Surgical Site Infection: A surgeon's perspective

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Health Care to God's Glory


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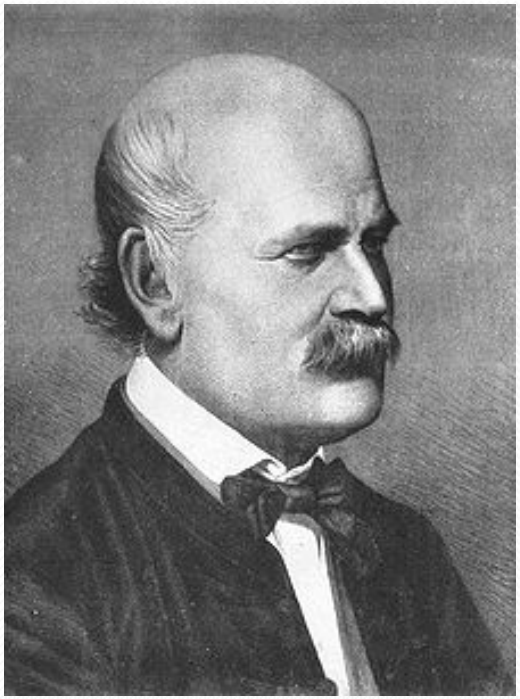
SSIs - Introduction

Joseph Lister

Ignaz Semmelweis



SSIs - Introduction

- Joseph Lister is considered the father of antisepsis.
  - After he introduced antisepsis in the 1860s, there was a sharp decline in the incidence of SSIs.
- Ignaz Semmelweis – is the father of surgical hand washing

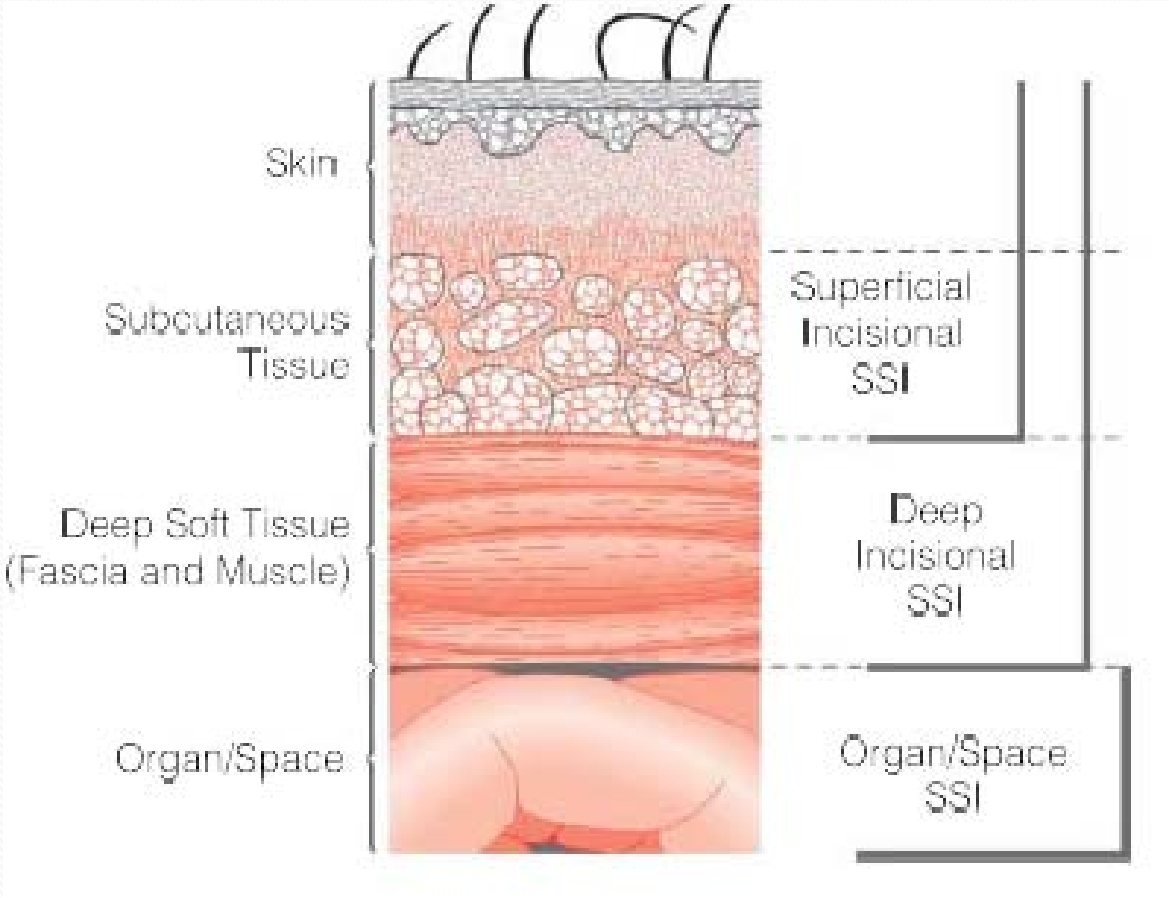
SSIs - Introduction

- SSIs pose a huge burden on patient safety leading to pain, suffering, delayed wound healing, increased antimicrobial use, repeat surgery, increased length of hospital stay, mortality, and morbidity.
- All these are reflected in increased healthcare costs.

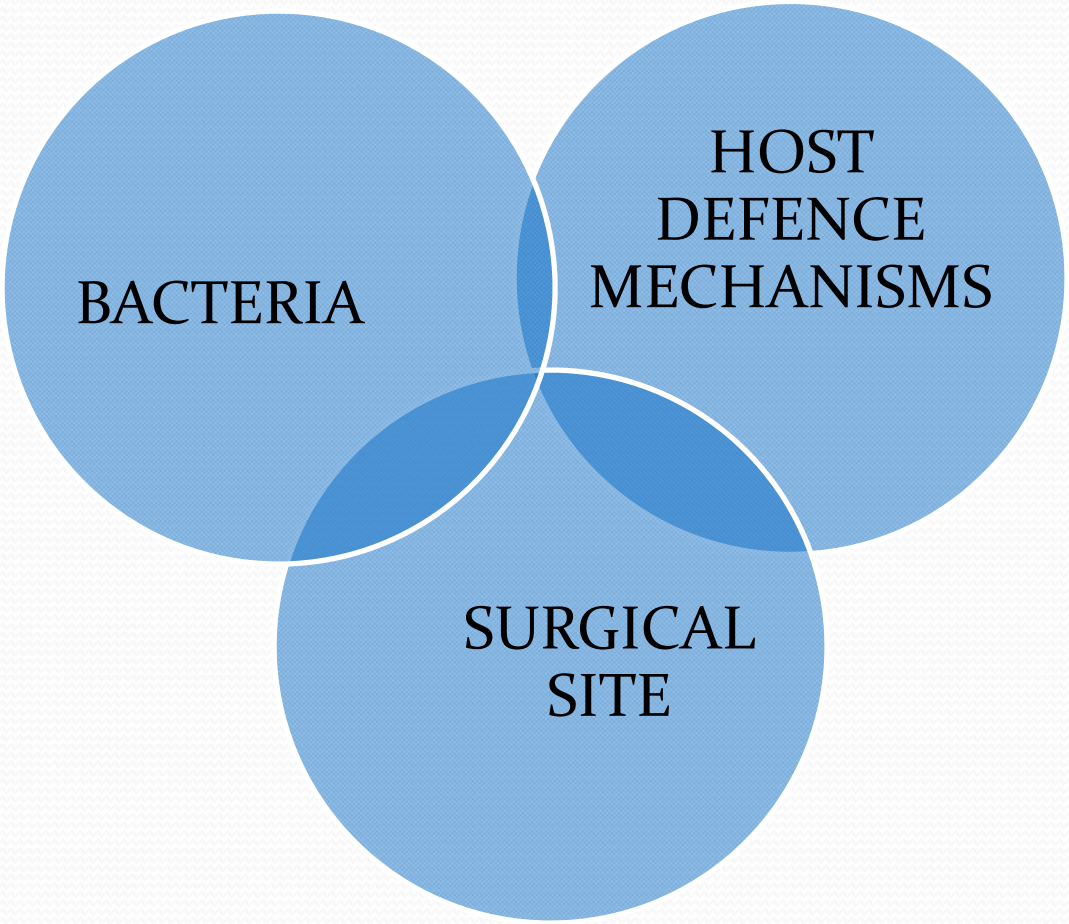
SSIs - Introduction

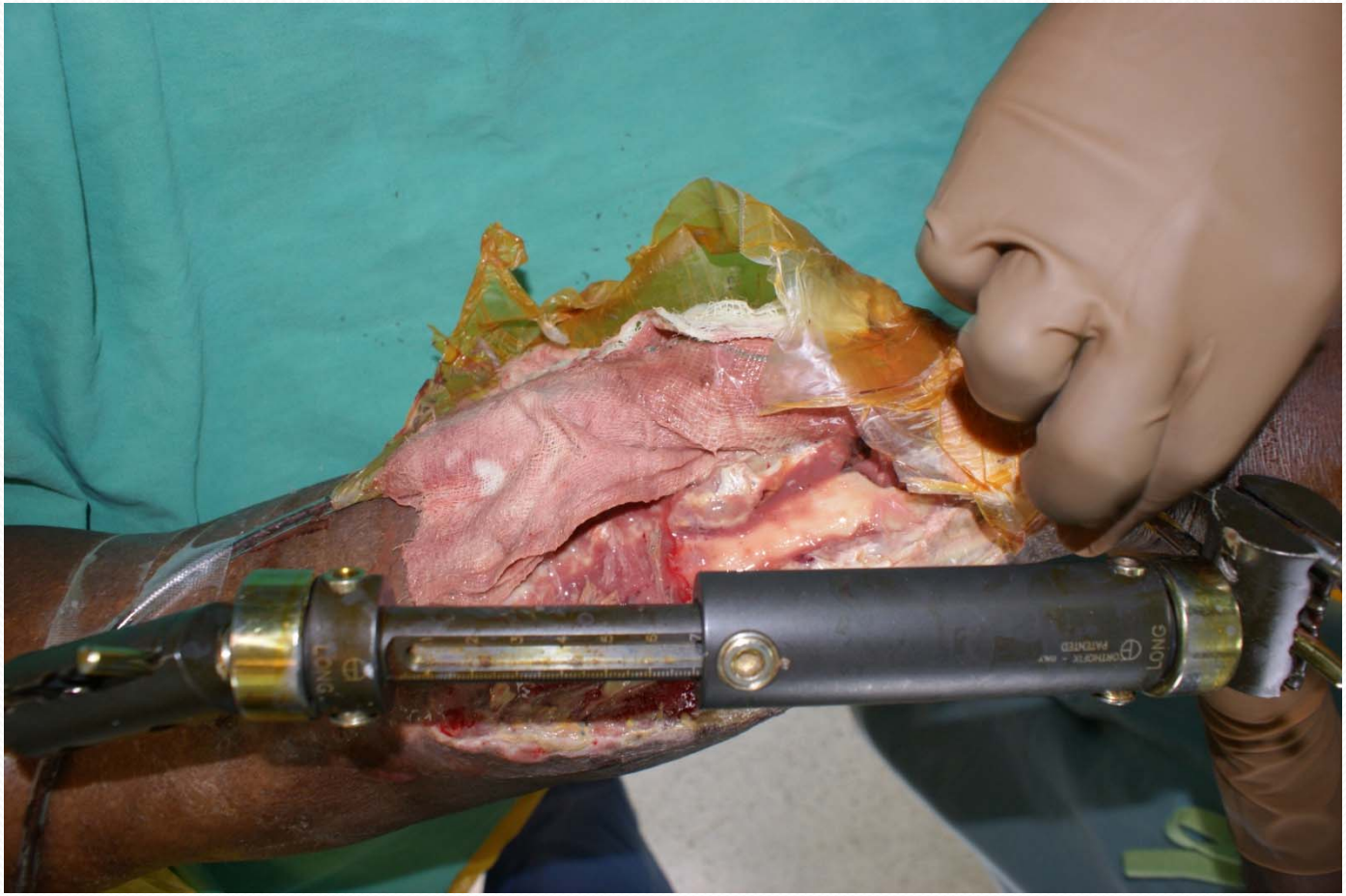
- A surgical site infection (SSI) is a type of hospital-acquired infection (HAI) that arises following surgery and is specifically related to the surgical site.
- It is estimated that SSIs account for between 10-30% of all HAIs

SSIs - Classification



Homeostatic normal state




LONG
LONG

SSI and the surgeon

Advances have been made in infection control practices, including:

- Improved operating room ventilation,
- Sterilization methods,
- Barriers,
- Surgical technique, and
- Availability of antimicrobial prophylaxis,

SSI and the surgeon

Despite these advancements, SSIs remain a substantial cause of morbidity and associated mortality.

- SSIs account for 15% of all HAI and, among surgical patients
- SSIs are the most common HAI.

SSIs and the surgeon

SSIs continue to ravage surgical outcomes partly because of:

- emergence of antimicrobial-resistant pathogens
- increased numbers of surgical patients who:
  - Are elderly and/or have a wide variety of chronic, debilitating, or immunocompromising underlying diseases.
  - Have prosthetic implant and organ transplant operations performed.

SSIs

SSIs occur in one of two phases:

- In patient period
  - Patients block beds, require clinical intervention and use extra consumables.
- Post-discharge period
  - Patients seek care from the hospital post-operatively and restrict patients and care givers from regular productive activities

SSIs

Lead to increased:

- Length of postoperative hospital stay,
- Cost of care,
- Rates of hospital readmission,
- Poor outcomes including mortality.

Cost of care

- Prolonged hospitalization,
- Additional diagnostic tests,
- Therapeutic antibiotic treatment, ±
- Additional surgery
- Loss of productivity by the patient

A mean increase of 115% for the cost of care of a patient with an SSI as compared with non-infected control subjects has been reported.

SSI costs - Australia

Table 5: Economic costs associated with surgical site infection in Australia

Study	Procedure	Additional cost associated with SSI	Extended hospital stay associated with SSI
Graves 2009	All procedures	AU$53 million / year	Loss of 53,536 bed-days in hospitals / year
Graves 2008	All procedures	Pre-discharge SSI: AU$2,047 Post-discharge SSI: AU$725	17.4 additional days
Jenney 2001	CABG	AU$12,419 per case of SSI	1.3 additional days in ICU 6.1 additional days in Ward
Platell 1997	Colorectal surgery	---	9 additional days

Abbreviations: CABG, Coronary artery bypass graft; ICU, Intensive care unit.

SSIs

- A number of authors have shown that most HAIs occur in the post-discharge period (1.5% to 20%)

SSI cost

Most estimates on the cost of SSI treatment do not account for:

- Re-hospitalization,
- Outpatient treatment,
- Post-discharge expenses,
- Quality of life or
- Any long term disability costs

Wound Classification

Wound Class	Risk of SSI	Description	Example
I/Clean	2%	Non-traumatic	Hernia
II/Clean contaminated	3-5%	GI/Resp T/Vagina/Oropharynx – no spillage	Elective colon resection (prep)
III/Contaminated	5-10%	Gross spillage/ Acute trauma	GSW to colon
IV/Dirty/Infected	30%	Trauma delayed treatment	Abscess

SSI terminology and reporting

- Standardization of reporting permits more effective surveillance and improve results
- Offer a more standardized approach as well to categorizing wounds to facilitate quality assurance.
- Offers a process that is both accurate and acceptable to the surgeon

Sub-Saharan Africa PROBLEM

- All this data is from the West.
- Where's all the data from AFRICA?

GAPS – KNOWLEDGE, WILL AND ABILITY

- **Hold drivers responsible for accidents and death**
- Updated Thursday, August 29th 2013 at 20:55 GMT +3
- **By Kipkoech Tanui**
- **Kenya:** The killing of 41 Kenyans in Ntulele through a horrific bus road crash as the rest of us snored away Wednesday night is yet again a painful and shameful indictment of our road safety standards.

Although laws are very clear on matters of traffic and its relations, are they just 'contained in books' or are they just there because they ought to be? Have road transport stakeholders substituted lives with money and irresponsibility?

GAPS – KNOWLEDGE, WILL AND ABILITY

- Lack of leadership – political will
  - Finances – health care financing
  - Lack of focus – too many other 'attention seeking burdens'
  - Requirements by financing institutions

GAPS – KNOWLEDGE, WILL AND ABILITY

- HCW – awareness
- Culture
  - Concepts of patient safety culture in surgery
  - Paternalistic healthcare systems

GAPS

- Lack of homogeneity in standards – lack of standardized data collections/ reporting methods
  - Terminology
  - Definitions

Potential determinants of high SSI burden

- Inadequate environmental hygienic conditions
- Poor infrastructure
- Insufficient equipment
- Understaffing
- Overcrowding

Potential determinants of high SSI burden

- Paucity of knowledge and application of basic infection-control measures
- Prolonged and/or inappropriate use of invasive devices and antibiotics
- Scarcity and absence of local and national guidelines and policies

SSI outcomes

USA

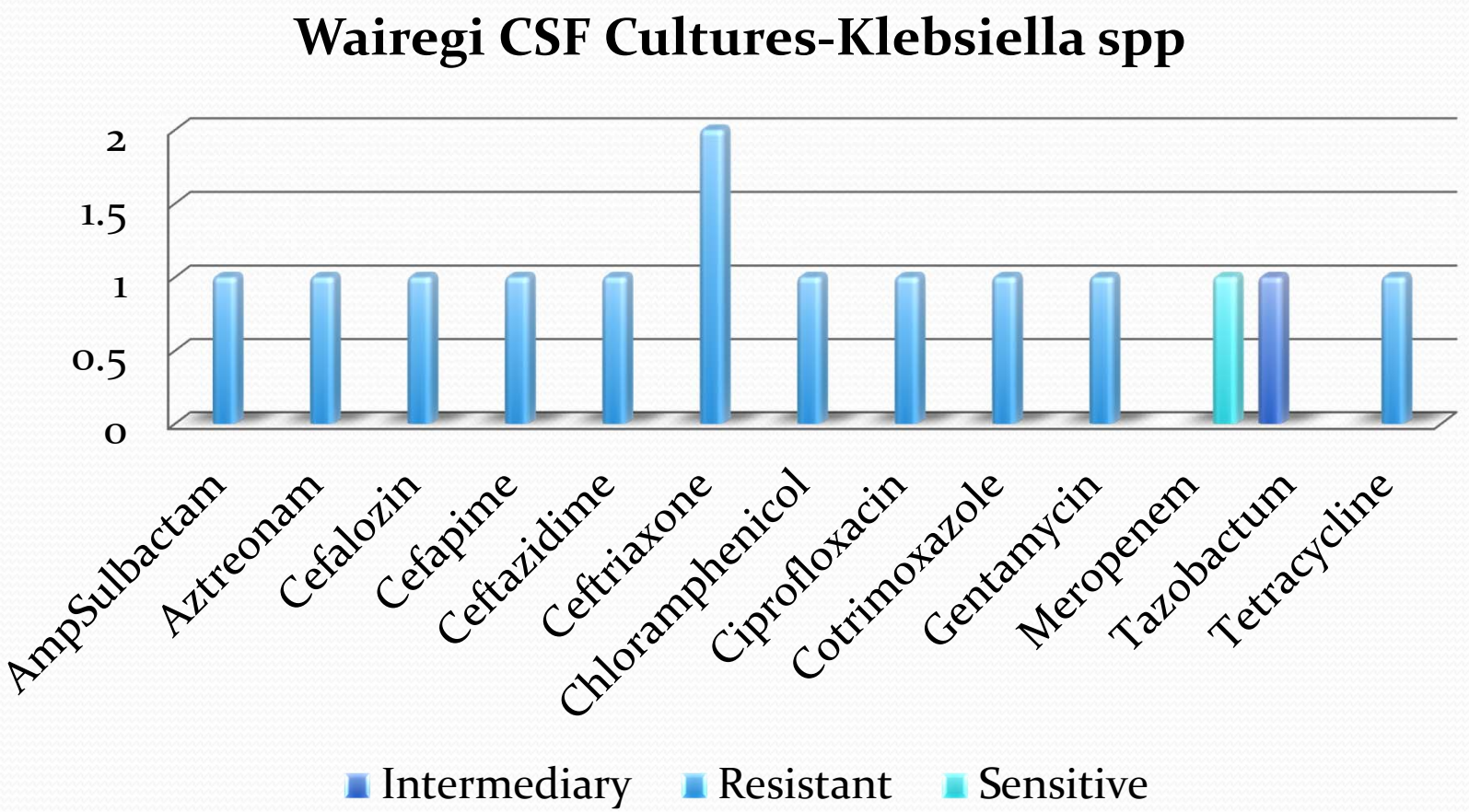
- A mortality rate of 3% is attributed to SSIs.
- Of this, 75% of the mortality rate is directly related to the SSIs

Sub-Saharan Africa

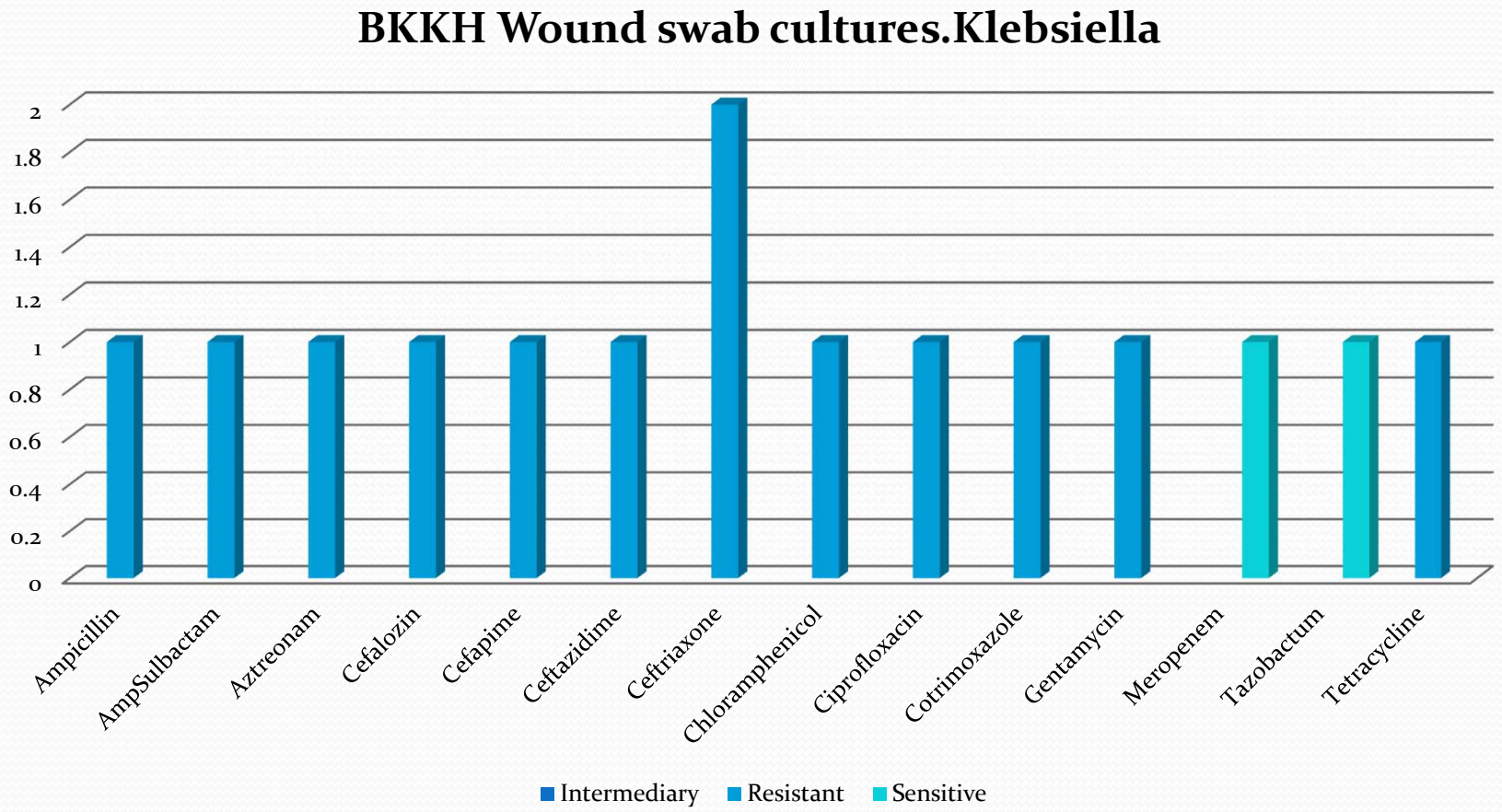
- A review of SSIs in **3149** patients following surgery for complicated intra-abdominal infections revealed a mortality of **7%**, most of which was directly related to SSIs
- The SSI rate in this review was **37.5**%

SSI outcomes

- Many SSIs lead to long term disability


Wairegi CSF Cultures-Klebsiella spp
2
1.5
1
0.5
0
AmpSulbactam
Aztreonam
Cefalozin
Cefapime
Ceftazidime
Ceftriaxone
Chloramphenicol
Ciprofloxacin
Cotrimoxazole
Gentamycin
Meropenem
Tazobactum
Tetracycline
Intermediary
Resistant
Sensitive

Problems


BKKH Wound swab cultures.Klebsiella
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Ampicillin
AmpSulbactam
Aztreonam
Cefalozin
Cefapime
Ceftazidime
Ceftriaxone
Chloramphenicol
Ciprofloxacin
Cotrimoxazole
Gentamycin
Meropenem
Tazobactum
Tetracycline
Intermediary
Resistant
Sensitive

INTERVENTIONS

ID	Pt name	Age	IP no.
	Primary Diagnosis	Sex	Surveillance no.

1	Type of surgery : _____ _____ Surgical Procedure _____ Date of surgery _____	Theatre Room # [ ] Lead Surgeon _____ Grade _____

PROCESS MEASURES

2

Patient skin preparation

Pre – op bath/shower [Y / N] Date _____

Antiseptic soap used [Y / N]

Hair removal: Razor [ ] Clippers [ ] Not done [ ]

Date _____

Where was hair removal done? Ward [ ] Theatre [ ]

Patient skin scrub

chlorhex-alc [ ] iodine+alc [ ] chlorhex-aq [ ] iodine-aq [ ]

Allowed to dry fully ? [Y / N]

Surgeon's hand preparation*

Alcohol-handrub [ ] Plain soap+water [ ] antimicrobial soap+water [ ]

Time spent on handwash: [ ] mins [ ] secs

Scoring of handwash technique: low [ ] medium [ ] high [ ]

Theatre traffic*

Headcount at start of op _____ total : ___

People entering theatre _____ total : ___

Door openings during op _____ total : ___

* ENHANCED DATA COLLECTION OPERATIONS ONLY

3

Start time (knife to skin) [:] 24hr clock

End time [:] 24hr clock

Duration = _____ hrs _____ mins

Urgency of operation

[ ] **Emergency** – must be done immediately to save life (eg. major bleed)

[ ] **Urgent** – must be done within 24-48hrs (eg. repair of fracture)

[ ] **Semi-elective** – must be done within days-weeks (eg. tumour removal)

[ ] **Elective** – no time constraints (eg. cosmetic procedure)

4

ASA class = [ ]

1. Normal healthy person.
2. Mild systemic disease. (eg hypertension, well controlled diabetes)
3. Severe systemic disease, not incapacitating (eg. moderate COPD/ diabetes/ malignancy)
4. Incapacitating systemic disease that is a constant threat to life (eg. pre-eclampsia, very advanced HIV, heavy bleeding)
5. Moribund patient, not expected to survive 24hrs with or without operation.(eg major trauma)

5

Surgical wound class:

Clean [ ] = Sterile tissue with no resident bacteria eg. Neurosurgery

Clean-Contaminated [ ] = CONTROLLED entry to tissue with resident bacteria eg. hysterectomy

Contaminated [ ] = UNCONTROLLED entry to tissue with bacteria eg. acute g-i perforation

Dirty / Infected [ ] = Heavy contamination (eg soil in wound) or infection already established

6

Foreign material:

Drain used? [Y / N] If drain, type: open [ ] Closed [ ]

Implant used? [Y / N] metal (ortho) [ ] graft [ ] patch [ ] shunt [ ] other _____

7

Antibiotic Prophylaxis ? No prophylaxis required [ ]

Required but not given due to: Unavailable [ ] Other _____

Ampicillin [ ] Cefazolin [ ] Cloxacillin [ ] Ceftriaxone [ ]

Gentamicin [ ] Metronidazole [ ] Ciprofloxacin [ ] Clindamicin [ ]

Other drug _____ Dose _____(mg/g)

Time given [:] 24hr clock

Time re-dosed [:] 24hr clock

Post-surgical antibiotics

Were any antibiotics prescribed to start after surgery?

Drug _____ Dose _____(mg/g)

Doses/day _____ Duration (days) _____

Date form completed_____ Computer input [ ] Signature_____

Sub-Saharan Africa SOLUTIONS

WE CAN HELP - DEVELOP SYSTEMS

- EDUCATION
- TRAINING
- RESEARCH
- EXECUTION OF PROGRAMS
- ADVOCY – POLICY MAKERS

International Surgical Infections Study Group

Sub-Saharan Africa SOLUTIONS

WE NEED PARTNERSHIPS

- PROFESSIONAL BODIES/ASSOCIATIONS
- INDIVIDUALS – CHAMPIONS
- INDUSTRY COLLABORATORS – SPONSORSHIP
- GOVERNMENTS

International Surgical Infections Study Group

Sub-Saharan Africa SOLUTIONS

Sub-Saharan Africa SOLUTIONS

THANK YOU

International Surgical Infections Study Group

SSI and the surgeon

- In most SSIs, the pathogen source is the native flora of the patient's **skin**, **mucous membranes**, or **hollow viscera**.
- When skin is incised, underlying tissue is exposed to overlying endogenous flora.

Clinical presentation

SSIs are heralded by the 5 classic signs of local inflammation:

- Calor,
- Dolor,
- Rubor,
- Tumor, and
- loss of function.

Clinical presentation

- Infections require drainage and some form of surgical packing.
- Use of antibiotics depends on the appearance of the infection and evidence of local spread or systemic toxicity;
  - Choice of antimicrobial agent will depend, in part, on local patterns of antimicrobial resistance
    - Most institutions in Africa will not have resistance patterns

SSI Risk factors

- Wound classification,
- Emergency procedures,
- Long procedure length,
- Use of non-absorbable suture,
- Length of preop hospital stay
- Foreign bodies,
- Excessive use of subcutaneous electrocautery,
- Excessive blood loss, and
- Hypothermia

Implant surgery

SSI decrease due to:

- Same-day admission for surgery (patients are colonized by hospital flora prior to surgery),
- Effective skin preparation (alcohol preps)
- Antiseptic impregnated plastic drapes,

Prevention

- Appropriate **selection** and **timing** of antimicrobial prophylaxis, with redosing
- Maintenance of normothermia and normoglycemia
- Decreased use of blood transfusions

Prevention

- Careful operative technique,
- Timely administration of appropriate dosage of antibiotics, including redosing
- Other preventive measures aimed at neutralizing the threat of bacterial, viral, and fungal contamination posed by:
  - OR staff,
  - OR environment, and
  - Patient endogenous skin flora

Common Pathogens by Surgical Procedure

Operations	Likely Pathogens*†
Placement of all grafts, prostheses, or implants	*Staphylococcus aureus*; coagulase-negative staphylococci
Cardiac	*S aureus*; coagulase-negative staphylococci
Neurosurgery	*S aureus*; coagulase-negative staphylococci
Breast	*S aureus*; coagulase-negative staphylococci
Ophthalmic Limited data however, commonly used in procedures such as anterior segment resection, vitrectomy, and scieral buckles	*S aureus*; coagulase-negative staphylococci; streptococci; gram-negative bacilli
Orthopedic Total joint replacement Closed fractures/use of nails, bone plates, other internal fixation devices Functional repair without implant/device Trauma	*S aureus*; coagulase-negative staphylococci; gram-negative bacilli

Noncardiac thoracic Thoracic (lobectomy, pneumonectomy, wedge resection, other noncardiac mediastinal procedures) Closed tube thoracostomy	*S aureus*; coagulase-negative staphylococci, *Streptococcus pneumoniae*, gram-negative bacilli
Vascular	*S aureus*; coagulase-negative staphylococci
Appendectomy	Gram-negative bacilli, anaerobes
Biliary tract	Gram-negative bacilli, anaerobes
Colorectal	Gram-negative bacilli, anaerobes
Gastroduodenal	Gram-negative bacilli; streptococci; oropharyngeal anaerobes (eg, peptostreptococci)
Head and neck (major procedures with incision through oropharyngeal mucosa)	*S aureus*; streptococci; oropharyngeal anaerobes (eg, peptostreptococci)
Obstetric and gynecologic	Gram-negative bacilli; enterococci; group B streptococci; anaerobes
Urologic May not be beneficial if urine is sterile	Gram-negative bacilli

*Likely pathogens from both endogenous and exogenous sources.
†Staphylococci will be associated with surgical site infection following all types of operations.
Reprinted with permission from Mangram AJ et al.[2]

Barrier devices

- Primary role for barrier devices (masks, caps, gowns, drapes, and shoe covers) is to protect operating room personnel from exposure to infectious blood or body fluids.
- Role in SSI prevention is not supported by rigorous study,
- Routine use is universally accepted in hospitals where such equipment is available

Unresolved issues

- Very few studies have examined the relationship between surgical attire and SSIs
- Some studies have suggested that there is no relationship between surgical mask use and SSIs in ORs

Gloves and SSI

- Double gloving should be mandatory in all major surgical procedures, and especially those involving:
  - Heavy contamination
  - Long duration
  - High exposure to sharps
- For long procedures, gloves should be changed every 2 hours so that barrier integrity can be maintained to an optimum level

Gloves and SSI

- If a tear is noted in a glove, these should be changed
- After the procedure and removal of gloves, hands should be washed to eliminate any chance of cross infection from unseen glove tears.
- Where available, a double-glove system indicator should be used for gloves of the same color when double gloving

Double Gloving – benefits for the HCW

- Double gloving substantially reduces the risk of percutaneous contact with blood from a perforation.
- In a study of 66, there were 32 glove perforations (22 outer, 10 inner, 4 both); most of these perforations (83.3%) had gone unnoticed
- Double-gloving reduces the size of the blood innoculum in a normal phlebotomy needle to less than 5%, effectively reducing the risk of transmission from 0.3% to 0.009%

Double Gloving – benefits for the HCW

- **1** glove removes >97% of contaminant off a tapered needle,
- **2** gloves remove about 91% of contaminant from a cutting suture needle.
- **3** gloves offer the same protection as do 2

Unresolved issues

- The benefit of bathing with an antiseptic preparation prior to surgery to reduce the risk of SSIs is uncertain at this time

Unresolved issues

- Practices such as the standard use of “scrub suits,” surgical caps, and shoe covers have never been definitively demonstrated
  - SSI outbreaks have been traced to hair or scalp organisms (regardless of whether a cap was worn), and
- Increased foot traffic through the operating room has been demonstrated to increase ambient microbial levels and ensuing infection risk.

Surveillance programs

- Surveillance of SSI with feedback of appropriate data to surgeons has been shown to be an important component of strategies to reduce SSI risk.
- Surveillance will help identify surgeons or wards with increased SSI rates

S. aureus decolonization

- *S. aureus* routine preoperative screening and routine preoperative decolonization have no proven benefit or cost effectiveness for patients undergoing surgery.
- There is no consensus regarding the benefit of attempting preoperative decolonization in surgical patients with known MRSA colonization,
  - Some guidelines recommend its use among such patients undergoing cardiac surgery, total joint procedures, spinal procedures, and hip fracture repair

Hair removal

- Preoperative hair removal has been associated with an increased risk for SSIs
- Rates of SSI for shaving, clipping, or use of depilatory creams in one study were 5.6, 1.7, and 0.6 percent, respectively.
  - Scanning electron micrographs - razors cause gross skin cuts, and clippers cause less injury than razors; depilatory agents cause no injury to the skin surface
  - The timing of hair removal is also important; the lowest rates of SSI were observed when hair was removed just prior to the surgical incision
  - In a meta-analysis including 11 randomized controlled trials, there was no difference in SSI rate among patients who had hair removed prior to surgery and those who did not

Skin antisepsis

- Routine application of antiseptics to the skin - reduces the burden of skin flora.
  - Preoperative antiseptic agents **cannot** eradicate bacteria in hair follicles and sebaceous glands
- The following do not affect the likelihood of SSI:
  - skin preparation in concentric circles (rather than horizontal preparation) and
  - use of surgical site markers

Skin antisepsis

- Preoperative skin cleansing with chlorhexidine-alcohol is superior to povidone-iodine
  - Chlorhexidine is not inactivated by blood or serum – hence its superiority

SSI Prevention

- Good surgical technique reduces the risk of SSIs.
  - gentle traction, effective hemostasis, removal of devitalized tissues, obliteration of dead space, irrigation of tissues with saline to avoid excessive drying, use of fine non-absorbed monofilament suture material, judicious use of closed suction drains, and wound closure without tension

Thermoregulation

- The optimal approach to thermoregulation in surgery is uncertain.
  - Perioperative hypothermia MAY increase risk for SSI by triggering vasoconstriction and in turn reducing subcutaneous oxygen tension.
  - However, hypothermia MAY protect tissue from ischemia by reducing oxygen consumption during surgery.
  - Most surgeons, anesthesiologists, and hospital epidemiologists acknowledge the benefit of perioperative normothermia in reducing the risk of SSI.

Minimally invasive procedures

- Minimally invasive and laparoscopic-assisted procedures are generally associated with lower rates of SSI than open procedures.

Laminar airflow

- Use of laminar airflow may reducing the burden of microorganisms in the operating room for patients undergoing implantation of prosthetic material.
  - There is insufficient evidence supporting its routine use.
  - Because the minimum inoculum of organisms capable of producing a SSI is markedly reduced in the setting of prosthetic material, the risk of SSI is increased among patients undergoing implantation of such material.

Laminar airflow

- Laminar flow is designed to move particle-free air over the aseptic operating field at a uniform velocity (vertically or horizontally).
  - Even under laminar flow, bacteria can be isolated from wound surfaces at the end of the operation.
  - In addition, the cost-effectiveness of laminar airflow is uncertain in the setting of frequent air exchange and use of antimicrobial prophylaxis

Supplemental oxygen

- Use of supplemental oxygen therapy has been proposed as a means of reducing the risk of SSI by increasing oxygen pressure in surgical wound tissue,
  - There is insufficient evidence for its routine use.
  - Oxygen is important for wound healing, including collagen deposition and proper immune function

Local antibiotic delivery

- Antibiotic impregnated implants can allow local delivery of antibiotics to a surgical site as a means of reducing the incidence of SSI.
- Several materials, including hydrogels, bone cements, and polymer beads, have been impregnated with antibiotics to provide a local release mechanism

Blood transfusion

- The evidence that postoperative infection is increased in patients receiving allogeneic blood during surgery is compelling, though not absolute, as are the data implicating the leukocyte as the "culprit”
- it is premature at this time to recommend routine use of leukocyte-depleted blood in order to diminish the risk of postoperative infections.

Glucose

- Surgery and general anesthesia cause a neuroendocrine stress response with release of counterregulatory hormones such as epinephrine, glucagon, cortisol, and growth hormone, and of inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha.
- These neurohormonal changes result in metabolic abnormalities including insulin resistance, decreased peripheral glucose utilization, impaired insulin secretion, increased lipolysis and protein catabolism, leading to hyperglycemia and even ketosis in some cases

Glucose

- Baseline glucose levels can also help to stratify risk for postoperative wound infections. Elevated preoperative glucose levels (>200 mg/dL [>11 mmol/L]) were associated with deep wound infections

Surveillance programs

A successful surveillance program includes:

- Use of epidemiologically-sound infection definitions and
- Effective surveillance methods,
- Stratification of SSI rates according to risk factors associated with SSI development, and
- Data feedback

SSI Monitoring

- Requires active, patient-based, prospective surveillance
- Post-discharge and ante-discharge surveillance methods should be used to detect SSIs following inpatient and outpatient operative procedures.

SSI Monitoring

These methods include

- Direct examination of patients' wounds during follow-up visits – clinics/physicians' offices
- Review of medical records/ OPD records,
- Surgeon surveys by mail or telephone, and
- Patient surveys by mail or telephone
  - **NB:** patients may have a difficult time assessing their infections.

Any combination of these methods is acceptable for use.

SSI Monitoring

- Pus drained from SSIs should ideally be cultured, and the organism(s) responsible be identified.
  - Some SSIs may be from unusual organisms, or antibiotic resistant organisms
  - May trace organisms to potentially one source, if an outbreak is identified
  - Allows for specific therapy

Antimicrobial	Recommended Dose		Half-life in Adults With Normal Renal Function, h [19]	Recommended Redosing Interval (From Initiation of Preoperative Dose), h[c]
	Adults[a]	Pediatrics[b]		
Ampicillin–sulbactam	3 g (ampicillin 2 g/sulbactam 1 g)	50 mg/kg of the ampicillin component	0.8–1.3	2
Ampicillin	2 g	50 mg/kg	1–1.9	2
Aztreonam	2 g	30 mg/kg	1.3–2.4	4
Cefazolin	2 g, 3 g for pts weighing ≥120 kg	30 mg/kg	1.2–2.2	4
Cefuroxime	1.5 g	50 mg/kg	1–2	4
Cefotaxime	1 g[d]	50 mg/kg	0.9–1.7	3
Cefoxitin	2 g	40 mg/kg	0.7–1.1	2
Cefotetan	2 g	40 mg/kg	2.8–4.6	6
Ceftriaxone	2 g[e]	50–75 mg/kg	5.4–10.9	NA
Ciprofloxacin[f]	400 mg	10 mg/kg	3–7	NA
Clindamycin	900 mg	10 mg/kg	2–4	6
Ertapenem	1 g	15 mg/kg	3–5	NA
Fluconazole	400 mg	6 mg/kg	30	NA
Gentamicin[g]	5 mg/kg based on dosing weight (single dose)	2.5 mg/kg based on dosing weight	2–3	NA
Levofloxacin[f]	500 mg	10 mg/kg	6–8	NA
Metronidazole	500 mg	15 mg/kg Neonates weighing <1,200 g should receive a single 7.5-mg/kg dose	6–8	NA

Antimicrobial	Recommended Dose		Half-life in Adults With Normal Renal Function, h [19]	Recommended Redosing Interval (From Initiation of Preoperative Dose), h[c]
	Adults[a]	Pediatrics[b]		
Moxifloxacin[f]	400 mg	10 mg/kg	8–15	NA
Piperacillin–tazobactam	3.375 g	Infants 2–9 mo: 80 mg/kg of the piperacillin component Children >9 mo and ≤40 kg: 100 mg/kg of the piperacillin component	0.7–1.2	2
Vancomycin	15 mg/kg	15 mg/kg	4–8	NA
Oral antibiotics for colorectal surgery prophylaxis (used in conjunction with a mechanical bowel preparation)				
Erythromycin base	1 g	20 mg/kg	0.8–3	NA
Metronidazole	1 g	15 mg/kg	6–10	NA
Neomycin	1 g	15 mg/kg	2–3 (3% absorbed under normal gastrointestinal conditions)	NA

TABLE 2. RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS

Type of Procedure	*Recommended Agents*[a,b]	*Alternative Agents in Pts With β-lactam Allergy*	*Strength of Evidence*[c]
Cardiac			
Coronary artery bypass	Cefazolin, cefuroxime	Clindamycin,[d] vancomycin[d]	A
Cardiac device insertion procedures (e.g., pacemaker implantation)	Cefazolin, cefuroxime	Clindamycin, vancomycin	A
Ventricular assist devices	Cefazolin, cefuroxime	Clindamycin, vancomycin	C
Thoracic			
Noncardiac procedures, including lobectomy, pneumonectomy, lung resection, and thoracotomy	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	A
Video-assisted thoracoscopic surgery	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	C
Gastroduodenal[e]			
Procedures involving entry into lumen of gastrointestinal tract (bariatric, pancreaticoduodenectomy[f])	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
Procedures without entry into gastrointestinal tract (antireflux, highly selective vagotomy) for high-risk patients	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
Biliary tract			
Open procedure	Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Laparoscopic procedure			
Elective, low-risk[l]	None	None	A
Elective, high-risk[l]	Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Appendectomy for uncomplicated appendicitis	Cefoxitin, cefotetan, cefazolin + metronidazole	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Small intestine			
Nonobstructed	Cefazolin	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	C
Obstructed	Cefazolin + metronidazole, cefoxitin, cefotetan	Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	C

TABLE 2. (CONTINUED)

Type of Procedure	*Recommended Agents*[a,b]	*Alternative Agents in Pts With β-lactam Allergy*	*Strength of Evidence*[c]
Hernia repair (hernioplasty and herniorrhaphy)	Cefazolin	Clindamycin, vancomycin	A
Colorectal[m]	Cefazolin + metronidazole, cefoxitin, cefotetan, ampicillin–sulbactam,[h] ceftriaxone + metronidazole,[n] ertapenem	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone,[h-j] metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Head and neck			
Clean	None	None	B
Clean with placement of prosthesis (excludes tympanostomy tubes)	Cefazolin, cefuroxime	Clindamycin[d]	C
Clean-contaminated cancer surgery	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam	Clindamycin[d]	A
Other clean-contaminated procedures with the exception of tonsillectomy and functional endoscopic sinus procedures	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam	Clindamycin[d]	B
Neurosurgery			
Elective craniotomy and cerebrospinal fluid-shunting procedures	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Implantation of intrathecal pumps	Cefazolin	Clindamycin,[d] vancomycin[d]	C
Cesarean delivery	Cefazolin	Clindamycin + aminoglycoside[g]	A
Hysterectomy (vaginal or abdominal)	Cefazolin, cefotetan, cefoxitin, ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Ophthalmic	Topical neomycin–polymyxin B–gramicidin or fourth-generation topical fluoroquinolones (gatifloxacin or moxifloxacin) given as 1 drop every 5–15 min for 5 doses[o] Addition of cefazolin 100 mg by subconjunctival injection or intracameral cefazolin 1–2.5 mg or cefuroxime 1 mg at the end of procedure is optional	None	B
Orthopedic			
Clean operations involving hand, knee, or foot and not involving implantation of foreign materials	None	None	C
Spinal procedures with and without instrumentation	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Hip fracture repair	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Implantation of internal fixation devices (e.g., nails, screws, plates, wires)	Cefazolin	Clindamycin,[d] vancomycin[d]	C
Total joint replacement	Cefazolin	Clindamycin,[d] vancomycin[d]	A

(*continued*)

TABLE 2. (CONTINUED)

Type of Procedure	*Recommended Agents*[a,b]	*Alternative Agents in Pts With β-lactam Allergy*	*Strength of Evidence*[c]
Urologic			
Lower tract instrumentation with risk factors for infection (includes transrectal prostate biopsy)	Fluoroquinolone,[h-j] trimethoprim–sulfamethoxazole, cefazolin	Aminoglycoside[g] with or without clindamycin	A
Clean without entry into urinary tract	Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis])	Clindamycin,[d] vancomycin[d]	A
Involving implanted prosthesis	Cefazolin ± aminoglycoside, cefazolin ± aztreonam, ampicillin–sulbactam	Clindamycin ± aminoglycoside or aztreonam, vancomycin ± aminoglycoside or aztreonam	A
Clean with entry into urinary tract	Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis])	Fluoroquinolone,[h-j] aminoglycoside[g] with or without clindamycin	A
Clean-contaminated	Cefazolin + metronidazole, cefoxitin	Fluoroquinolone,[h-j] aminoglycoside[g] + metronidazole or clindamycin	A
Vascular[p]	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Heart, lung, heart–lung transplantation[q]	Cefazolin	Clindamycin,[d] vancomycin[d]	A (based on cardiac procedures)
Lung and heart–lung transplantation[r,s]	Cefazolin	Clindamycin,[d] vancomycin[d]	A (based on cardiac procedures)
Liver transplantation[q,t]	Piperacillin–tazobactam, cefotaxime + ampicillin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	B
Pancreas and pancreas–kidney transplantation[r]	Cefazolin, fluconazole (for patients at high risk of fungal infection [e.g., those with enteric drainage of the pancreas])	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
Plastic surgery			
Clean with risk factors or clean-contaminated	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	C

[a]The antimicrobial agent should be started within 60 min before surgical incision (120 min for vancomycin or fluoroquinolones). While single-dose prophylaxis is usually sufficient, the duration of prophylaxis for all procedures should be less than 24 h. If an agent with a short half-life is used (e.g., cefazolin, cefoxitin), it should be readministered if the procedure duration exceeds the recommended redosing interval (from the time of initiation of the preoperative dose [see Table 1]). Readministration may also be warranted if prolonged or excessive bleeding occurs or if there are other factors that may shorten the half-life of the prophylactic agent (e.g., extensive burns). Readministration may not be warranted in patients in whom the half-life of the agent may be prolonged (e.g., patients with renal insufficiency or failure).

[b]For patients known to be colonized with methicillin-resistant *Staphylococcus aureus*, it is reasonable to add a single preoperative dose of vancomycin to the recommended agent(s).

[c]Strength of evidence that supports the use or nonuse of prophylaxis is classified as A (levels I–III), B (levels IV–VI), or C (level VII). Level I evidence is from large, well-conducted, randomized controlled clinical trials. Level II evidence is from small, well-conducted, randomized controlled clinical trials. Level III evidence is from well-conducted cohort studies. Level IV evidence is from well-conducted case–control studies. Level V evidence is from uncontrolled studies that were not well conducted. Level VI evidence is conflicting evidence that tends to favor the recommendation. Level VII evidence is expert opinion.

(*continued*)

Preoperative-dose timing

- The optimal time for preoperative ATB doses is within 60 min before surgical incision.
- Some ATBs e.g. fluoroquinolones and vancomycin, require administration over one to two hours;
  - Administration of these agents should begin within 120 min before surgical incision.

Selection and dosing

- Weight-based dosing in obese patients
  - Pharmacokinetics of drugs may be altered in obese patients, hence dosage adjustments
- Need for repeat doses during prolonged procedures
  - Intraoperative redosing needed to ensure adequate serum and tissue concentrations if the duration of the procedure exceeds 2 half-lives of the drug **or** there is excessive blood loss during the procedure.

Duration of prophylaxis

- Recommendations for a shortened postoperative course of antimicrobials involving a single dose or continuation for less than 24 hours as provided above.
- Further clarity on the lack of need for postoperative ATB prophylaxis based on the presence of indwelling drains and intravascular catheters is included.