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Surgical Site Infections
Part II

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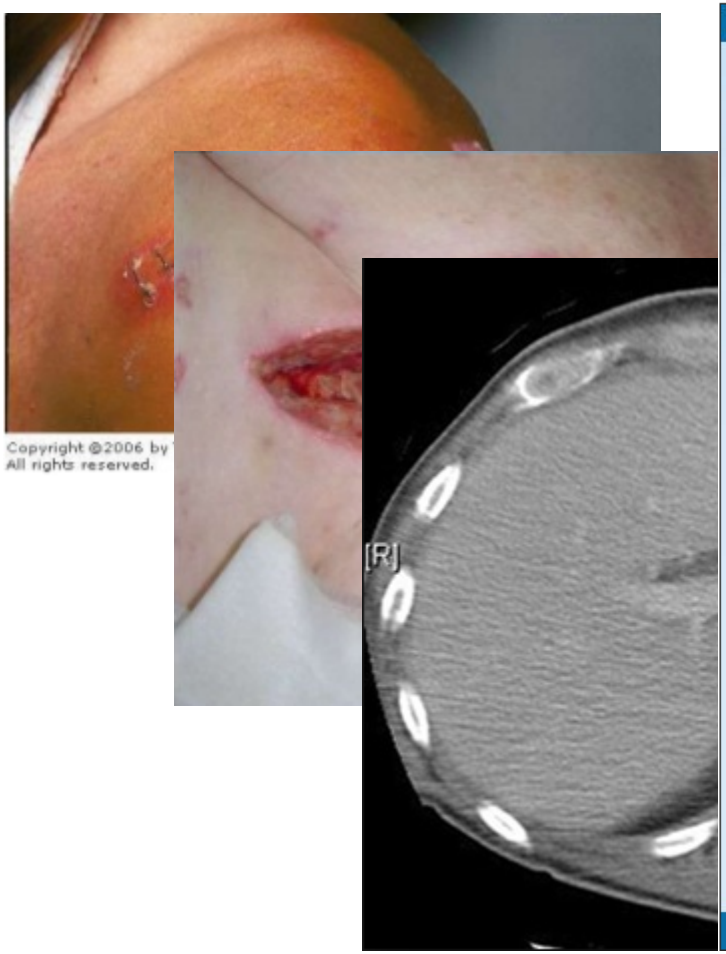
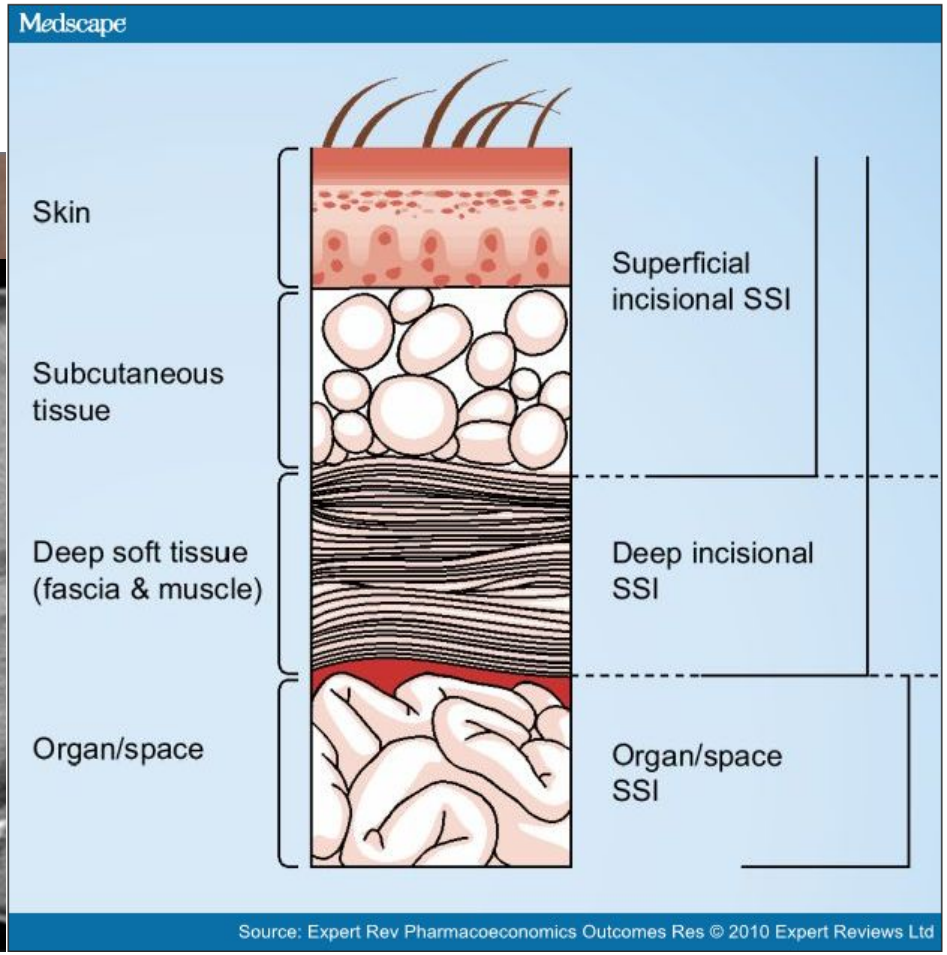
What is it?





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FAQ SAP

- Do all procedures need SAP?
- What med and what dose?
- When to dose?
- Re-dosing?
- Decolonization strategies
- New developments

SSI Definitions

- **Clean Wound:** Uninfected operative wound with no inflammation and is closed primarily. No viscus is entered during the procedure.
- **Clean-contaminated wound:** Viscus (respiratory, alimentary, genital or urinary canal) is entered under controlled conditions and with no unusual contamination.
- **Contaminated wound:** are open, fresh accidental wounds, or there is a break in the sterile technique, or spillage from a viscus.
- **Dirty wound:** Old traumatic wounds with retained debris, feces, or devitalized tissue.

Culver, DV; et al. Surgical Wound Infection Rates by Wound Class, Operative Procedure, and Patient Risk Index. The American Journal of Medicine. 1991: 91.

Micro

TABLE 4
OPERATIONS, LIKELY SURGICAL SITE INFECTION (SSI) PATHOGENS, AND REFERENCES ON USE OF ANTIMICROBIAL PROPHYLAXIS*

Operations	Likely Pathogens†‡	References
Placement of all grafts, prostheses, or implants	*Staphylococcus aureus;* coagulase-negative staphylococci	269,282-284,290
Cardiac	*S. aureus;* coagulase-negative staphylococci	251-253,462,463
Neurosurgery	*S. aureus;* coagulase-negative staphylococci	241,249,258,259,261,464,465
Breast	*S. aureus;* coagulase-negative staphylococci	242,248
Ophthalmic	*S. aureus;* coagulase-negative staphylococci; streptococci;	466
Limited data; however, commonly used in procedures such as anterior segment resection, vitrectomy, and scleral buckles	gram-negative bacilli	
Orthopedic	*S. aureus;* coagulase-negative staphylococci; gram-	60,243-246,254,255,467-473
Total joint replacement	negative bacilli	
Closed fractures/use of nails, bone plates, other internal fixation devices		
Functional repair without implant/device		
Trauma		
Noncardiac thoracic	*S. aureus;* coagulase-negative staphylococci;	240,247,474,475
Thoracic (lobectomy, pneumonectomy, wedge resection, other noncardiac mediastinal procedures)	*Streptococcus pneumoniae;* gram-negative bacilli	
Closed tube thoracostomy		
Vascular	*S. aureus;* coagulase-negative staphylococci	250,463,476,477
Appendectomy	Gram-negative bacilli; anaerobes	263,452,478
Biliary tract	Gram-negative bacilli; anaerobes	260,262,479-484
Colorectal	Gram-negative bacilli; anaerobes	200,239,256,287-289,485-490
Gastroduodenal	Gram-negative bacilli; streptococci; oropharyngeal anaerobes (e.g., peptostreptococci)	256,257,491-493
Head and neck (major procedures with incision through oropharyngeal mucosa)	*S. aureus;* streptococci; oropharyngeal anaerobes (e.g., peptostreptococci)	494-497
Obstetric and gynecologic	Gram-negative bacilli; enterococci; group B streptococci; anaerobes	270-280,435
Urologic	Gram-negative bacilli	267
May not be beneficial if urine is sterile		

* Refer to "Antimicrobial prophylaxis in surgery," *The Medical Letter*, 1997,[266] for current recommendations of antimicrobial agents and doses.
† Likely pathogens from both endogenous and exogenous sources.
‡ Staphylococci will be associated with SSI following all types of operations.

Mangram, AJ; et al. "Guideline for Prevention of Surgical Site Infection, 1999." Infection Control and Hospital Epidemiology. April, 1999 (20) 4.

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Table 3.1.1. **Distribution and percentage of pathogenic isolates associated with SSI and resistant to selected antimicrobial agents, NHSN, 2009-2010***

Rank	Pathogen	No. of pathogens/ total SSI pathogens reported (%)	Antimicrobial agent (s)	No. of isolates tested (%)	Resistance (%)
1	*S. aureus*	6415 (30.4)	OX/METH	6304 (98.3)	43.7
2	Coagulase-negative staphylococci	2477 (11.7)	NA	NA	NA
3	*E. coli*	1981 (9.4)	ESC4	1627 (82.1)	10.9
			FQ3	1876 (94.7)	25.3
			Carbapenems	1330 (67.1)	2
			MDR1	1390 (70.2)	1.6
4	*E. faecalis*	1240 (5.9)	VAN	1187 (95.7)	6.2
5	*Pseudomonas aeruginosa*	1156 (5.5)	AMINOS	664 (57.4)	6
			ESC2	1097 (94.9)	10.2
			FQ2	1111 (96.1)	16.9
			Carbapenems	872 (75.4)	11
			PIP/PIPTAZ	818 (70.8)	6.8
			MDR2	1053 (91.1)	5.3
6	*Enterobacter spp.*	849 (4.0)	ESC4	816 (96.1)	27.7
			Carbapenems	594 (70.0)	2.4
			MDR1	648 (76.3)	1.7
7	*Klebsiella spp.*	844 (4.0)	ESC4	710 (84.1)	13.2
			Carbapenems	582 (69.0)	7.9
			MDR1	621 (73.6)	6.8

Bennett, et al. Mandell's Principles and Practice of Infectious Diseases. 8th Edition. Vol 2. 2015.

Type of Procedure

TABLE 3. Meta-Analyses and Types of Surgery for Which a Relative Risk Could be Calculated

Review Number	Type of Surgery	Cleanliness	Type of Infection	Relative Risk (95% CI)	Odds Ratio	Baseline Risk of Infection	Absolute Risk Reduction	No. Trials (Patients)
1	Arterial reconstruction, Stewart et al[4]	Clean	Wound	0.25 (0.17, 0.38)	0.22*	0.16	0.12†	10 (1297)
2	Pacemaker insertion, Da Costa et al[5]	Clean	Any	0.26‡ (0.10, 0.66)	0.26	0.04	0.03†	7 (2023)
3	Tube thoracostomy, Sanabria et al[6]	Clean	Wound	0.19 (0.07, 0.50)	0.18*	0.08	0.06†	5 (614)
4	Craniotomy, Barker[7]	Clean	Wound	0.21§ (0.13, 0.35)	0.20§	0.09	0.07†	8 (2075)
5	Intracranial ventricular shunts, Ratilal et al[8]	Clean	Shunt and wound	0.55‡ (0.38, 0.76)	0.52	0.11	0.05†	16 (1736)
6	Total hip replacement, Glenny and Song[9]	Clean	Wound	0.24 (0.14, 0.43)	0.23*	0.04	0.03†	5 (2582)
7	Closed long bone fractures, Gillespie and Walenkamp[10]	Clean	Wound	0.58§ (0.44, 0.75)	0.56§	0.08	0.03†	7 (3500)
8	Hip fracture repair, Southwell-Keely et al[11]	Clean	Wound	0.58‡ (0.38, 0.86)	0.55	0.10	0.05	10 (2417)
9	Spinal surgery, Barker[12]	Clean	Wound	0.38‡ (0.18, 0.79)	0.37	0.06	0.03	6 (843)
10	Breast surgery, Tejirian et al[13]	Clean	Wound	0.60 (0.45, 0.81)	0.56*	0.15	0.06†	5 (1307)
11	Inguinal hernia repair (without mesh), Sanchez-Manuel and Seco-Gil[14]	Clean	Wound	0.85‡ (0.54, 1.32)	0.84	0.05	0.01†	5 (1867)
12	Inguinal hernia repair (with mesh), Aufenacker et al[15]	Clean	Wound	0.55‡ (0.25, 1.20)	0.54	0.03	0.01†	6 (2507)
13	Caesarean section (elective), Smaill and Hofmeyr[16]	Clean	Wound	0.73 (0.53, 0.99)	0.71*	0.09	0.02†	12 (2015)
14	Caesarean section (non-elective), Smaill and Hofmeyr[16]	Clean-contaminated§	Wound	0.36 (0.26, 0.51)	0.34*	0.08	0.05†	20 (2780)
15	Abdominal hysterectomy, Mittendorf et al[17]	Clean-contaminated§	Any	0.43§ (0.36, 0.51)	0.37§	0.21	0.12†	25 (3604)
16	Biliary tract surgery, Meijer et al[18]	Clean-contaminated§	Wound	0.33‡ (0.26, 0.41)	0.30	0.135	0.09	42 (4129)
17	Percutaneous endoscopic gastrostomy, Sharma and Howden[19]	Clean-contaminated§	Wound	0.27 (0.17, 0.41)	0.22*	0.24	0.18	7 (777)
18	Laparoscopic cholecystectomy (elective), Catarci et al[20]	Clean-contaminated§	Wound	0.82‡ (0.37, 1.81)	0.82	0.03	0.01†	6 (974)
19	Colorectal surgery, Song and Glenny[21]	Contaminated§	Wound	0.35‡ (0.20, 0.56)	0.24	0.40	0.26†	4 (293)
20	Simple appendicitis, Andersen et al[22]	Contaminated* or clean-contaminated§	Wound	0.40‡ (0.32, 0.49)	0.37	0.11	0.06†	26 (5317)
21	Complicated appendicitis, Andersen et al[22]	Dirty	Wound	0.37‡ (0.29, 0.48)	0.28	0.35	0.22†	24 (1152)

*An odds ratio that has been calculated on the basis of the relative risk and the baseline risk of infection.

†An absolute risk reduction that has been calculated on the basis of information about the treatment and baseline probabilities of infection that is given in the review concerned. Here treatment probabilities of infection were calculated on the basis of baseline probabilities of infection and either relative risks or odds ratios if these figures were given in the review.

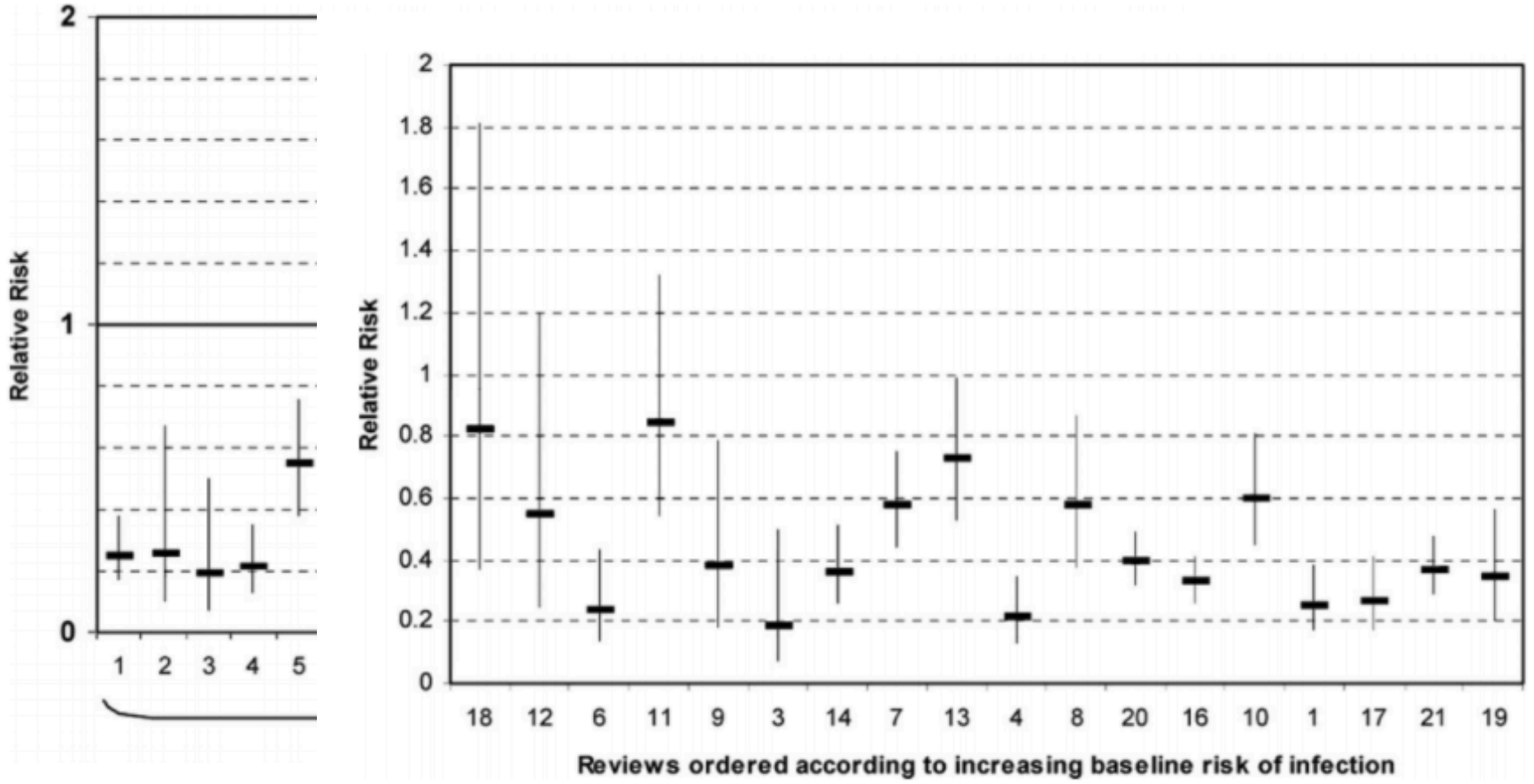
‡A relative risk that has been calculated on the basis of the odds ratio and the baseline risk of infection.

§A relative risk or an odds ratio that has been calculated on the basis of information about the treatment and baseline probabilities of infection that is given in the review concerned.

For review 7, the results for both deep and superficial wound infections have been combined to give overall results for any type of wound infection and also the results for this review are based on the results for the single dose meta-analysis rather than the separate multiple-dose meta-analysis that is also contained in this review.

Bowater, et al. “Is Antibiotic Prophylaxis in Surgery a Generally Effective Therapy?” Annals of Surgery. Vol 249 (4) 2009.

SAP



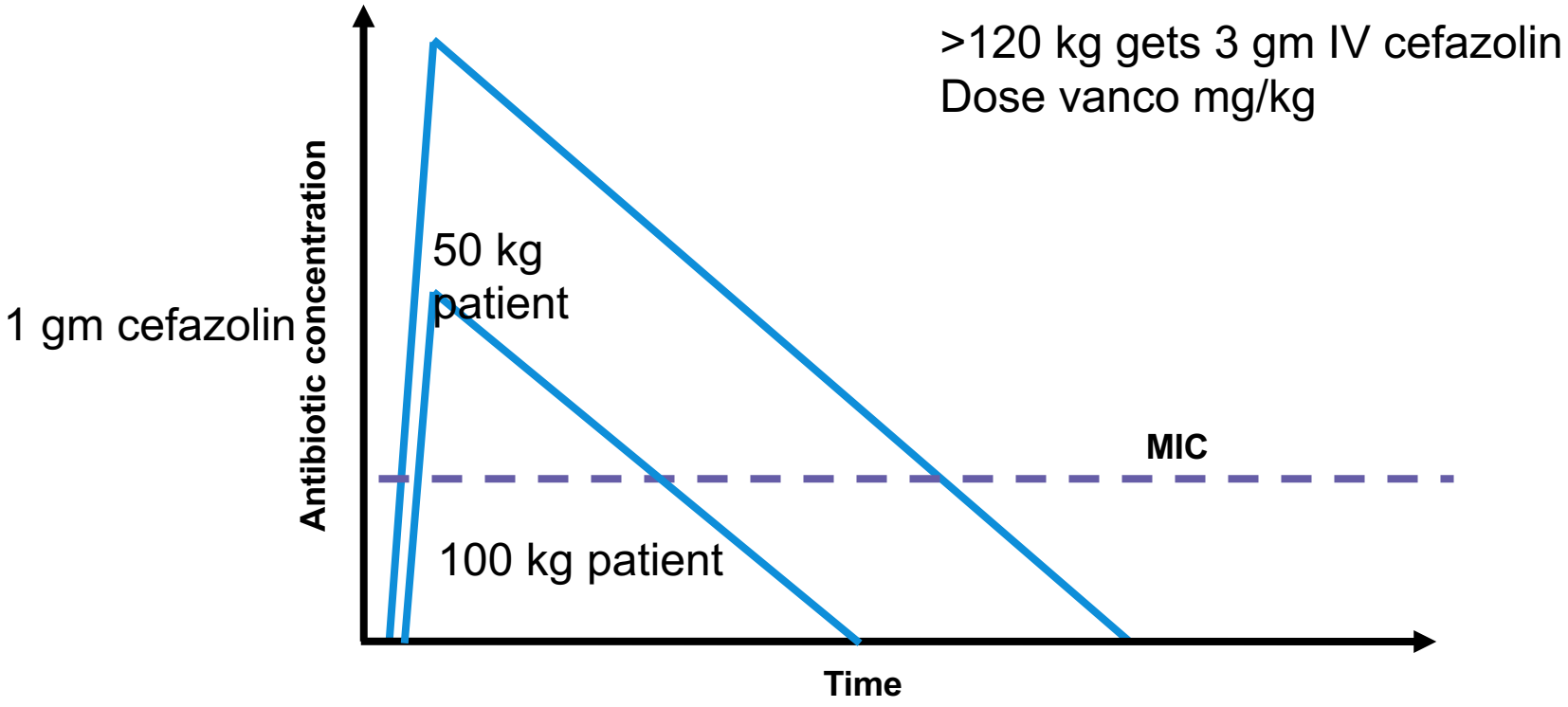
Bowater, et al. “Is Antibiotic Prophylaxis in Surgery a Generally Effective Therapy?” Annals of Surgery. Vol 249 (4) 2009.

Surgical Antibiotic Prophylaxis, SAP

- Clean procedure: Skin flora
  - Staph ->Cefazolin ->Vanco if known to be MRSA colonized.
- Clean-contaminated:
  - Abdominal, heart, kidney, liver procedures. Staph plus GNR and enterococci.
- Contaminated:
  - No prophy. Typically therapeutic abx.

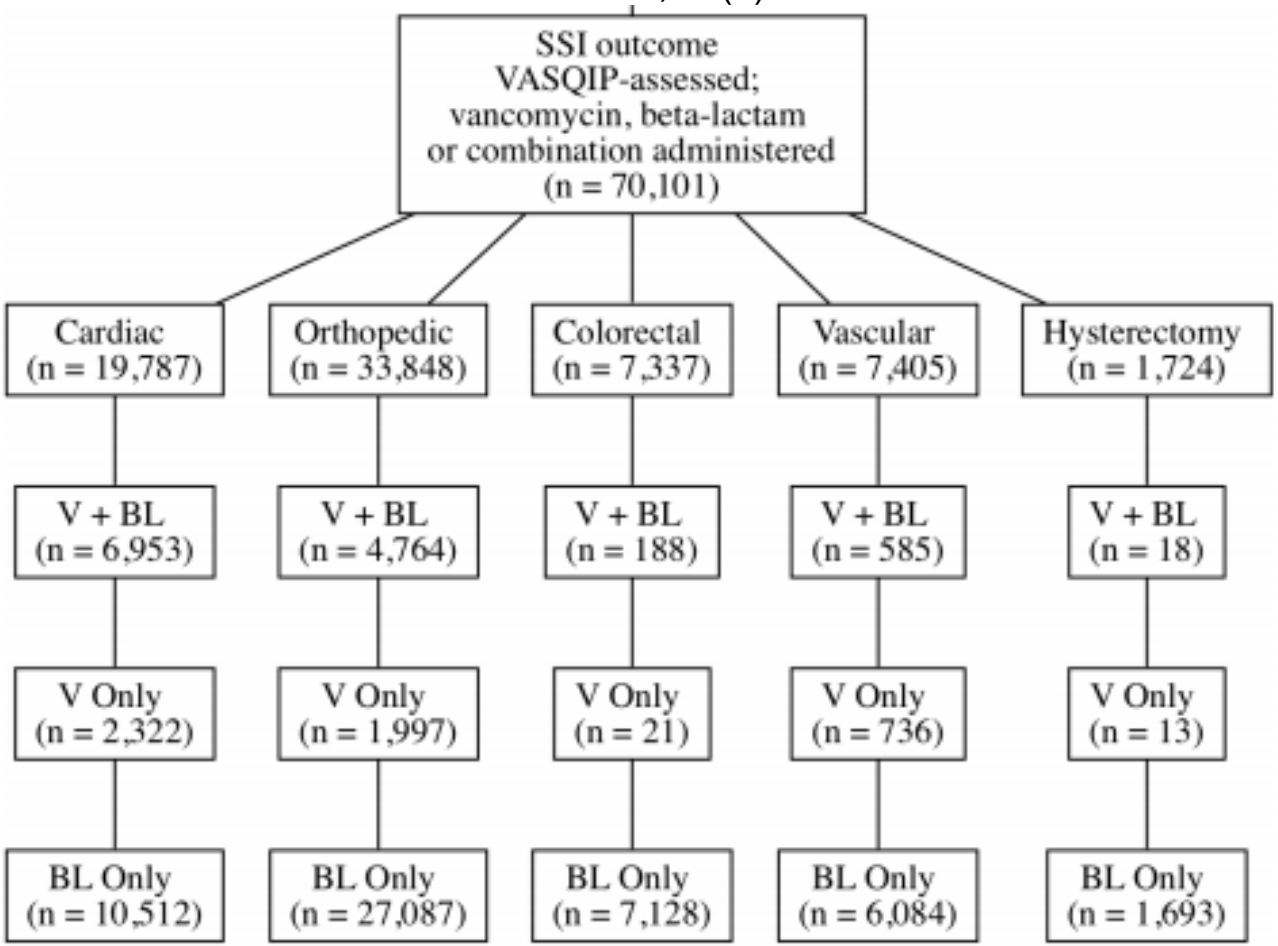
Concentration = Dose/Volume

If your Volume goes up, your Dose must go too



Two is not better than one, except for cardiac surgery

Plos Med. 2017; 14(7):e1002340



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Two is not better than one, except for cardiac surgery

Plos Med. 2017; 14(7):e1002340

Among cardiac surgery patients, combination prophylaxis was associated with a lower incidence of SSI

- NNT (MRSA-colonized) = 53
- NNT (non-MRSA colonized) = 176

No advantage was seen for any other surgical procedure

Risk of AKI increased in patients receiving combination therapy

- NNH = 167
- 23.8% combo vs. 20.8% vancomycin vs. 13.9% beta-lactam

No differences seen in rates of C. difficile infection

Staph Colonization

- 30% of SSIs caused by Staph. Aureus.
- Staph aureus colonization of the nares increases risk of SSI by 2-14 fold.
- No definitive guideline recommendations for pre-op decolonization.
- There is data in orthopedics and cardiac patients suggesting an overall reduction in MRSA SSI if decolonization is done pre-op.

Hebert C, Decolonization therapy in infection control. Current Opinion in Infectious Diseases. 2010, 23: 340-345

Timing

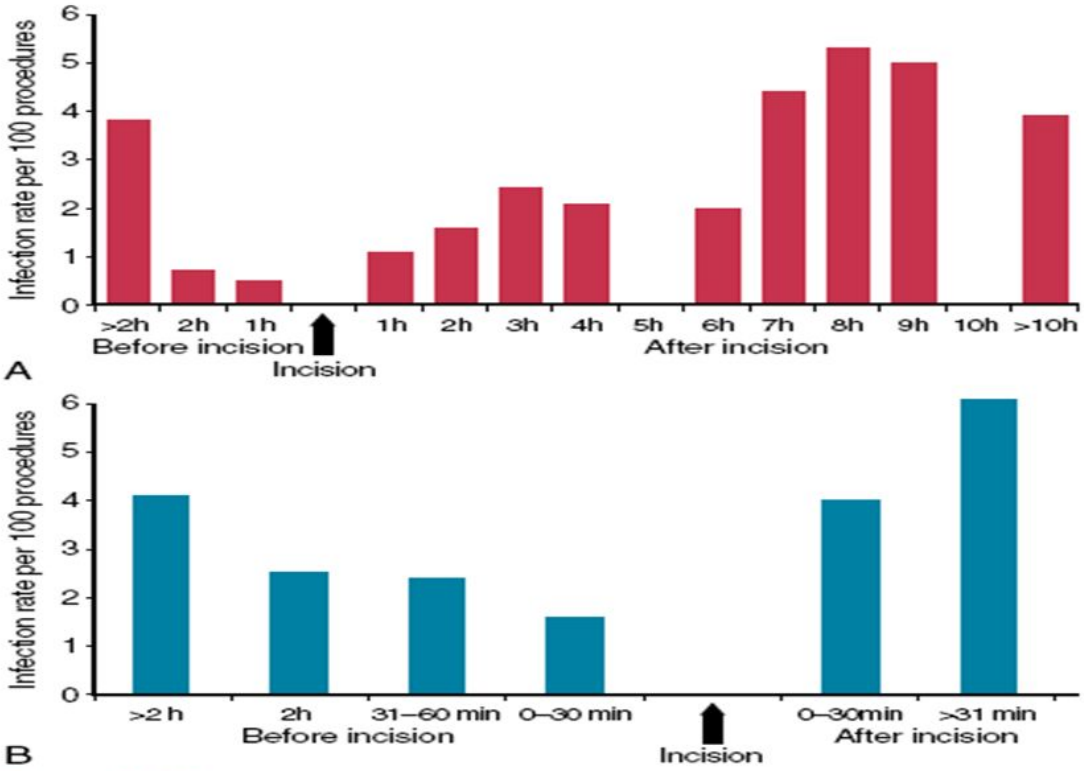


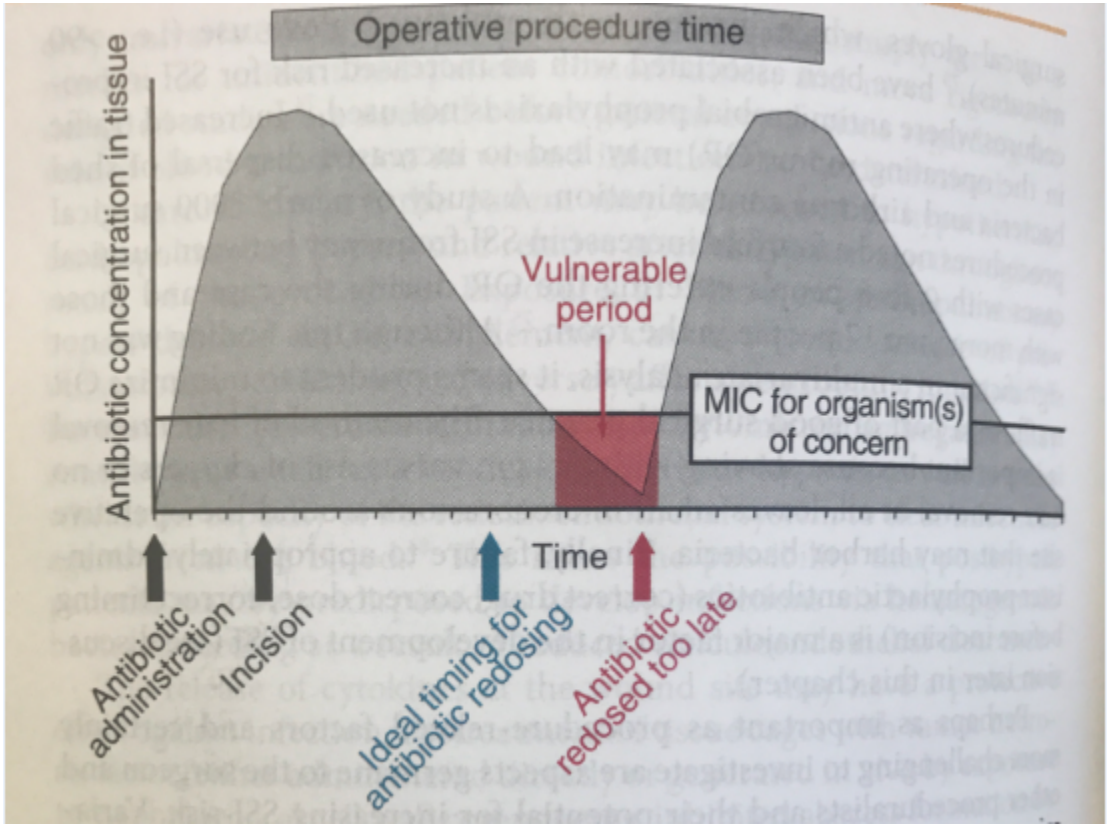
Figure 317-5 Timing of administration and infection rate. Relationship between timing of administration of prophylactic antibiotics and surgical site infection rate from two large studies. **A**, Data from 2,847 elective surgical patients (Classen 1992);[11] **B**, Data from 3,656 cardiac, orthopaedic and gynecologic surgical patients (Trial to Reduce Antimicrobial Prophylaxis Errors 2008).[113]

Bennett, et al. Mandell's Principles and Practice of Infectious Diseases. 8th Edition. Vol 2. 2015.

Re-dosing

- Morita et al. showed that rates of SSI increase to 26.5% from 8% if abx not re-dosed in procedures longer than 4 hours.
- TRAPE showed SSI 5.5% without redosing and 1.8% with re-dosing.
- Re-dosing should happen after 2 half lives.

Re-dosing



When to stop?

- There is no evidence for prolonging antibiotics beyond the procedure.
  - WHO and CDC recs agree on this.

- Meta-analysis of 44 studies showed no benefit.

- Moderate level of evidence for some benefit in prevention of SSI in ortho and cardiac surgeries if continued beyond a single dose, but likely outweighed by adverse events from abx.

Global Guidelines for the Prevention of Surgical Site Infections. WHO. 2016.

C Section SAP

- 4-15% infection rate after C section
  - 24% of elective c-sections and up to 60% of emergent c-sections complicated by endometritis.

- Endmoetritis micro = staph, strep, enterococci, lactobacilli, E Coli, peptostreptococcus, bacteroides, fusobacterium.
  - Increasingly recognized role of ureaplasma urealyticum and mycoplasma.

- Historically given at time of cord clamping, but emerging data shows no benefit of waiting until the cord is clamped versus at time of incision.

C Section SAP

- RCT examining cefazolin v cefazolin + azithro showed 12% v. 6.1% rate of endometritis and superficial SSI.
- Hysterectomy and C section:
  - Cefazolin 2 gm IV x 1 or if >120 kg 3 gm.
  - Add azithro 500 mg IV x 1 for patients in labor and BMI > or = 30.
- Gyn Onc:
  - cefazolin 1gm add 1 gm of metronidazole.
  - Hx of MRSA add Vanco.
  - Add azithro 500 mg IV x 1 for patients in labor and BMI > or = 30.

Tita NEJM 2016

HMC and UWMC SAP Protocols

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HMC

Procedure	Abx	Re-dose
Standard	Cefazolin 2 gm	3 hours
GU	Levofloxacin 750mg IV	None
Colorectal/GYN/OB	Cefazolin 2 gm IV + Metronidazole 500 mg IV	Cefazolin 3 Hrs Metro None
Head/Neck, Dental or NSG when mouth entered	Amp/sulbactam 3 gm	3 HRS

When using cefazolin If patient > 120 kg increase cefazolin to 3 gm

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HMC

- PCN Allergic

Procedure	ABX	Re-dose
GI/colo/GYN/Ob	Levoflox 750 mg IV plusClinda 900 mg IV Or Levo 750 gm IV + Metro 500mg IV	Levo None Clinda 6 hrs Metro None
Ortho/Thoracic/Vascular/NSG/Burns/Plastics	Vanco 15 mg/kg IV x 1	8 Hours

In all cases of SSI prophy if patient is MRSA screen positive of known to be colonized add vancomycin 15 mg/kg IV and re-dose at >8 hrs.

HMC

MRSA (positive by screen or history): IN ADDITION to standard pre-operative antibiotic, give:

Procedure	Antibiotic	Adult Dose	Pediatric Dose#	Duration	Intra-Op Re-Dose
All Cases	Vancomycin	1gm (50-70kg) 1.5gm (71-100kg) 2gm (> 100kg)	15mg/kg	IVPB 60 mins IVPB 90 mins IVPB 120 mins	No re-dose

UWMC

Procedure	ABX	Re-dose
Upper GI/biliary	Cefazolin 2 gm IV	3 Hr
GU	Cefazolin 2 gm IV	3 Hr
Head and Neck (no OP)	Cefazolin 2 gm IV	3 Hr
Ortho	Cefazolin 2 gm IV	3 Hr
Ortho shoulder	Ceftriaxone PLUS Vanco	None. Re-dose if surgery >8 hours

UWMC

Procedure	ABX	Re-dose
Thoraciv/vascular/burns/plastic	Cefazolin 2 gm IV	3 Hr
Colorectal/GynOnc	Cefazolin 2gm IV PLUS Metronidazole 500 mg IV	Cefazolin 3 Hrs Metro None
GYN/OB	Cefazolin 2 gm IV	3 Hr
GU	Levofloxacin 750 mg IV	None
H&N, dental, NSG involving OP	Amp/Sulbactam 3 gm IV	3 Hrs

UWMC

PCN Allergic

Procedure	ABX	Re-dose
GI/colorectal/Gyn Onc	Levo 750 mg IV + Clinda 900 MG IV Or Metro 500 mg IV	Clinda at 6 Hrs. None for levo or metro
GynOb	Levo 750 mg IV + Vanco 15 mg/kg	Vanco if surgery >8 Hrs
Head and neck	Clinda 900 mg IV	6 Hrs
Ortho/thoracic/NSG/Burns/Plastics	Vancomycin 15 mg/kg IV	8 Hrs
Ortho Shoulder	Clinda 900 mg IV + Vanco 15 mg/kg IV	Clinda at 6 hours Vanco at 8 Hrs
Hx or MRSA or + Screen	Add Vanco 15 mg/kg IV	8 Hrs

UWMC

Procedure	ABX	Re-dose
VAD	Cefazolin 2 gm IV + Vanco 15 mg/kg IV	Cefazolin 3 Hr Vanco if >8 Hr
VAD PCN Allergic	Levo 750 mg IV + Vanco 154 mg/kg IV	None If >8 Hr
Pacer/ICD	Cefazolin 2 gm IV + cefazolin irrigation	3 Hr
Pacer/ICD PCN allergic	Vanco 15 mg/kg IV plus vanco irrigation.	> 8 Hr
CABG	Cefazolin 2 gm IV	3 Hr
Hx of MRSA or screen positive	Add Vanco 15 mg/kg IV	>8 Hr
CABG PCN Allergic	Levo 750 mg IV + Vanco 15 mg/kg IV	None > 8Hr
Valves	Cefazolin 2 gm IV + Vanco 15 mg/kg IV	3 Hr >8 Hr
Valves PCN allergic	Levo 750 mg IV + Vanco 15 mg/kg IV	None > 8 Hr

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Surgical Abx Prophy

- Cardiac (CABG, pacemaker, VAD):
  - Staph Aureus
  - Cefazolin or cefuroxime
- Gastroduodenal:
  - Coliform GNR, strep, staph.
  - Cefazolin.
- Biliary:
  - GNR
  - Cefazolin, cefoxitin, cefotetan, ceftriaxone, amp/sulb.
- Appendectomy:
  - GNR or anaerobes
  - Cefoxitin, cefotetan, cefazolin plus metronidazole.
- Colorectal:
  - GNR, anaerobes
  - Cefazolin plus metronidazole, cefoxitin, cefotetan, amp/sulb, ceftriaxone plus metronidazole, ertapenem. Plus add mech bowel prep.
- NSG:
  - Staph aureus, CoNS
  - Cefazolin
- C Section or hysterectomy:
  - Staph aureus, CoNS, strep, enterococci, vaginal anaerobes.
  - Cefazolin.
- Ortho:
  - No prophy recommended unless spinal procedure, then cefazolin.
- Urology:
  - GNR and rarely enterococci.
    - FQ, TMP/SMX, or cefazolin for lower tract instrumentation.
    - Cefazolin for clean procedure.
    - Cefazolin plus metronidazole or cefoxitin for clean contaminated.
- Vascular
  - S Aureus or CoNS
    - Cefazolin

Bennett, et al. Mandell's Principles and Practice of Infectious Diseases. 8th Edition. Vol 2. 2015.

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