

# **Surgical Site Infections**

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# Incidence

- 2<sup>nd</sup> most common nosocomial infection after asymptomatic bacteriuria
- Most common (38%) nosocomial infection in surgical patients
- Approx. incidence 2 to 5% – likely underestimate
- Increased morbidity & mortality
  - Increased hospital stay, long-term disabilities & costs
  - 3% mortality in patients with SSI
  - 75% of post-op deaths in patients with SSIs – directly due to SSI

# Significance

- Some surgeons feel SSI is relatively trivial
- SSI rates are of interest to public & regulatory agencies
- Hospitals & increasingly, individual surgeons required to report SSI rates
- Regulatory agencies – financial incentives for best practices in SSI prevention & penalties for SSI

# Definition

- Centre for Disease Control and Prevention (CDC), Atlanta, USA
- Infections related to operative procedure occurring at or near surgical incision within 30 days of surgery or within 1 year, if implant used

# SSI – clinical criteria

Any of the following

- Purulent exudate from a surgical site
- Positive fluid culture from a primarily closed surgical site
- Surgeon's diagnosis of infection
- Surgical site that requires reopening

# SSI - Classification

- **Incisional SSIs**

- superficial (skin or subcutaneous tissue)
- deep (deep soft tissues)

- **Organ/space SSI**

- involves any part of anatomy (other than incision) opened or manipulated during surgery (eg, meningitis after elective neurosurgery or mediastinitis after CABG)
- only 1/3<sup>rd</sup> of all SSIs
- 93% of deaths due to SSIs
- also vastly more costly

# SSI surveillance

- 1985 Study on Efficacy of Nosocomial Infection Control (**SENIC** study) – risk factors for SSI
  - abdominal op
  - op > 2 hrs
  - 3 or more discharge diagnoses
  - contaminated or dirty-infected wound
- Well-organised surveillance & infection control programmes with feedback to surgeons → significant SSI reductions

# NNIS index

- **National Nosocomial Infections Surveillance (NNIS)** risk index
- Predictive model for SSI
- Allows valid comparison of SSI rates among surgeons, hospitals or across time

# NNIS index scoring

- One point each for
  - Preop ASA score of 3, 4, or 5
  - A contaminated or dirty surgical wound
  - An op lasting over T hours, where T depends on surgery
- Possible scores 0, 1, 2 & 3

# ASA score

- American Society of Anaesthesiologists
  - Class 1 – normal
  - Class 2 – mild systemic disease
  - Class 3 – severe systemic disease, not incapacitating
  - Class 4 – incapacitating systemic disease, already life threatening & not always correctable by operation
  - Class 5 – moribund patient, little chance of survival

# Wound Classification (CDC)

- Degree of contamination likely to be present at surgery

## Clean wounds

- Uninfected operative wounds, no inflammation
  - Respiratory, GI, GU tracts or oropharynx not entered
  - No break in aseptic technique
  - Primarily closed & if drainage, closed
- 
- Only microbes from skin & external environment likely to be introduced into wound

# Wound Classification

## Clean-contaminated wounds

- Respiratory, GI, GU tracts entered under controlled conditions & without unusual contamination
- Operations involving biliary tract, appendix, vagina & oropharynx
- Provided no infection or major break in aseptic technique

# Wound Classification

## Contaminated wounds

- Operations on fresh, open traumatic wounds
- Major break in aseptic technique
- Gross spillage from GI tract
- Acute inflammation without pus

# Wound Classification

## Dirty or infected wounds

- Acute inflammation & pus, perforated viscera
- Traumatic wounds with retained devitalised tissue, foreign bodies or faecal contamination
- Delayed op on traumatic wound
- Organisms causing post-op infection likely to have been present in field before surgery

# T hours

75<sup>th</sup> percentile of duration of surgery

- Bile duct, liver, pancreatic surgery – 4hrs
- Cholecystectomy – 2hrs
- Large bowel surgery – 3hrs
- Gastric surgery – 3hrs
- Small bowel surgery – 3hrs
- Hernia – 1hr

## NNIS index & SSI rate

NNIS index	Rate of SSI (%)
index 1 (0 points)	1.5
index 2 (1 point)	2.9
index 3 (2 points)	6.8
index 4 (3 points)	13

# Miscellaneous

- Intrinsic disparities in SSI rates with different procedures  
eg:- 5-fold higher in colonic vs breast surgery  
lower in lap. surgery vs open
- Other risk factors add to impact
- Analyses help monitor trends in SSI rates & allows institutions to benchmark their data against national averages
- Do not easily allow targeted interventions for SSI prevention

# Microbiology

- Most SSIs acquired at the time of surgery – mostly patient's endogenous flora, sometimes exogenous
- 1986 to 1996 – NNIS system – 17,671 isolates with SSI
  - > 50% – gram-positive cocci
    - *S. aureus* (most common), coagulase-negative staph & *Enterococcus* spp.
  - 33% – gram-negative bacilli
    - *E. coli*, *P. aeruginosa* & *Enterobacter* spp
  - 5% – anaerobes

# Microbiology

- Clean ops – Staphylococci
  - Axilla, perineum & groin – gram-negative & other enteric organisms
  - CABG → gram-positive sternal & gram-negative leg wound infection
- Clean-contaminated or contaminated – bacteria from respiratory, GI or GU tracts
  - gram-negative bacilli & anaerobes – lower GI surgery
- Increasing involvement of resistant microbes (MRSA, VRE)

# Prevention of Surgical Site Infections

# SSI prevention

## Interventions to prevent SSI

- Pre-operative
- Peri-operative preparations
- Operating room environment
- Conduct of operation
- Post-op management
- Infection control and surveillance

# Type of data

- **Class I** – data from prospective, RCTs or meta-analyses of such trials
- **Class II** – data from well-controlled prospective or retrospective studies with good study design
- **Class III** – data from uncontrolled studies, case series or expert opinion

# Selected interventions for SSI prevention

## Pre-operative

- Reduce HbA1c to  $<7\%$  (Class II)
- Smoking cessation 30 days pre-op (Class II)
- Special nutritional supplements or enteral nutrition – severe nutritional risk  $\rightarrow$  7–14d preop
- preop parenteral nutrition in severe malnutrition (Class I & II)

# SSI prevention

- Adequately treat pre-op infections, like UTIs (Class II)
- Decolonization of all patients with mupirocin – not currently recommended (Class I)
- Identification & decolonization of *S. aureus* carriers – may be potentially useful – needs further investigation (Limited Class I)
- Pre-op showering with chlorhexidine – not recommended (Class I)

# SSI prevention

## Peri-operative preparations

- Remove hair only if it interferes with op
- Clipping immediate pre-op or with depilatories; no pre or peri-op shaving (Class I)
- Antiseptic surgical scrub or alcohol-based antiseptic for pre-op cleansing of hands & forearms (Class II)
- Prepare skin around op site with appropriate antiseptic agent (Class II)

# SSI prevention

- Prophylactic antibiotics for most clean-contaminated & contaminated procedures & selected clean procedures (Strong Class I)
- Not required in most clean surgeries unless high risk of infection or consequences of infection disastrous (eg, CABG, insertion of prosthesis or laminectomy)
- Use antibiotics appropriate for potential pathogens (Strong Class I)

# SSI prevention

- Administer prophylactic antibiotics within 1 hr before incision (2 h for vancomycin & fluoroquinolones) – (Strong Class II)
- Use higher dosages for morbidly obese patients (Limited Class II)
- Use Vancomycin prophylaxis only when significant risk of MRSA infection (Class I)

# SSI prevention

## Operating room environment

- Provide adequate ventilation, minimize OR traffic & clean instruments & surfaces with approved disinfectants (Class II & Class III)
- Avoid flash sterilization (Class II)
- Laminar airflow for ortho implant procedures – *uncertain use (Contradictory Class II)*

# SSI prevention

## Conduct of operation

- Carefully handle tissue, eradicate dead space & adhere to standard principles of asepsis (Class III)
- Avoid surgical drains unless absolutely necessary (Limited Class I, Class II)
- Leave contaminated or dirty-infected wounds open, except in perforated appendicitis (Limited Class I, Class II)

# SSI prevention

- Intra-op redosing prophylactic antibiotics with short half-lives, if op prolonged (cefazolin, if op >3 hrs) or if extensive blood loss (Limited Class I, Class II)
- Maintain intra-op normothermia (Class I; some contradictory Class II)
- Use 80% O<sub>2</sub> intra-op & immediate post-op – Low cost, low risk & strong scientific rationale, not currently advised (Heterogeneous Class I data; meta-analysis supports use)

# SSI prevention

## Post-op management

- Stop prophylactic antibiotics after skin closure (Class I; meta-analyses support single dose regimens)
- Stop prophylactic antibiotics within 24 hrs (48 hrs for cardiac surgery & liver transplant)
- Maintain serum glucose levels <200 mg/dL on post-op days 1 & 2 (Class II)
- Monitor wound for SSI (Class III)

# SSI prevention

## Infection control and surveillance

- Maintain active surveillance system for monitoring SSI incidence (Class II)
- Feedback to surgeons individual SSI rates (Class II)

# Reducing SSIs – possible ?

- Am J Surg. 2005 Jul;190(1):9-15
- 44 hospitals, 35543 surgical patients
- 4 simple measures
- 27% reduction in SSI rates
- 2.3% in first to vs 1.7% last 3 months of study

# 1. Appropriate use of antibiotics

- Within 1 hr before incision
- Choice of prophylactic antibiotics consistent with guidelines
- Prophylactic antibiotics discontinued within 24 hrs after surgery

## 2. Appropriate hair removal

- Ban all razors from entire hospital
- Razors no longer purchased
- Educate patients not to self-shave pre-op

# Shaving & SSI

- Pre-op hair removal by any means – increased SSI rates  
→ no hair removal (3 studies)
- Is shaving necessary?  
shaved more likely to develop SSI (3 trials, 3193 patients)
- SSI rates
  - shaving – 5.6%
  - clipping hair – 1.7%
  - depilatory creams – 0.6%

# Timing of hair removal

Time of clipping	SSI rate
immediate pre-op	1.8%
clip or shave night before	4%

Time of shaving	SSI rate
immediate pre-op	3.1%
within 24hrs	7.1%
>24hrs	>20%

### 3. Maintenance of post-op glucose control

- Increased glucose levels ( $>200$  mg/dL) immediate post-op ( $<48$  hours)  $\rightarrow$  increased SSI risk
- Implement glucose control protocol (insulin infusion vs sliding scale)
- Tight glucose control requires critical care
  - expensive
  - distinct risk of hypoglycemia

# Insulin infusion

- Cardiac surgical patients admitted to CCU
- Significant reduction in deep sternal wound infections
- MOF, sepsis & mortality reduced
  
- Whether this can be extrapolated to other surgical patients remains to be determined

## 4. Establishment of peri-op normothermia

- warmed, forced-air blankets pre-op, intra-op & in recovery
- warmed IV fluids / blood
- increase ambient temperature in OR
- warming blankets under patients on operating table
- use hats & booties on patients

# Peri-op normothermia

- Reduces infection risk & shortens hospital stay

	Normothermic	Hypothermic	p
Number	104	96	-
Temperature (°C)	36.6 ± 0.5	34.7 ± 0.6	<.001
Infection (%)	6	19	<.01
Hospital stay (days)	12.1 ± 4.4	14.7 ± 6.5	.001

# Supplemental O<sub>2</sub> & SSI

- RCT – 300 patients – colon resection
- randomly assigned to 30% or 80% FiO<sub>2</sub> intra-op & 6 hours post-op
- SSI in 24.4% with 30% O<sub>2</sub> vs 14.9% with 80% O<sub>2</sub> (p = .04)
- Of 3 RCTs, 2 (800 pts) found SSI reduction & 1 smaller study (160 pts) found increase
- Low cost, low risk, strong scientific rationale & metaanalyses support 80% O<sub>2</sub> use

# Hand hygiene

- Single most important measure to reduce transmission of microbes
- Handwashing with plain soap & water **OR** use of waterless alcohol-based gels or foams
- Problems → Compliance rarely > 45% even under study conditions & even in ICUs, recommended 15-30 secs
- Bedside Alcohol based hand disinfection (AHD) – easier to perform & takes less time, NOT effective against spores

# Hand hygiene

- Swiss teaching hospital
- Bedside alcohol-based hand disinfectant → significant improvement in hand hygiene compliance
- Decreased SSI (9.9 vs 16.9%)
- Less transmission of MRSA (0.9 vs 2.2 episodes / 10,000 patient days)

# SSI prevention – Summary

Many factors under direct control of anaesthetists

- prophylactic antibiotics timing
- Normothermia
- Supplemental O<sub>2</sub>

Surgeons

- Prophylactic antibiotic policy, duration
- Shaving
- Hand hygiene

# SSI Surveillance – The Future

- **Passive** – rely on SSI reporting by staff without designated responsibility for surveillance → lower case-finding sensitivity
- **Active** – designated, trained personnel identify SSI
- **Retrospective** review of case-records after discharge
- **Prospective surveillance** – methods to detect SSI from time of surgery → Better

# SSI Surveillance – The Future

- **Post discharge Surveillance**
  - 1324 CABG patients – over a 27-month period
  - 88 SSIs
  - only 28% detected during initial hospital stay

## How to arrange follow up

- Telephone survey
- Questionnaire
- Repeat visit at or after 30 days or 1 year (if implant)

# List A

From Oct 08, Medicare & Medicaid refuse supplementary payments for

1. Catheter-associated UTI
2. Pressure ulcers (decubitus ulcers)
3. Vascular catheter-associated infection
4. Mediastinitis after CABG
5. Fractures, dislocations & other hospital-acquired injuries
6. Objects left in during surgery
7. Air embolism
8. Blood incompatibilities

# List B – planned for 2009

1. Elective surgical site infections
  - Total knee replacement
  - Lap gastric bypass/lap gastroenterostomy
  - Ligation & stripping of varicose veins
2. Legionnaires' disease
3. Extreme blood sugar derangement
4. Iatrogenic pneumothorax
5. Delirium
6. Ventilator-associated pneumonia
7. DVT / PE
8. Staph. aureus septicemia
9. Clostridium difficile-associated infection

**Thank you**