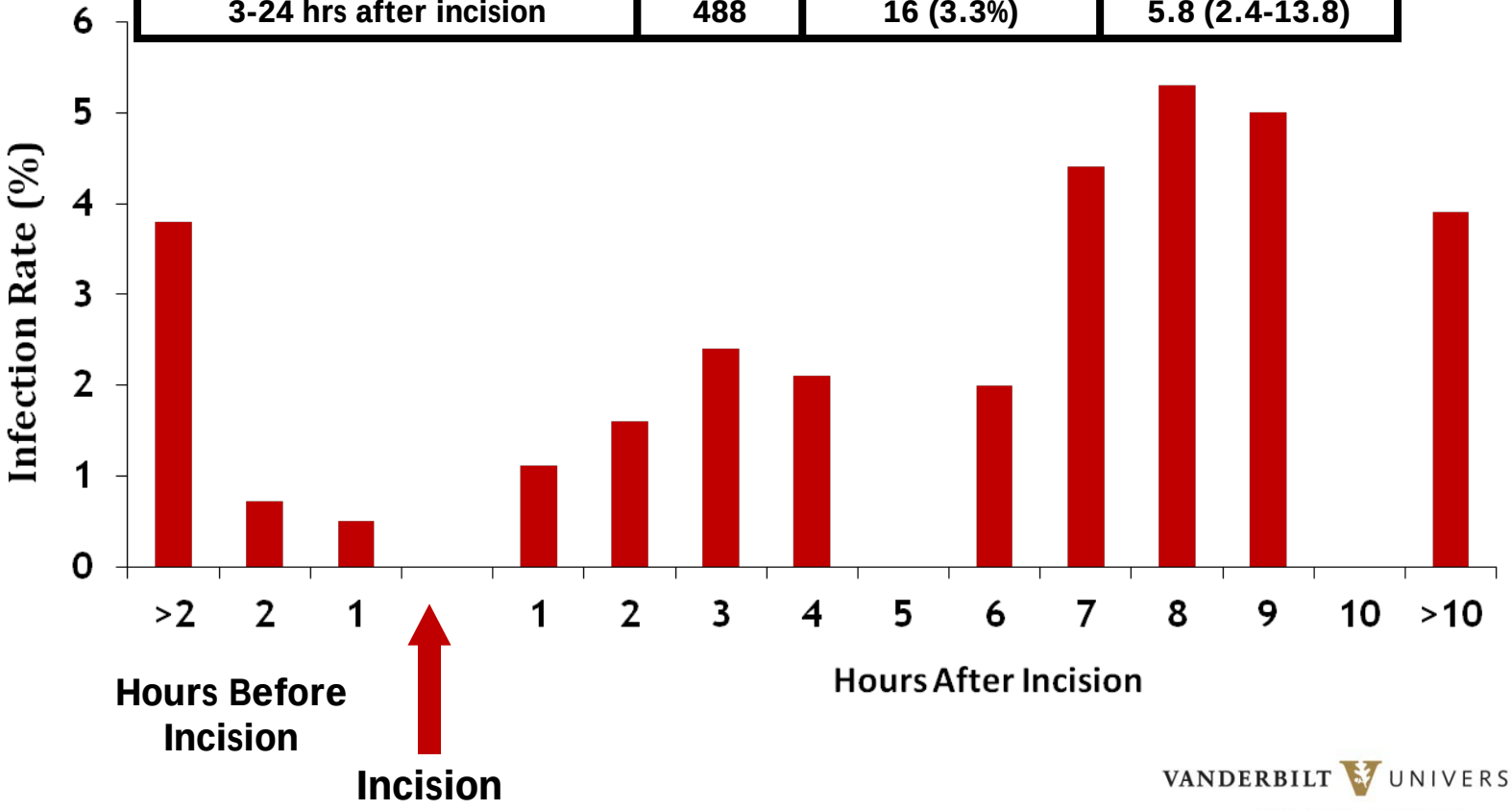
# RIGHT DELIVERY:
# Relation of Abx Timing to Risk for Developing SSI

| Time of Administration | # Pts | No (%) of SSI | OR (95% CI) |
|---|---|---|---|
| >2 hrs before incision | 369 | 14 (3.8%) | 4.3 (1.8-10.4) |
| 0-2 hrs before incision | 1708 | 10 (0.6%) | 1.0 |
| 0-3 hrs after incision | 282 | 4 (1.4%) | 2.1 (0.6-7.4) |
| 3-24 hrs after incision | 488 | 16 (3.3%) | 5.8 (2.4-13.8) |




Classen DC et al NEJM 1992;326:281+

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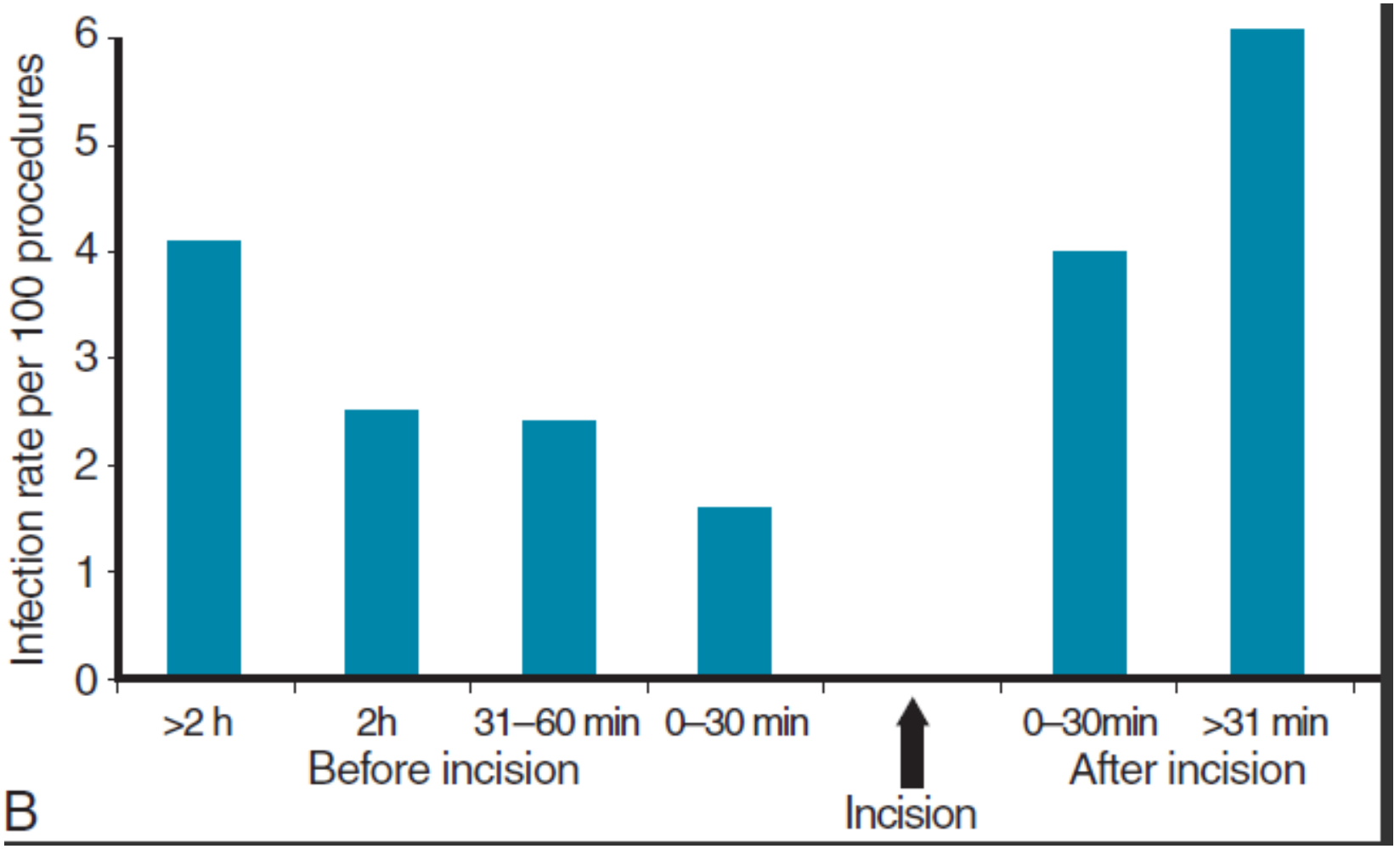
# RIGHT DELIVERY:
# Relation of Abx Timing to Risk for Developing SSI




Steinberg JP et al Arch Surg 2009;250:10+

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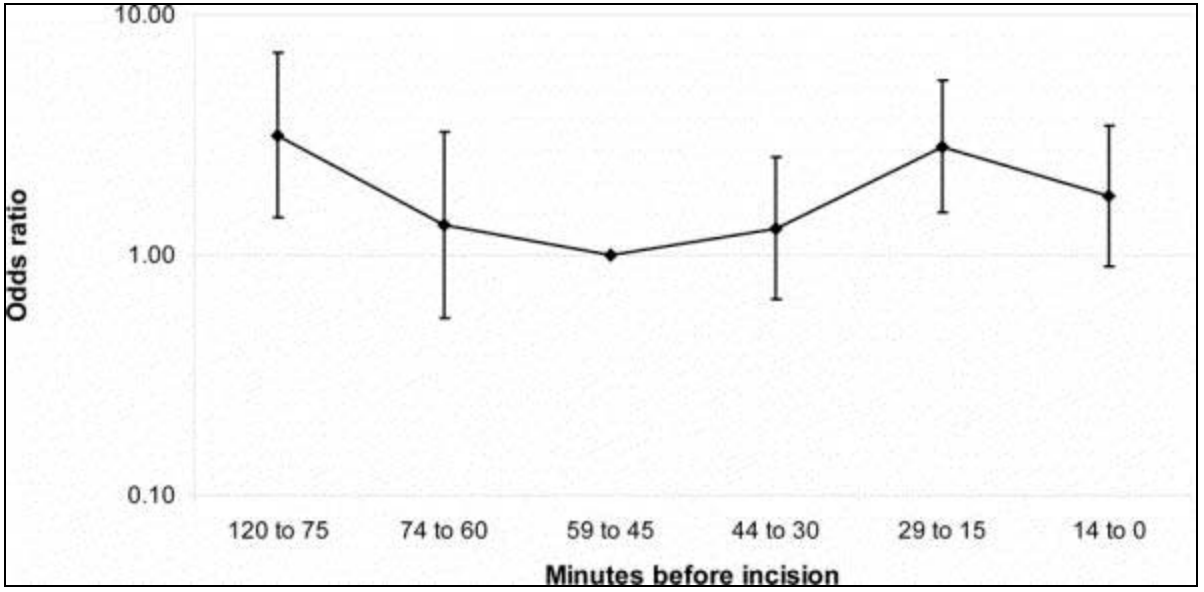
# RIGHT DELIVERY: Too Close to Incision Time = Bad?

- Cohort of >3,800 surgical pts
- All received cefuroxime prophylaxis
  - +metronidazole in colorectal pts




Weber WP et al Ann Surg 2008;247:918+

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# RIGHT DELIVERY: Too Close to Incision Time = Bad?

- Cohort of >2,000 cardiac surgery pts
- All received vancomycin prophylaxis

| Time of vancomycin administration | No. of patients | No. (%) of infections[a] | Relative risk (95% CI) | Odds ratio (95% CI)[b] |
|---|---|---|---|---|
| 0–15 min | 15 | 4 (26.7) | 7.8 (2.5–24.7) | 11.6 (2.6–52.4)[c] |
| 16–60 min | 176 | 6 (3.4) | 1.0 | 1.0 |
| 61–120 min | 888 | 68 (7.7) | 2.2 (0.99–5.09) | 2.3 (0.98–5.61)[d] |
| 121–180 min | 700 | 48 (6.9) | 2.0 (0.87–4.62) | 2.6 (1.1–6.2)[e] |
| >180 min | 269 | 21 (7.8) | 2.3 (0.94–5.56) | 2.1 (0.82–5.62)[f] |

[a] $P = 0.0119$ by the $\chi^2$ analysis.
[b] Determined using multivariate logistic regression, controlling for significant covariates.
[c] $P = 0.0014$.
[d] $P = 0.056$.
[e] $P = 0.037$.
[f] $P = 0.12$.

Garey KW et al J Antimicrob Chemother 2006;58:645+

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# RIGHT DRUG:
# Basic Principles

- Spectrum of activity
  - Cover the pathogens of concern at anatomic location
- Bioactivity/penetration into target tissues
- Limited toxicity
- Pt allergies
- Cost (if all other factors equal)

# RIGHT DRUG: Which Antibiotic?

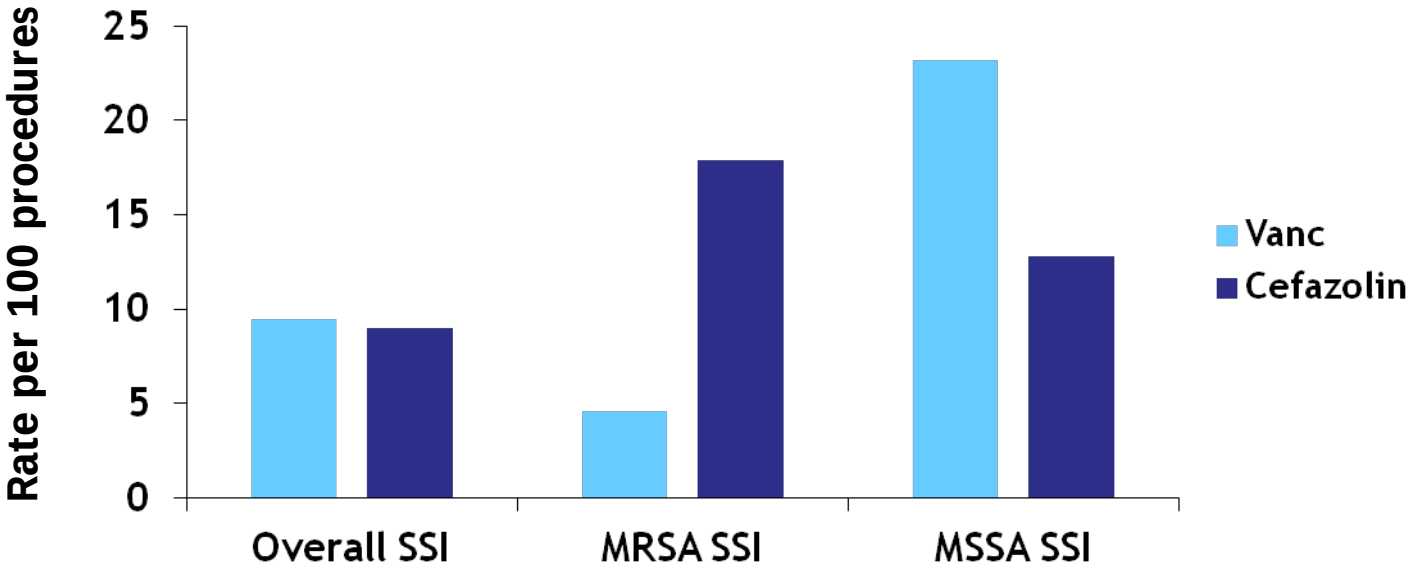
- Cephalosporins most widely tested
- Vancomycin (if MRSA a concern)
- Metronidazole/clindamycin for anaerobes
- Newer agents?
  - Indication not commonly pursued
  - Desire to save newer agents
  - Older agents seem to work
- New prophylaxis guidelines from IDSA/SHEA/SIS/ASHP due ASAP

# What About MRSA Coverage?

- Use of vancomycin recommended if outbreak situation or if local incidence levels are "**high**"
- Many communities do not know local incidence of MRSA (infection or colonization)

# RIGHT DRUG:
# Vancomycin for Routine Abx Prophylaxis

- RCT of 855 cardiac surgery patients
- Vancomycin vs. cefazolin for prophylaxis




Finkelstein R et al J Thorac Cardiovasc Surg 2002;123:326+

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# RIGHT DRUG:
# Vancomycin for Routine Abx Prophylaxis

- Retrospective analysis of all patients with SSI

- Multivariate analysis:
  - Receipt of vancomycin prophylaxis not associated with reduced risk for MRSA SSI
  - **OR 1.9 (0.7-4.9)**

*Journal of Antimicrobial Chemotherapy* (2006) 57, 589–608
doi:10.1093/jac/dkl017
Advance Access publication 28 February 2006

JAC

# Guidelines for the prophylaxis and treatment of methicillin-resistant *Staphylococcus aureus* (MRSA) infections in the UK

Curtis G. Gemmell[1], David I. Edwards[2], Adam P. Fraise[3], F. Kate Gould[4], Geoff L. Ridgway[5] and Rod E. Warren[6]* on behalf of the Joint Working Party of the British Society for Antimicrobial Chemotherapy, Hospital Infection Society and Infection Control Nurses Association

We recommend that patients who require surgery and have a history of MRSA colonization or infection without documented eradication receive glycopeptide prophylaxis alone or in combination with other antibiotics active against other potential pathogens. The use of glycopeptides may also be considered if there is an appreciable risk that patients' MRSA carriage may have recurred or they come from facilities with a high prevalence of MRSA. [Category II]

# Meta-analysis Studies

| Study | Population | Sample Size | Comparisons | Results |
|---|---|---|---|---|
| **Bolon et al** | Cardiothoracic pts | 7 RCTs | β-lactams vs. glycopeptides | SSI 30 days post-op RR 1.14 (95% CI 0.91-1.42) |
| **Chambers et al** | Clean & clean-contaminated procedures | 14 RCTs | β-lactams vs. glycopeptides | Similar effectiveness for SSI prevention |

**Bolon MK et al Clin Infect Dis 2004;38:1357+**
**Chambers D et al Surg Infections 2010;11:455+**

# Vancomycin for Surgical Prophylaxis?

**Tonya Crawford,[1] Keith A. Rodvold,[1] and Joseph S. Solomkin[2]**

[1]Department of Pharmacy Practice, University of Illinois at Chicago; and [2]Department of Surgery, University of Cincinnati College of Medicine, Ohio

Several systematic analyses concluded that no clear benefit in clinical effectiveness or cost-effectiveness has been demonstrated for the routine prophylaxis use of vancomycin compared with cephalosporins. However, most of these studies were conducted before the increasing prevalence of MRSA and do not reflect current clinical situations.

**Crawford T et al Clin Infect Dis 2012;epub ahead of print**

# Questions re: Vancomycin for Surgical Prophylaxis

- What is the level of MRSA prevalence where vancomycin has benefit?
- Use of MRSA bundle
  - Screen for carriage
  - Decolonization with mupirocin
    - Nares and at chest tube sites
  - Add vancomycin for MRSA + pts

# RIGHT DRUG:
# What Type of Antibiotic?

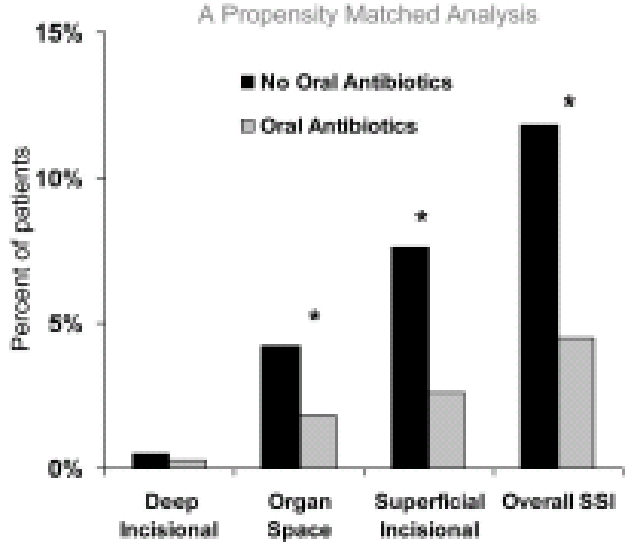
- Intravenous (IV)
- Oral
- Local compounds
  - Impregnated sutures (triclosan)
  - Impregnated cement/implants
  - Wound irrigant

# A Statewide Assessment of Surgical Site Infection Following Colectomy

## *The Role of Oral Antibiotics*

*Michael J. Englesbe, MD,* Linda Brooks, RN,* James Kubus, MS,* Martin Luchtefeld, MD,† James Lynch, MD,‡ Anthony Senagore, MD,† John C. Eggenberger, MD,§ Vic Velanovich, MD,¶ and Darrell A. Campbell, Jr., MD**

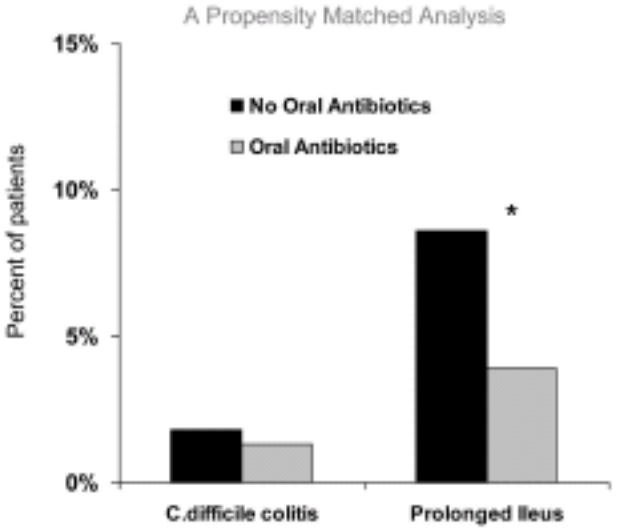
**Oral Antibiotics with a Bowel Preparation Prior to Elective Colon Surgery**




* P < 0.05

**FIGURE 3.** Surgical site infection rates among propensity matched cohorts of patients who either did or did not receive oral nonabsorbable antibiotics at the time of mechanical bowel preparation prior to elective colon surgery. Patients that received oral antibiotics were observed to have significantly lower rates of organ space infections, superficial surgical site infection, and overall surgical site infection rates.

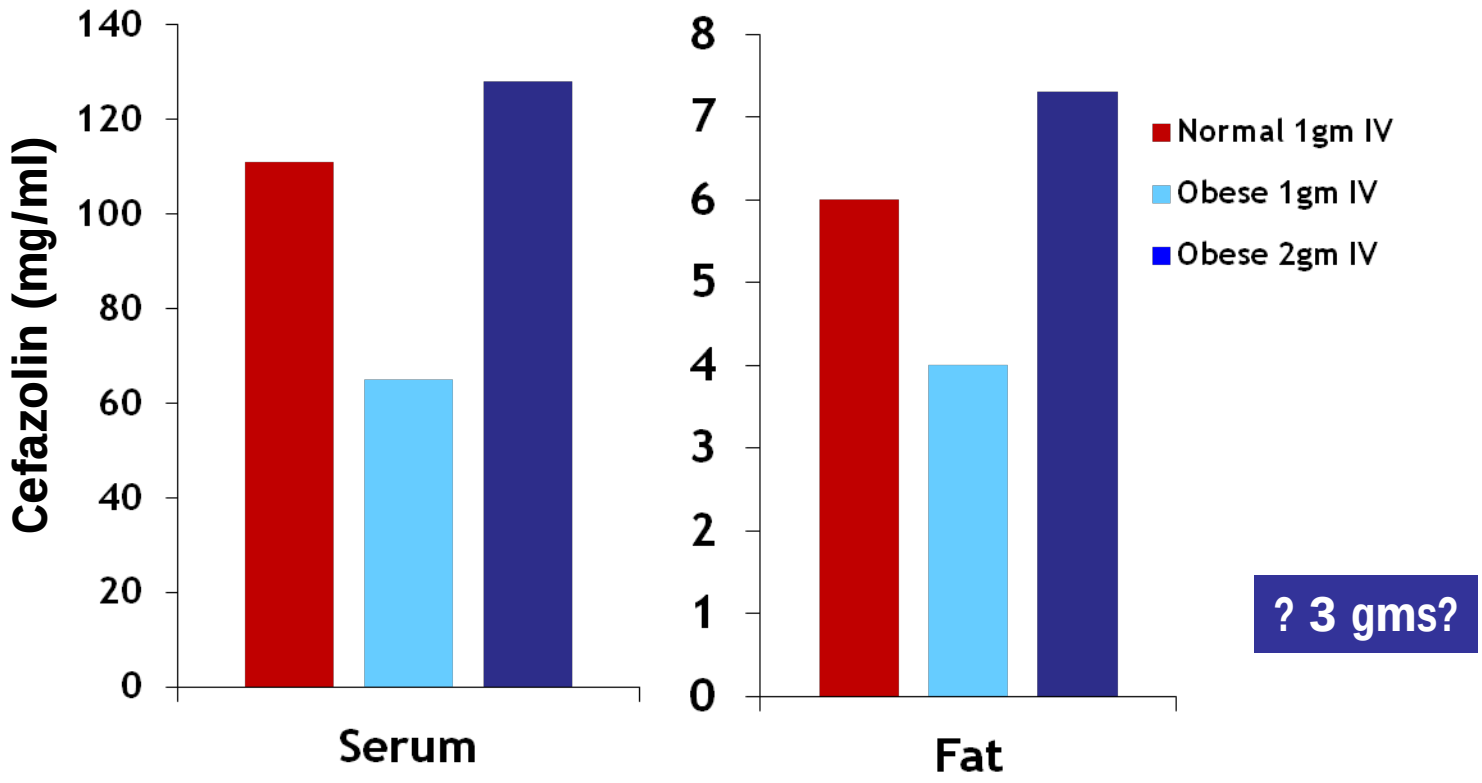
**Oral Antibiotics and Complications Following Colon Surgery**




* P < 0.05

**FIGURE 4.** Surgical site infection rates among propensity matched cohorts of patients who either did or did not receive oral nonabsorbable antibiotics at the time of mechanical bowel preparation prior to elective colon surgery. Patients that received oral antibiotics were observed to have significantly lower rates of prolonged ileus and overall surgical site infection. Importantly, patient to receive oral antibiotics did not have significantly higher rates of *C. difficile* colitis.

# RIGHT DOSE:
# Gastroplasty Patients and Cefazolin Levels




Forse RA et al Surgery 1989;106:750+

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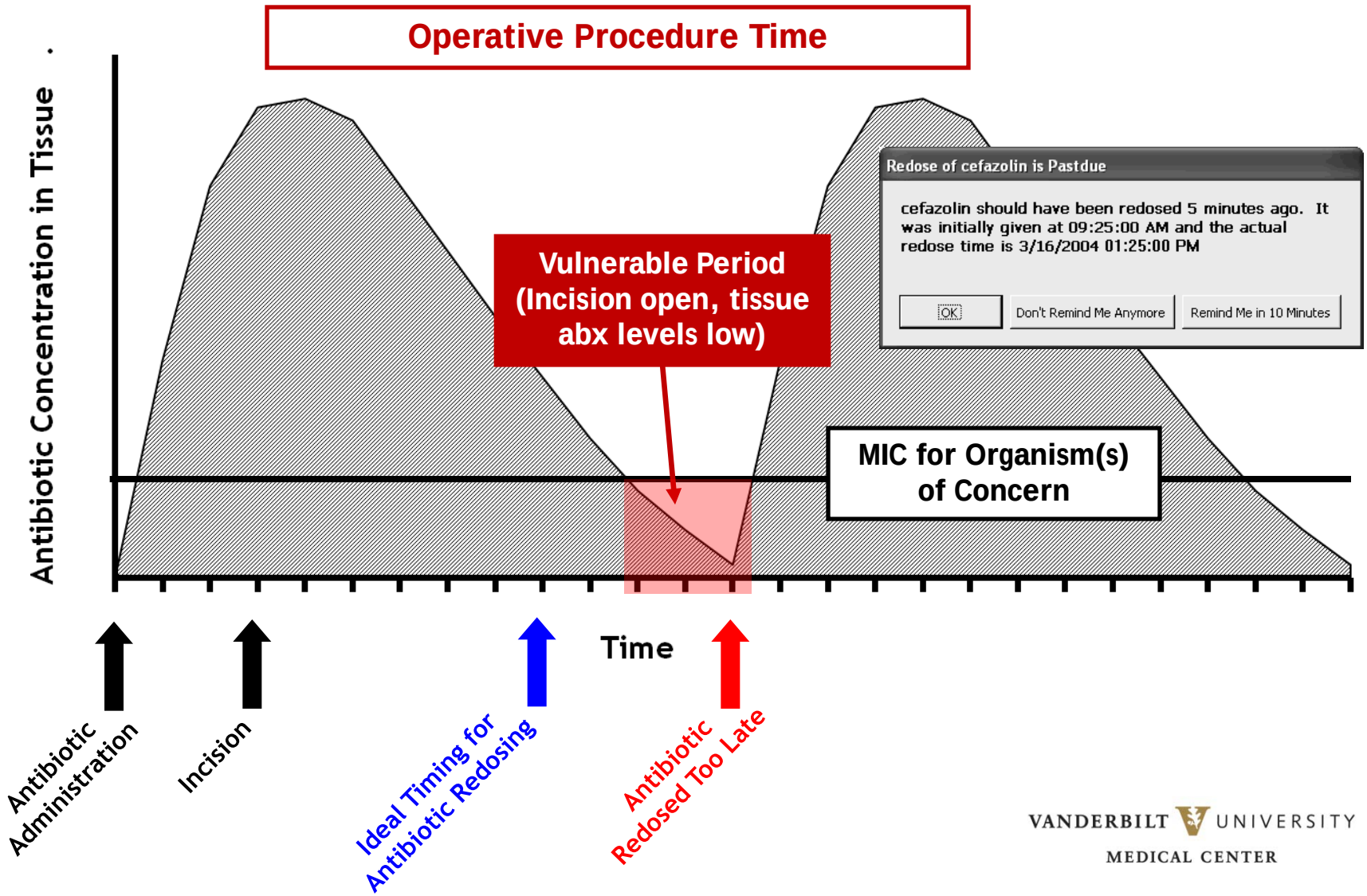
# What About Another Dose?

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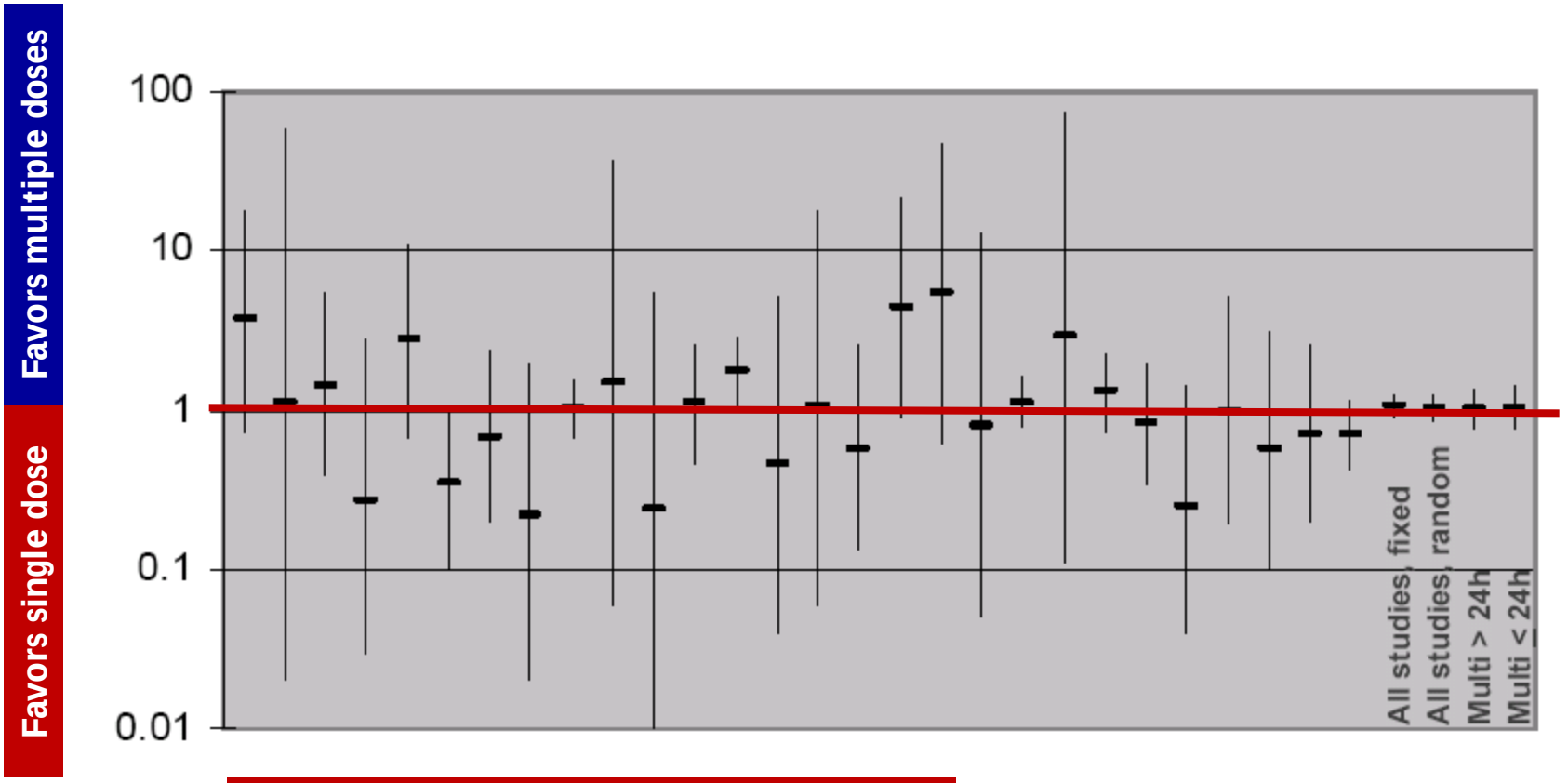
# RIGHT DURATION: How Long Should Abx be Continued?

- Desire to "protect tubes and drains"
- May increase risk of infection with antibiotic resistant organism
  - Study in cardiac surgery patients
  - No difference in infection rate in those w/ abx ≥ 48 hrs vs. < 48 hrs
  - Significantly ↑ risk for infection w/ resistant organisms (by 60%) w/ prolonged abx

Harbarth S et al Circulation 2000;101:2916+

# RIGHT DURATION: Single vs. Multiple Doses




**No benefit of multiple doses over single perioperative dose**

McDonald M et al Aust N Z J Surg 1998;68:388+

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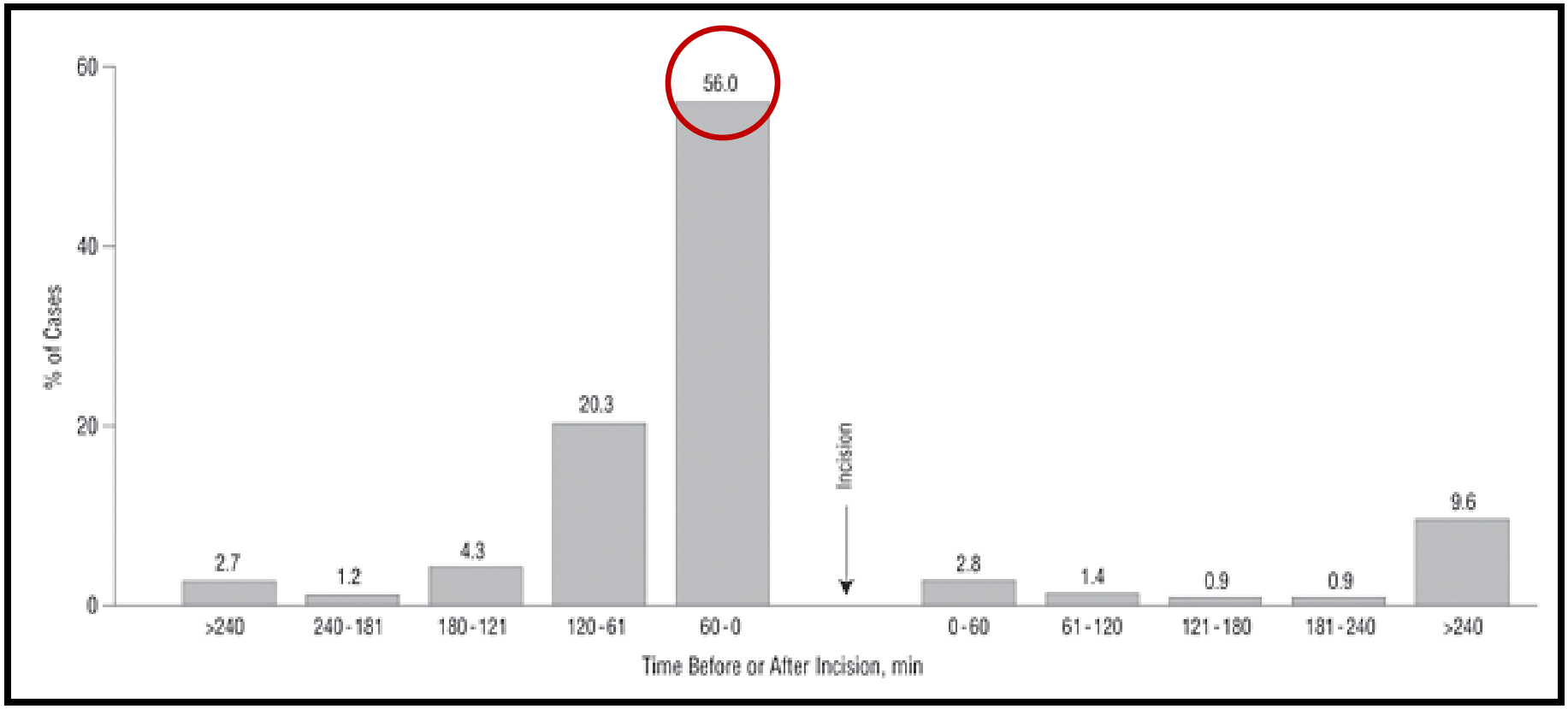
# Surgical Prophylaxis: How Well Do (Did?) We Do?

- Sample of >34,000 Medicare inpatients

| | |
|---|---|
| **Abx within 60 mins pre-incision** | **55.7%** |
| **Received recommended Abx** | **92.6%** |
| **Abx stopped at 24 hrs after procedure** | **40.7%** |

Bratzler DW et al Arch Surg 2005;140:174+

# How Well Do We Do?
# Timing of First Dose of Abx




Bratzler DW et al Arch Surg 2005;140:174+

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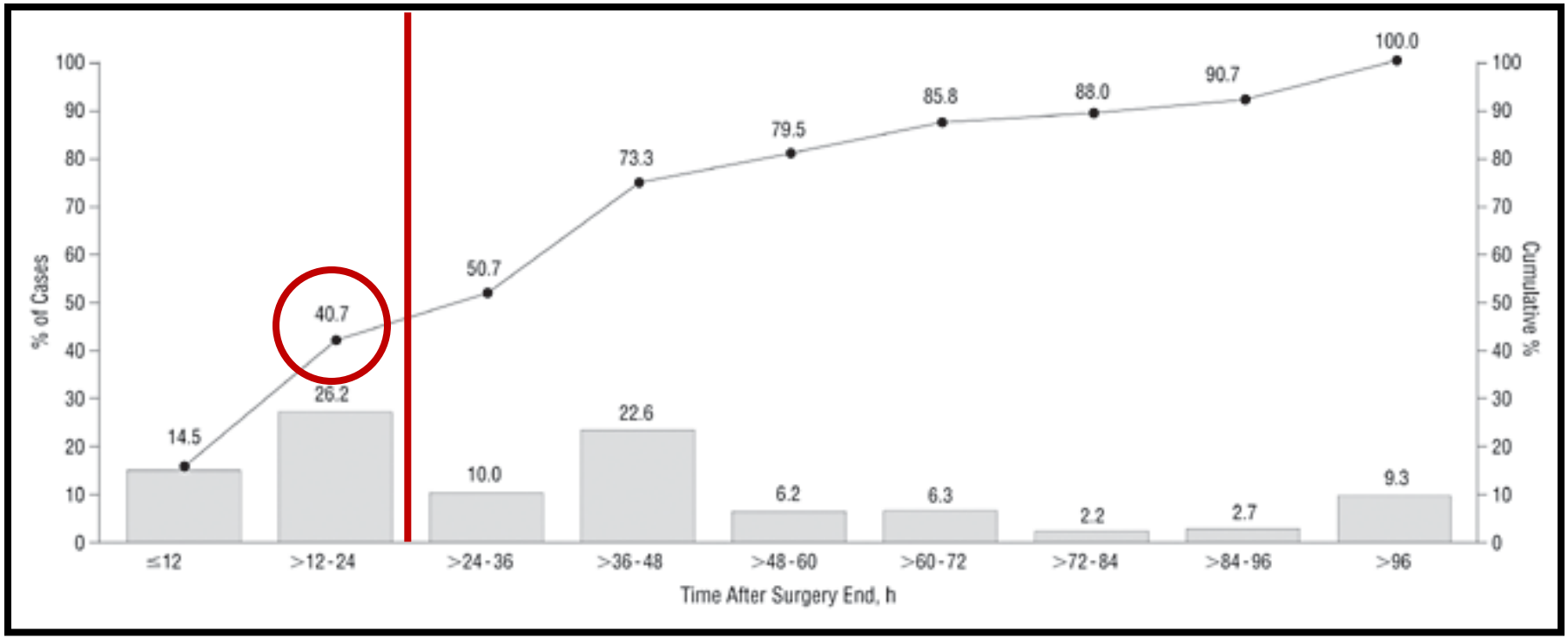
# How Well Do We Do?
# Duration of Surgical Prophylaxis




Bratzler DW et al Arch Surg 2005;140:174+

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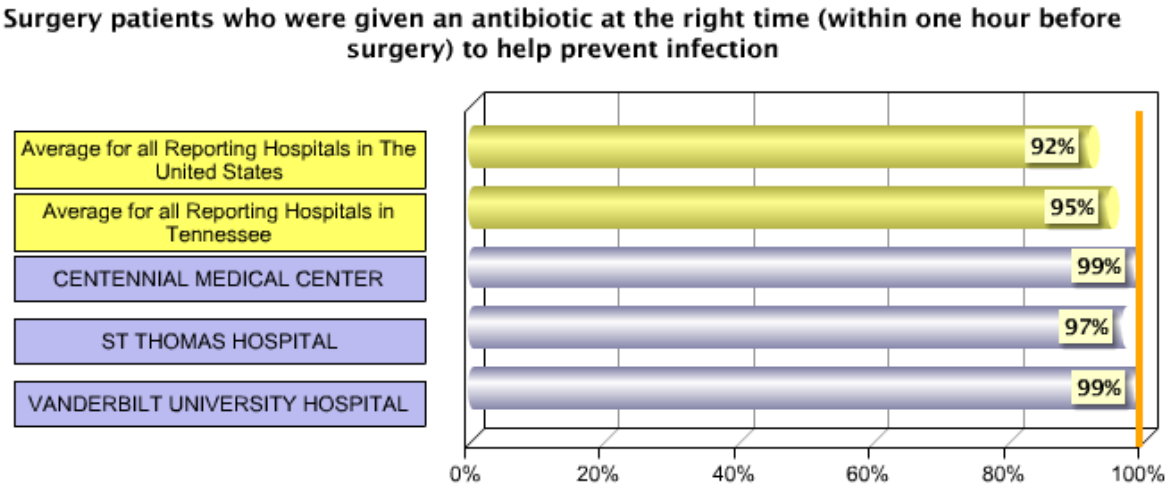
Surgical Care Improvement Project
A National Quality Partnership

# Quality Measures for Surgical Care:

**SCIP 1:** Abx within 1hr (2hr if vancomycin used)

**SCIP 2:** Selection of abx

**SCIP 3:** Timely discontinuation of Abx (24hrs, except for cardiac surgery = 48hrs)

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# SCIP Compliance and Postoperative Infections

- Retrospective cohort study
- Premier Inc.'s Perspective Database
  - 7/1/06 – 3/31/08
- N = 398 US hospitals
- Examined SCIP process measure adherence
- **Outcome = ICD-9 coded diagnosis of postoperative infection (998.59)**
- Examined relationship between individual measures and composite measures on infection

**Stulberg et al JAMA 2010;303:2479+**

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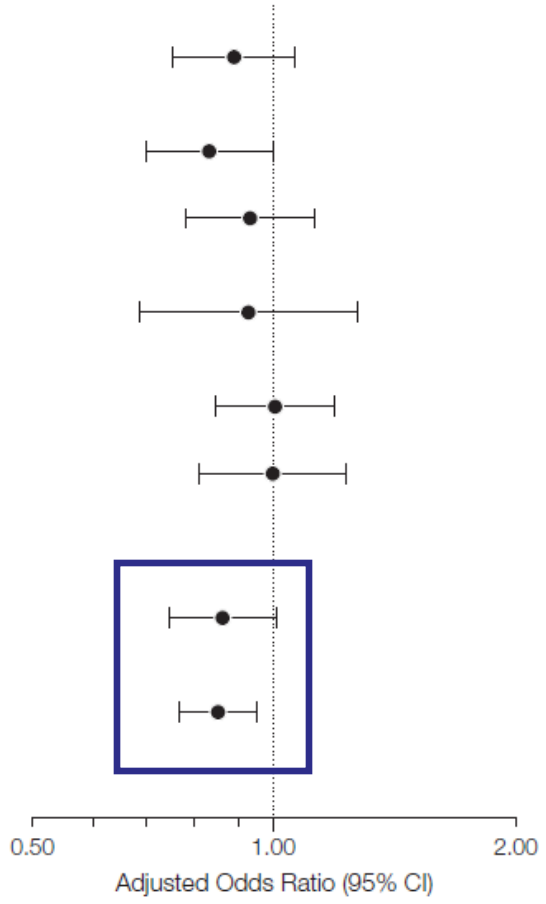
**Figure 1.** Surgical Care Improvement Project (SCIP) Infection-Prevention Process Measures

| | Nonadherent Discharges | | Adherent Discharges | | |
|---|---|---|---|---|---|
| | Postoperative Infections | Discharges | Postoperative Infections | Discharges | Adjusted Odds Ratio (95% CI) |
| **Individual SCIP measures** | | | | | |
| INF-1: prophylactic antibiotic received within 1 h prior to surgical incision | 251 | 18 147 | 1394 | 190 925 | 0.89 (0.75-1.06) |
| INF-2: prophylactic antibiotic selection for surgical patients | 266 | 12 670 | 1486 | 198 002 | 0.83 (0.69-1.00) |
| INF-3: prophylactic antibiotics discontinued within 24 h after surgery end time | 310 | 26 499 | 1024 | 173 228 | 0.94 (0.78-1.13) |
| INF-4: cardiac surgery patients with controlled 6 AM postoperative blood glucose | 65 | 4168 | 362 | 31 512 | 0.93 (0.68-1.27) |
| INF-6: surgery patients with appropriate hair removal | 194 | 21 308 | 3539 | 360 111 | 1.00 (0.85-1.19) |
| INF-7: colorectal surgery patients with immediate postoperative normothermia | 181 | 4564 | 676 | 18 101 | 1.00 (0.81-1.23) |
| **Composite measures** | | | | | |
| S-INF-Core: all 3 original Surgical Infection Prevention (SIP) project perioperative infection-prevention measures | 511 | 44 417 | 816 | 154 963 | 0.86 (0.74-1.01) |
| S-INF: all patients with at least 2 recorded SCIP infection-prevention measures in a single visit | 843 | 59 356 | 1070 | 158 304 | 0.85 (0.76-0.95) |

S-INF-Core = INF-1, INF-2, INF-3
S-INF = 2 or more of Any INF measure




Each estimate accounts for the surgical procedure performed, patient characteristics, and hospital characteristics. CI indicates confidence interval.

Stulberg et al JAMA 2010;303:2479+

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# Reasons for Failure of Surgical Antimicrobial Prophylaxis

- Patient risk factors
- Procedural risk factors
  - Hair removal with razor
  - Inappropriate skin antisepsis
  - Hypothermia during procedure
- Incorrect dosing/drug/delivery
- Antibiotic resistant pathogens
  - When to change standard agents?

# Preventing Hypoxia

# Hypoxia & SSI: Pathophysiology

- WBC bactericidal activity secondary to oxidative killing
  - Use of superoxide radicals
  - Dependent upon partial pressure of $O_2$ in tissue

- Disruption of local vascular supply → ↓ **$O_2$**

- Provision of higher FiO2 → reduced SSI?

# Randomized Trials of High and Low Inspired $FiO_2$ and SSI

| Study | Intervention | Sample Size | Patient Population | SSI Rates* | Comments |
|---|---|---|---|---|---|
| Grief et al (2000) | $FiO_2$ 30% vs. $FiO_2$ 80% | 250 per arm | Elective colorectal | 30% arm: 11.2%<br>80% arm: 5.2% | Trial stopped early |
| Pryor et al (2004) | $FiO_2$ 35% vs. $FiO_2$ 80% | 80 per arm | Elective major abdominal | 30% arm: 11.3%<br>80% arm: 25% | Trial stopped early |
| Belda et al (2005) | $FiO_2$ 30% vs. $FiO_2$ 80% | 143 in 30%; 148 in 80% | Elective colorectal | 30% arm: 24.4%<br>80% arm: 14.9% | |
| Mayzler et al (2005) | $FiO_2$ 30% vs. $FiO_2$ 80% (both w/$N_2O$) | 19 per arm | Elective colorectal | 30% arm: 17.6%<br>80% arm: 12.5% | Non-significant |
| Myles et al (2007) | $FiO_2$ 30% + $N_2O$ vs. $FiO_2$ 80% + nitrogen | 977 in arm 1; 1015 in arm 2 | Elective or emergent noncardiothoracic resection | 30% arm: 10.0%<br>80% arm: 7.7% | Differing comparators ($N_2O$ vs. N) |

***Variable SSI definitions**

**Grief R et al NEJM 2000;342:161+ Pryor KO et al JAMA 2004;291:79+ Belda FJ et al JAMA 2005;294:2035+ Mayzler O et al Minerva Anestesiol 2005;71:21+ Myles PS et al Anesthesiology 2007;107:221+**

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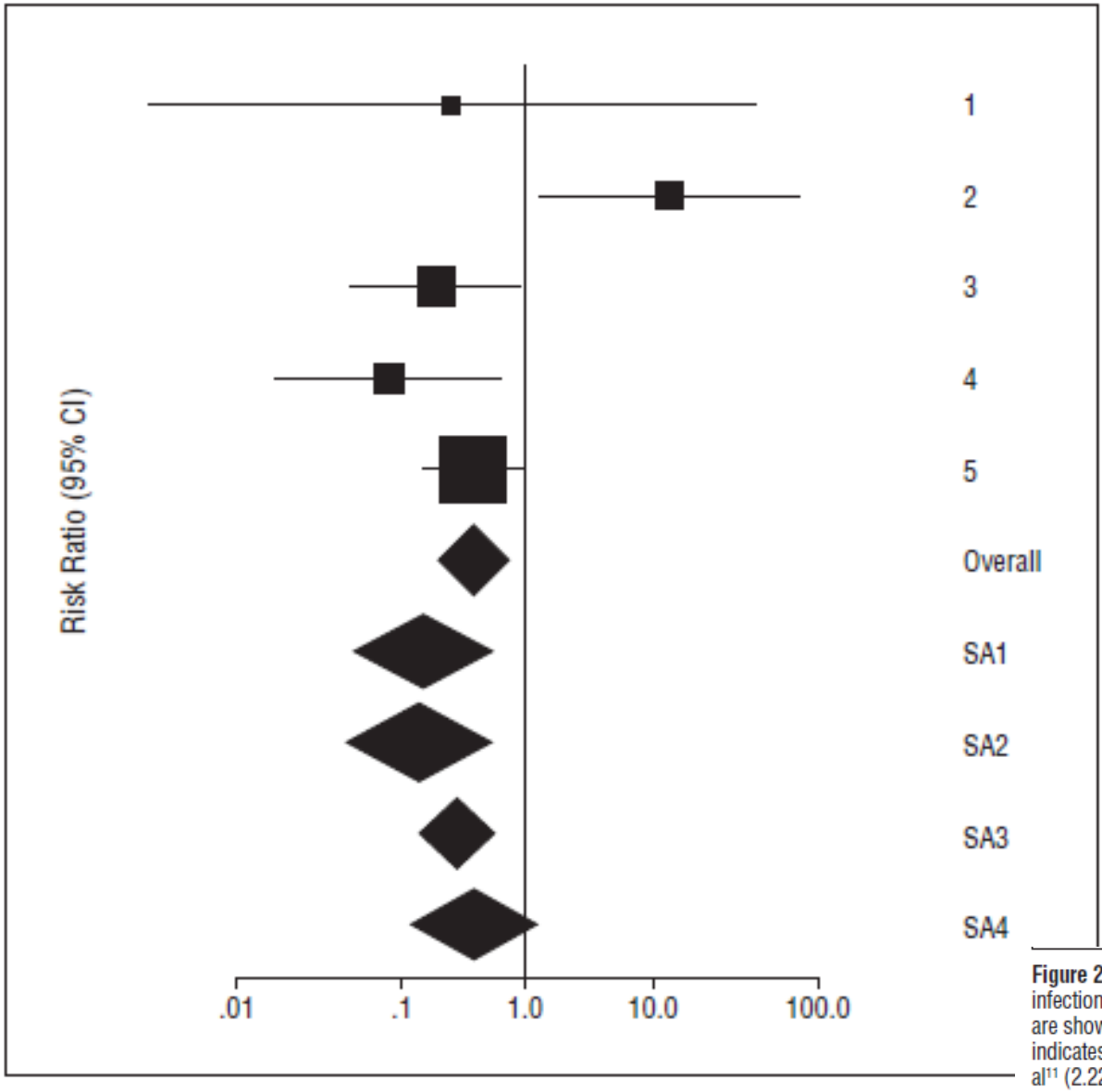



**Overall RR High FiO2 = 0.74 (95% CI 0.6-0.92)**

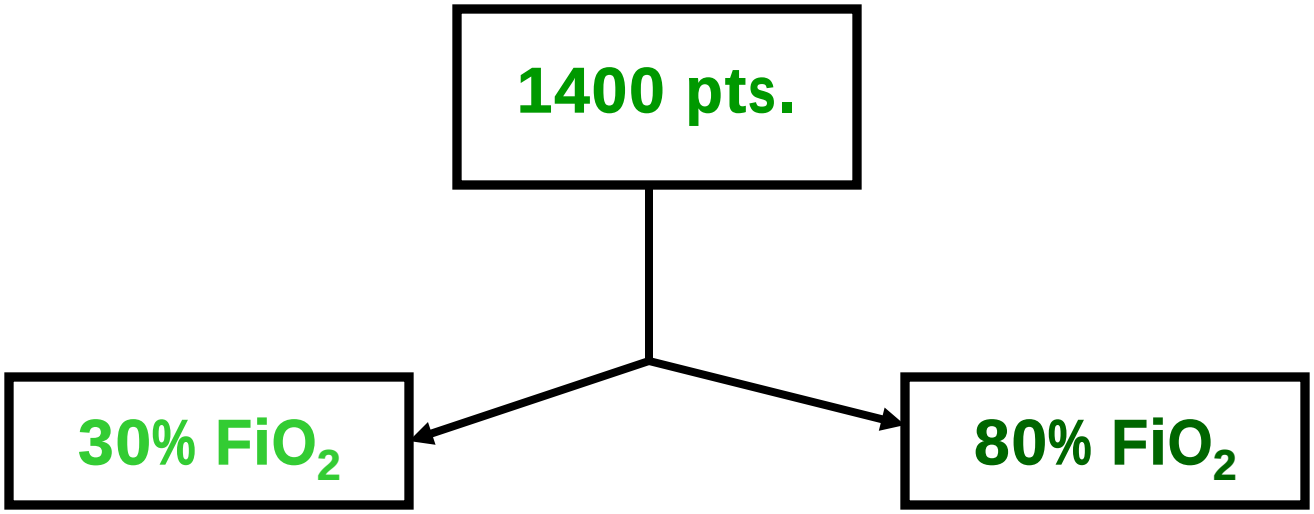
**Qadan M et al Arch Surg 2009;144:359+**

**Figure 2.** Effect of perioperative supplemental oxygen therapy on surgical site infection risk reduction. Risk ratios (RRs) with 95% confidence intervals (CIs) are shown for individual, combined, and sensitivity analysis (SA) values. 1 indicates Mayzler et al[10] (RR, 0.667; 95% CI, 0.125-3.550; $P=.64$); 2, Pryor et al[11] (2.222; 1.078-4.580; $P=.03$); 3, Belda et al[12] (0.607; 0.375-0.983; $P=.04$); 4, Greif et al[13] (0.464; 0.246-0.875; $P=.02$); 5, Myles et al[14] (0.740; 0.559-0.979; $P=.04$); overall (0.742; 0.599-0.919; $P=.006$; $I^2=65.584$); SA1, noncolorectal studies excluded (0.556; 0.383-0.808; $P=.002$; $I^2=0.000$); SA2, nitrous oxide studies excluded (0.551; 0.375-0.808; $P=.002$; $I^2=0.000$); SA3, the study by Pryor et al excluded (0.667; 0.533-0.835; $P=.000$; $I^2=0.000$); and SA4, the largest study excluded (0.744; 0.534-1.037; $P=.08$; $I^2=74.186$). Squares represent individual randomized controlled trials; lines attached to squares, individual 95% confidence intervals; diamonds, the combined effect of several (or all) meta-analyses.

# Effect of High Perioperative Oxygen Fraction on Surgical Site Infection and Pulmonary Complications After Abdominal Surgery

The PROXI Randomized Clinical Trial

- Acute or elective laparotomy
- Standard antibiotic prophylaxis; No colonic abx




Meyhoff CS et al JAMA 2009;302:1543+

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# Results

- Higher oxygen $FiO_2$ **not** associated with increase in pulmonary complications but no impact on SSI.
- Normothermia not maintained; less fluid volumes → local vasoconstriction and less $O_2$ delivery?

| | 35% | 80% |
|---|---|---|
| SSI | 141/701(20.1%) | 131/685 (19.1%) |
| Atelectasis | 7.1% | 7.9% |

Meyhoff CS et al JAMA 2009;302:1543+

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# The Scoop on $O_2$ and SSI

- **Benefits:**
  - It's cheap
  - It's easy
  - It worked in several RCTs
- **Risks:**
  - ? ↑ atelectasis
  - Pulmonary toxicity?
    - Not seen in RCT
  - Associated with increased risk in RCT
- **Questions**:
  - Variable SSI ascertainment
  - Use in colorectal pts?
  - Manner of delivery important?
    - Nasal cannula vs. mask

# Maintaining Sterile Technique: Glove Perforations

- Prospective observational cohort study
- 4,147 consecutive surgical procedures
- Outcome = SSI
- Glove perforation assessed intraop
- Higher likelihood of SSI in procedures in which gloves were perforated (OR = 2.0)
- Risk of perforation ↑ operative time
  - Significant increase after 2 hrs
- Double gloving/routine replacement?

Misteli H et al Arch Surg 2009;144:553+

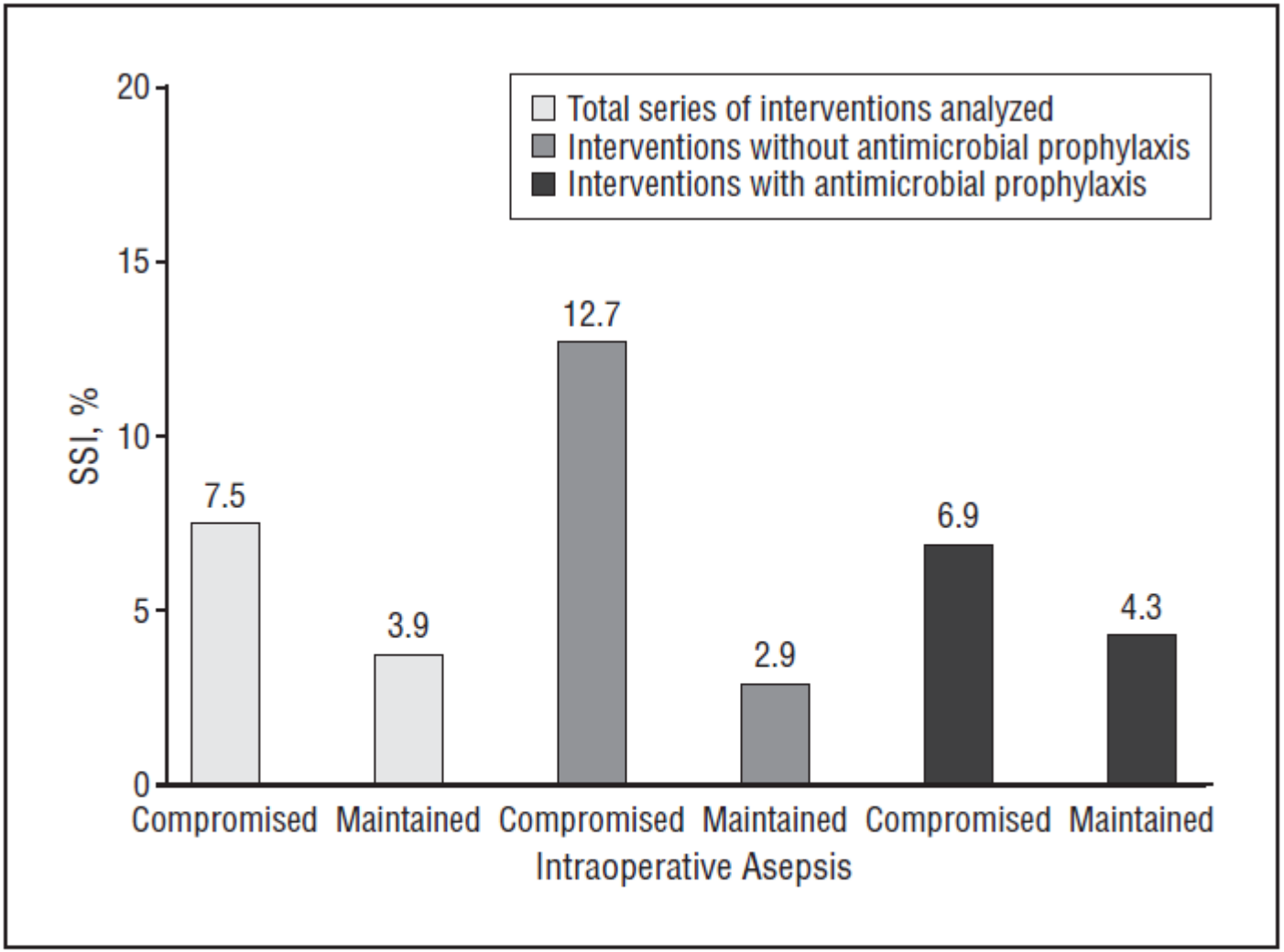
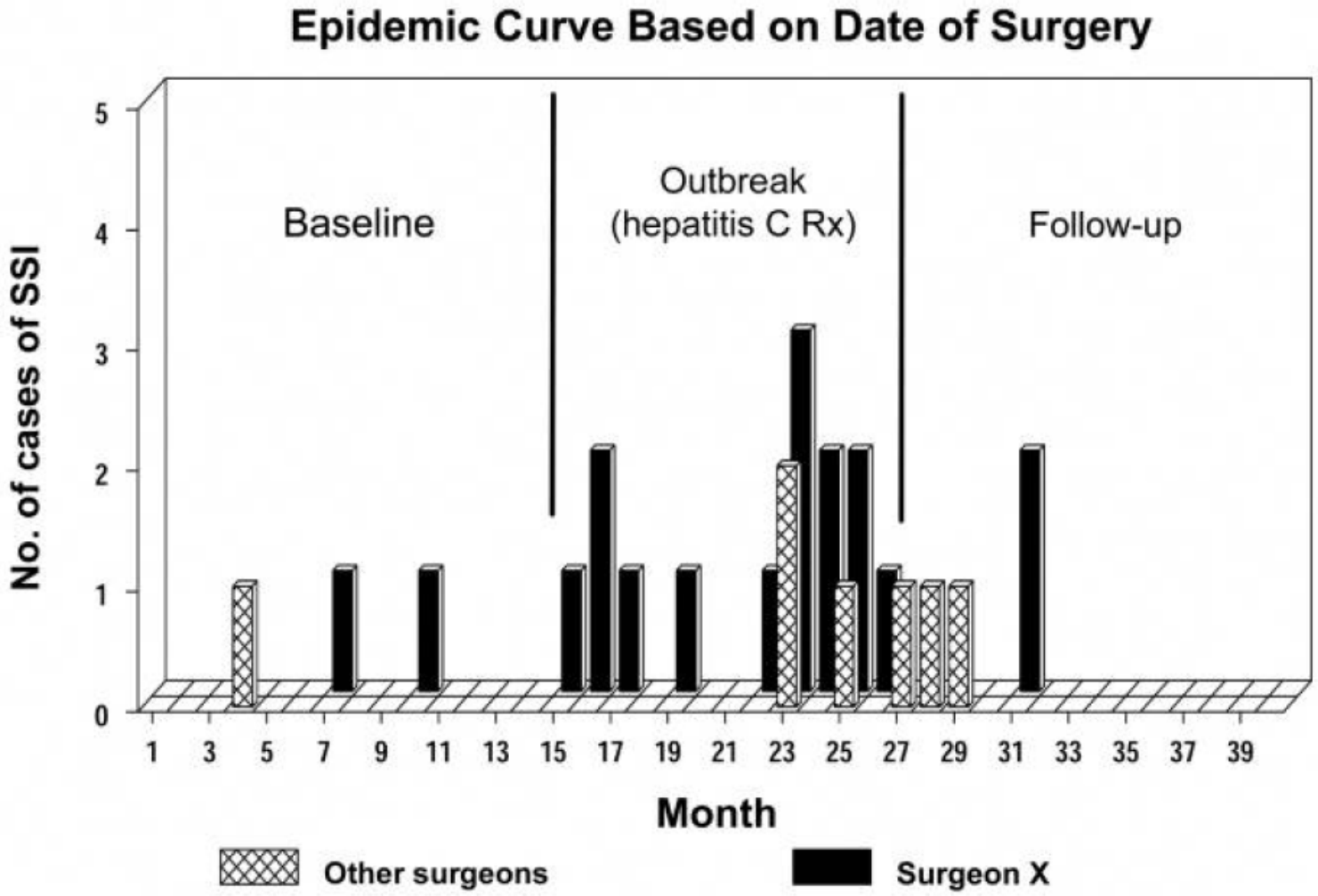



**Figure 2.** Rate of surgical site infections (SSIs) in 4147 surgical procedures by use of surgical antimicrobial prophylaxis and maintenance of intraoperative asepsis.

Misteli H et al Arch Surg 2009;144:553+

# Causes of SSI: Impaired Providers?




Sherertz RJ et al Infect Control Hosp Epidemiol 2009;30:1120+

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# Surgical Site Infections in Colon Surgery

## *The Patient, the Procedure, the Hospital, and the Surgeon*

*Martin Hübner, MD; Michele Diana, MD; Giorgio Zanetti, MD, MSc; Marie-Christine Eisenring, RN; Nicolas Demartines, MD; Nicolas Troillet, MD, MSc*

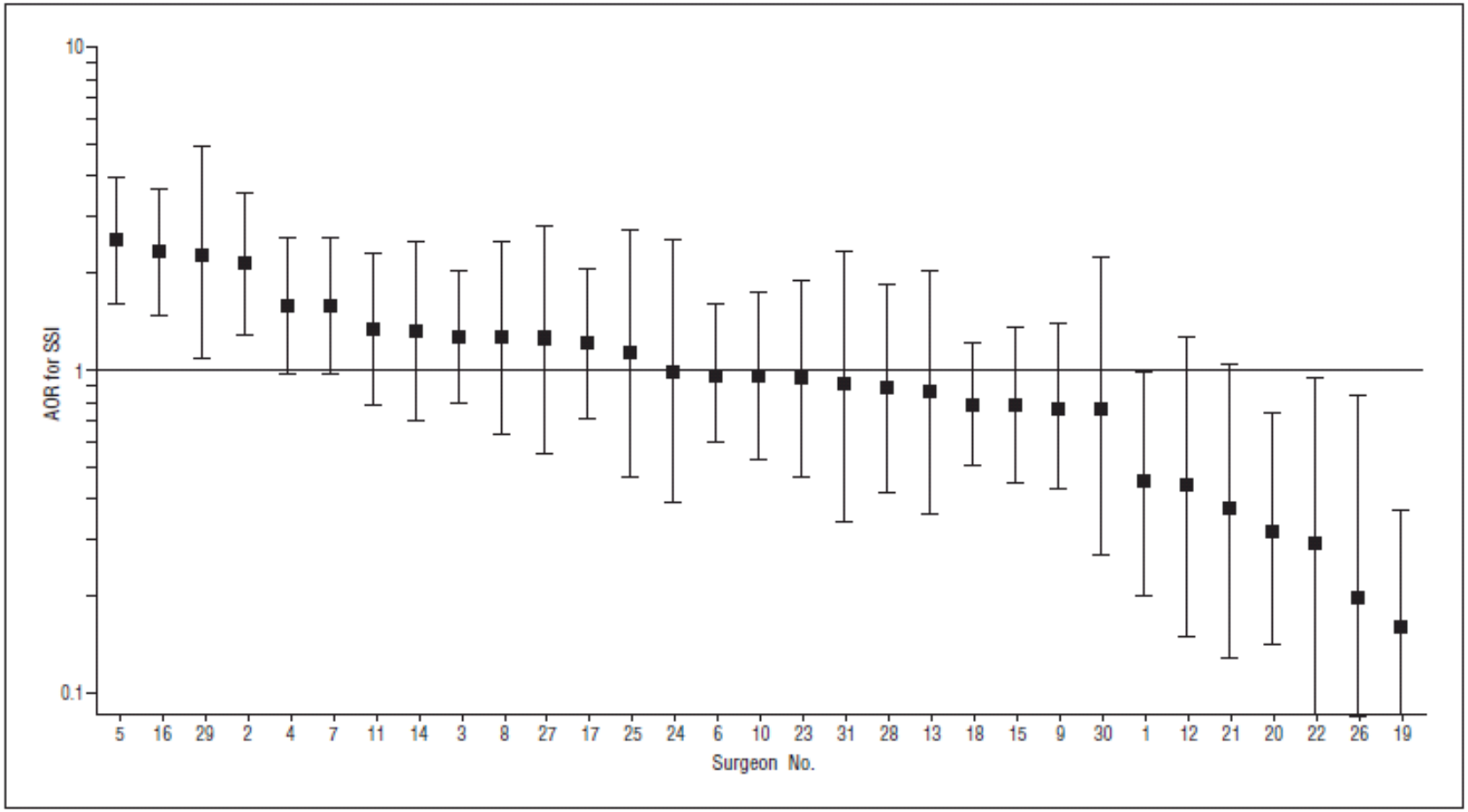



**Figure 1.** Surgeons' individual adjusted odds ratios (AORs) for surgical site infection (SSI) after colon surgery, adjusted for patients' sex and age, American Society of Anesthesiologists score, interventions' class of contamination and duration (>3 hours), emergency, laparoscopic approach, and properly timed antibiotic prophylaxis (≤1 hour before the incision). Error bars indicate 95% confidence interval.

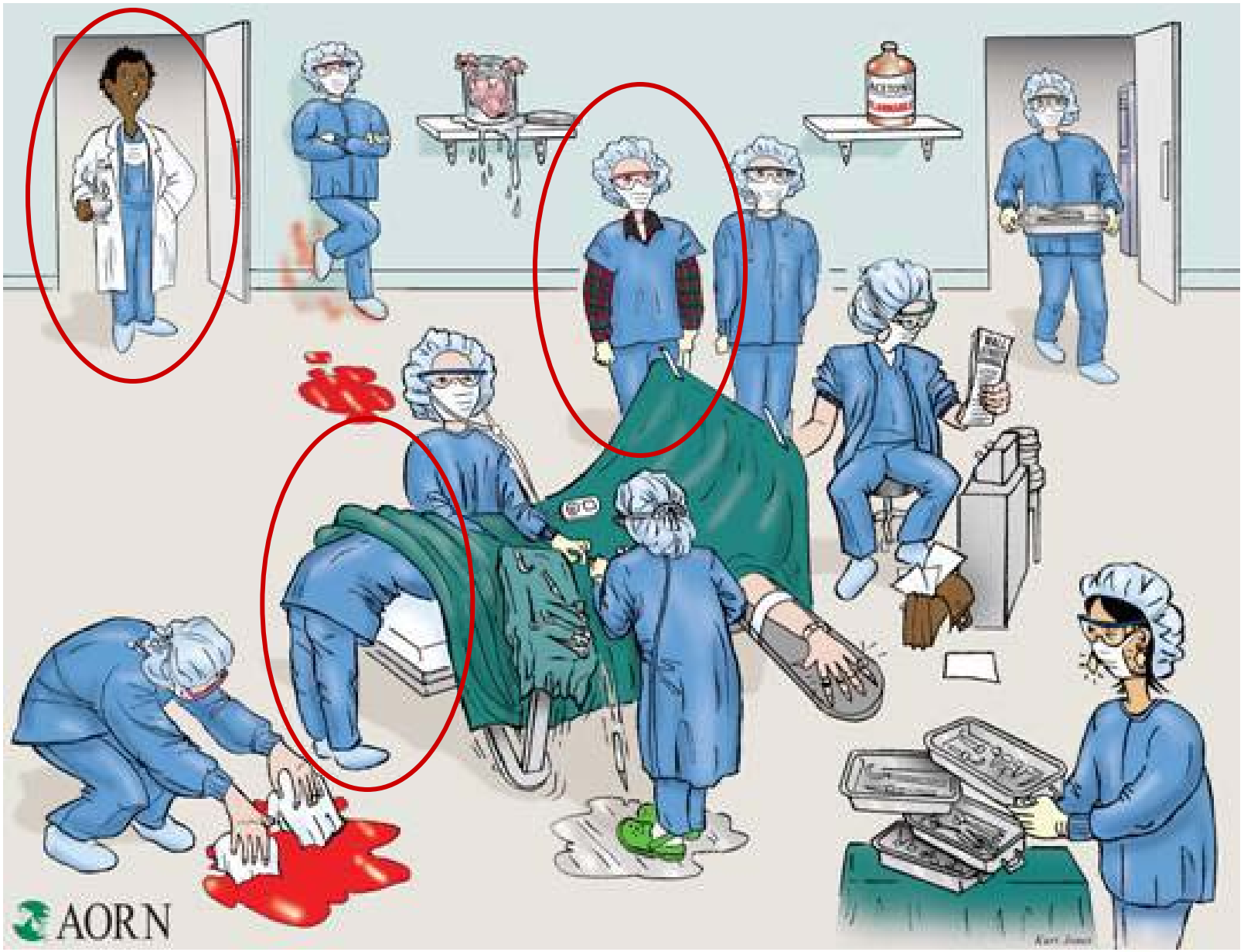
**Hübner M et al Arch Surg 2011;146:1240+**

# Ambulatory Surgical Centers: Surgical Infections = More Than SSI

- ASC in MD, NC, OK (n=68)
- **67.6%** had at least 1 lapse in infection control practices

| Infection Control Lapses Identified | No./Total No. (%) |
|---|---|
| Hand Hygiene/Use of PPE | 12/62 (19.4%) |
| Injection Safety/Medication Handling | 19/67 (28.4%) |
| *Single Dose Meds Used >1 Pt* | 18/64 (28.1%) |
| Equipment Reprocessing | 19/67 (28.4%) |
| Environmental cleaning | 12/64 (18.8%) |
| Handling of Blood Glucose Monitoring Equipment | 12/54 (46.3%) |

Schaefer MK et al JAMA 2010;303:2273+

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# Impact of intraoperative behavior on surgical site infections

Guido Beldi, M.D.[a,*], Sonja Bisch-Knaden, Ph.D.[a], Vanessa Banz, M.D.[a], Kathrin Mühlemann, M.D., Ph.D.[b], Daniel Candinas, M.D.[a]

**Table 4** Multivariate analysis of risk factors

| | Odds ratio (95% CI) | *P* value |
|---|---|---|
| BMI (≤30 kg/m² → >30 kg/m²) | 2.00 (1.22–3.20) | .006 |
| Surgeon (consultant→ fellow) | 1.27 (.80–2.03) | .32 |
| Duration of surgery (≤3 h → >3 h) | 3.34 (1.82–6.14) | <.001 |
| Discipline score (0 → ≥1) | 2.02 (1.05–3.88) | .04 |
| Intestinal anastomosis | 6.74 (3.42–13.30) | <.001 |

BMI = body mass index; CI = confidence interval.

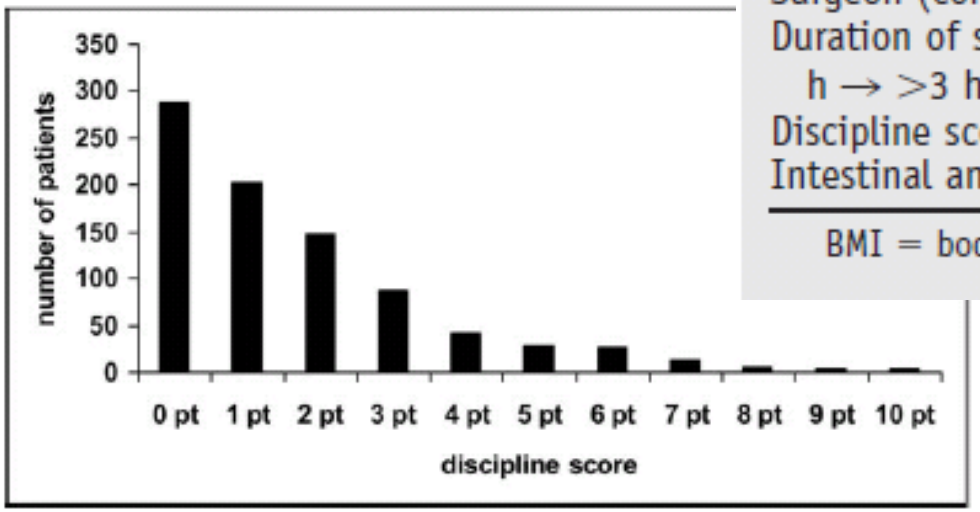



**Figure 1** Distribution of lapses in discipline in the study population.

The American Journal of Surgery, Vol 198, No 2, August 2009

# The Challenge

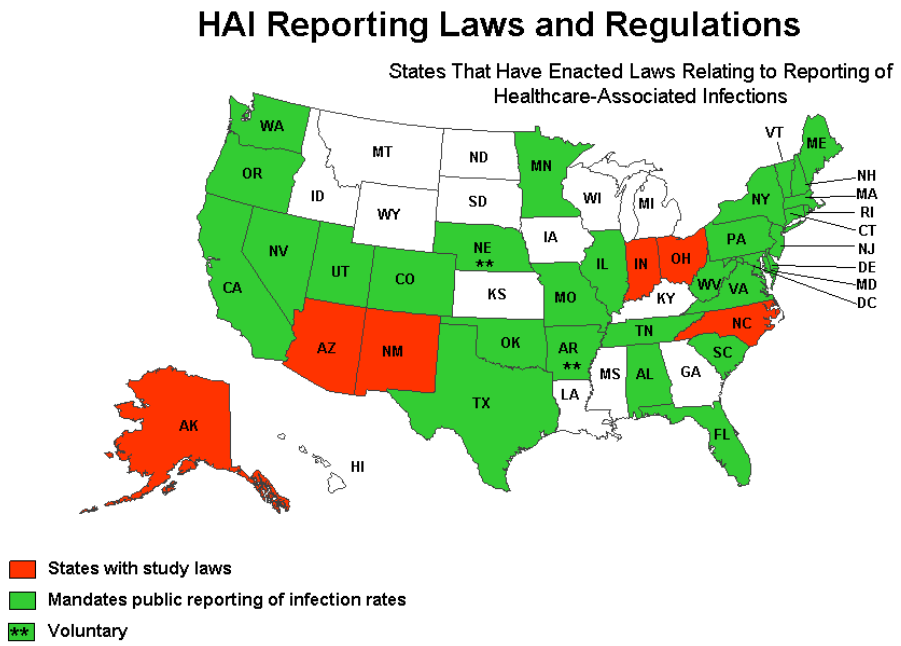
- Create a culture where speaking up is the norm
- Encourage vigilance for all members of the team
- Move from “Show me why I should do it” to “Show me why you should not”
- Standardize practices

# The Challenge

- Don't forget the basic practices & don't assume everyone knows them
- Make the training stick
- Provide granular, timely data (SWAT teams)

# Public Reporting of SSI Rates

- Risk adjustment limited
- ?Consistency with application of SSI definitions
- Tied to payments
  - SSI added to Centers for Medicaid and Medicare Services payment system
    - Colon surgery
    - Abd hysterectomy

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# New Challenges for SSI Care

- Changes in surgical arena
  - Move to outpatient/office venues
- New surgical techniques
  - Minimally-invasive procedures
- Optimizing surveillance
- Mandatory reporting of SSIs
- CA-MRSA and Abx prophylaxis