ASIA PACIFIC SOCIETY OF
INFECTION CONTROL

THE APSIC GUIDELINES

FOR

THE PREVENTION OF SURGICAL SITE INFECTIONS

Borneo

10. Korean Surgical Infection Society (KSIS)

Contents

Epidemiology of Surgical Site Infections (SSIs)

The incidence of SSI globally varies from 0.9% of cumulative SSI rate in the USA (NHSN 2014), to 2.6% in Italy, 2.8% in Australia (2002-13, VICNISS), 2.1% in Republic of Korea (2010-11) to 6.1% in Low Middle Income Countries(LIMC) (WHO, 1995-2015) and 7.8% in South East Asia (SEA) & Singapore (pooled incidence from 2000-2012). What definitely stands apart is the very high incidence rates in LMIC and SEA compared to the US and Europe and Australia. This highlights the need for the SEAsian countries to look at the specific risk factors and develop effective prevention strategies, which would be cost effective at local levels. The reasons for SSI in LIMC are multiple and identified causes include:

1. Lack of dedicated human resources and funds for surveillance

2. Difficulties in the application of standard definitions

3. Lack of reliable microbiological and other diagnostic tools

4. Poor-quality documentation from patient records

5. Need to evaluate clinical evidence to validate accuracy of data

6. Lack or insufficient microbiology laboratory capacity

7. Lack of skills for data interpretation and use

8. Existence of different payer

The microbiology of the SSI also varies with different regions of the world. In most parts of the world, *Staphylococcus aureus* and *Staphylococcus epidermidis* form the major organisms for most clean surgery related SSIs, with most of the countries showing methicillin resistance rates of 25% to 50% in *Staphylococcus aureus* isolates. However, some studies from developing countries, especially the Indian subcontinent showed quite high prevalence of Gram negative bacilli – *Klebsiella* species*, E.coli and Pseudomonas aeruginosa* - as significant pathogens in SSI, including clean surgeries.

An increase in the incidence of Gram-negative bacilli (e.g. ESBL, CRE) made the choice of antibiotic prophylaxis for clean contaminated surgeries difficult. The difference in microbiology in countries in SEA needs to be considered in more detail because of the lack of standardisation of sampling methods and definitions of SSI in these studies. However, the presence of Gram-negative bacilli in significant proportions is important because of the high extended spectrum beta lactamase

ESBL producer rates, and carbapenem resistant *Enterobacteriaceae* (CRE) prevalence among these organisms. This high multidrug resistance organisms (MDROs) prevalence makes the choice of antibiotic prophylaxis for clean-contaminated bowel surgeries and choice of therapeutic antimicrobials a challenge.

SSIs are preventable and are patient safety issues. This guideline aims to assist in giving guidance on best practices to prevent SSIs.

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Risk factors for SSI

Preoperative risk factors

Preoperative risk factors are classified as unmodifiable or modifiable. One of the unmodifiable risk factors is age. Increasing age is a risk factor of SSI until age 65 years, but at ages 65 years and older, increasing age decreases the risk of SSI. Other unmodifiable risks are recent radiotherapy and history of skin or soft tissue infection. Modifiable preoperative risk factors are uncontrolled diabetes, obesity, malnutrition, current smoking, immunosuppression, preoperative albumin <3.5 mg/dL, total bilirubin >1.0 mg/dL, and preoperative hospital stay of at least 2 days.

Perioperative & Intraoperative risk factors

Perioperative risk factors are divided into procedure-related, facility, patient preparation-related, and intraoperative factors. Procedure-related factors include emergency and more complex surgery, higher wound classification and open surgery. Facility risk factors include inadequate ventilation, increased operation theatre traffic, and inappropriate/inadequate sterilization of instruments/equipment. Patient preparation-related risk factors include a pre-existing infection, inadequate skin preparation, preoperative shaving, and wrong prophylactic antibiotic choice, administration/or duration. Intraoperative risk factors include long operating time, blood transfusion, asepsis and surgical technique, poor hand/forearm antisepsis and gloving, hypoxia, hypothermia, and poor glycaemic control.

Postoperative risk factors

Several risk factors are important during the postoperative period. Hyperglycaemia and diabetes are still critical during the immediate postoperative period. Two additional risk variables that are important postoperatively are wound care and postoperative blood transfusions. Postoperative wound care is determined by the closure technique of the surgical site. The primary wound that is closed must be kept clean with a sterile dressing for 1 to 2 days after surgery. Lastly, a meta-analysis showed that even a single unit of blood transfusion in the immediate postoperative period is a risk factor for SSI (odds ratio 5 3.5). However, the need for blood transfusions should not be withheld if clinically indicated.

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Table 1   Risk Factors for SSI

Preoperative risk factors

1. Unmodifiable
   a. Increasing age until age 65 years
   b. Recent radiotherapy and history of skin or soft tissue infection

2. Modifiable
   a. Uncontrolled diabetes
   b. Obesity, malnutrition
   c. Current smoking
   d. Immunosuppression
   e. Preoperative albumin <3.5 mg/dL
   f. Total bilirubin >1.0 mg/d
   g. Preoperative hospital stay of at least 2 days

Perioperative risk factors

1. Procedure-related
    a. Emergency and more complex surgery,
    b. Higher wound classification
    c. Open surgery.
2. Facility risk factors
    a. Inadequate ventilation,
    b. Increased operation theatre traffic
    c. Inappropriate/inadequate sterilization of instruments/equipment.
3. Patient preparation-related
    a. A pre-existing infection
    b. Inadequate antiseptic skin preparation
    c. Preoperative hair removal
    d. Wrong antibiotic choice, administration, and/or duration
4. Intraoperative risk factors
    a. Long operating time
    b. Blood transfusion
    c. Asepsis and surgical technique
    d. Hand/forearm antisepsis and gloving techniques
    e. Hypoxia
    f. Hypothermia
    g. Poor glycaemic control.

Postoperative risk factors

1. Hyperglycaemia and diabetes
2. Postoperative wound care
3. Transfusion

Surveillance of SSI

Surveillance is a systematic methodology which includes monitoring of a specific event, collection and analysis of necessary data associated with the event, and the timely feedback to clinical staff who can implement evidence based strategies to improve outcomes by decreasing the incidence of the event. Surveillance of SSI with feedback of appropriate data to surgeons and other healthcare workers involved in the care of those undergoing operative procedures has been shown to be an important component of strategies to reduce the risk of SSIs. A successful surveillance program includes the use of standardised SSI definitions and surveillance methods, stratification of SSI rates according to risk factors associated with SSI development, and timely feedback of data.

The National Healthcare Safety Network (NHSN) system developed by the Centers for Disease Control and Prevention in the United States of America provides modules/components for surveillance of various healthcare-associated infections, including SSI. This scheme is regarded as the international standard and many countries, develop their SSI surveillance programs based on that of NHSN with minor modifications.

When performing surveillance of SSI, the initial step is to develop your surveillance program by selecting targeted operative procedures to follow. Once determined, collect numerator and denominator data on the selected procedure for a pre-determined time period.

All operations included in the targeted operative procedure/procedures must be followed and monitored for superficial, deep, and organ/space Surgical Site Infection (see appendix for criteria). SSI monitoring requires active, patient-based, prospective surveillance, including review of medical records and visit to the wards. By definition, patients must be followed for 30 or 90 days postoperatively according to NHSN methodology. Post-discharge surveillance, therefore, is necessary. The role of telephone or remote wound photography-based follow-up remains to be determined.

Data analysis can be done in several ways. The most standard method is to calculate incidence of SSI in a certain period for a specific operative procedure. The calculation is done by dividing the number of SSI observed by the number of operative procedure.

When comparing the incidence of SSI between hospitals or at an individual hospital over time, risk adjustment should be performed. This is because even though patients undergo the same type of operative procedure, the risk for SSI can be different based on their general condition, level of contamination at the operative field and underlying risk factors. The Standardized Infection Ratio (SIR), which can be calculated by dividing the expected number of SSI by the observed number of SSI, gives us the best risk adjusted incidence.

Recommendation

1. Perform surveillance of SSIs using accepted international methodology. (IIB)

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Appendix

The National Healthcare Safety Network (NHSN) system Criteria for SSI

<u>**Superficial incisional SSI**</u>

Must meet all of the following criteria:

1. The date of event for infection occurs within 30 days after the operative procedure (where day 1 = the procedure date) **and**

2. involves only skin and subcutaneous tissue of the incision **and**

3. patient has at least one of the following:

   a. Purulent drainage from the superficial incision.

   b. Organisms identified from an aseptically-obtained specimen from the superficial incision or subcutaneous tissue by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment.

   c. Superficial incision that is deliberately opened by a surgeon, attending physician or other designee and culture or non-culture based testing is not performed AND patient has at least one of the following signs or symptoms: pain or tenderness; localized swelling; erythema; or heat.

   d. Diagnosis of a superficial incisional SSI by the surgeon or attending physician or other designee.

<u>**Deep incisional SSI**</u>

Must meet all of the following criteria:

1. The date of event for infection occurs within 30 or 90 days after the operative procedure (where day 1 = the procedure date) depending on the type of the procedure **and**

2. Involves deep soft tissues of the incision (e.g., fascial and muscle layers) **and**

3. Patient has at least one of the following:

   a. Purulent drainage from the deep incision.

   b. A deep incision that spontaneously dehisces, or is deliberately opened or aspirated by a surgeon, attending physician or other designee and organism is identified by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment or culture or non-culture based microbiologic testing method is not performed AND patient has at least one of the following signs or symptoms: fever (>38°C); localized pain or tenderness. A culture or non-culture based test that has a negative finding does not meet this criterion.

   c. An abscess or other evidence of infection involving the deep incision that is detected on gross anatomical or histopathologic exam, or imaging test.

<u>**Organ/Space SSI**</u>

Must meet all of the following criteria:

1. The date of event for infection occurs within 30 or 90 days after the NHSN operative procedure (where day 1 = the procedure date) depending on the type of procedure **and**
2. infection involves any part of the body deeper than the fascial/muscle layers, that is opened or manipulated during the operative procedure **and**
3. Patient has at least <u>one</u> of the following:
   a. Purulent drainage from a drain that is placed into the organ/space.
   b. Organisms are identified from fluid or tissue in the organ/space by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment.
   c. An abscess or other evidence of infection involving the organ/space that is detected on gross anatomical or histopathologic exam, or imaging test evidence suggestive of infection **and**
4. Meets at least one criterion for a specific organ/space infection site

More detailed information including the Patient Safety Component Manual is freely available at the CDC/NHSN web site
https://www.cdc.gov/nhsn/about-nhsn/index.html

Pre-operative preventive measures

Preoperative Bath

It is generally accepted that preoperative bathing with soap (antimicrobial or non-antimicrobial) is beneficial prior to surgery, despite the lack of study comparing preoperative bath versus no-preoperative bath on the occurrence of SSIs. Preoperative bath with chlorhexidine (CHG) can reduce bacterial colonization of the skin. However, in a recent systematic review and meta-analysis, the use of CHG versus placebo failed to demonstrate SSI reduction. Chlorhexidine needs to be on the skin for at least 5 minutes before rinsing off for maximal effect, which may be a limiting factor in chlorhexidine baths. Studies on the use of 4% chlorhexidine sequential showers and 2% chlorhexidine impregnated cloths in combination with chlorhexidine bathing to produce a more sustainable decrease in skin bacterial decolonization also failed to demonstrate the decrease in SSIs. Current evidences suggest that there are no differences between plain and antiseptic bathing. A total of 9 studies investigated preoperative bathing or showering with an antimicrobial soap compared with plain soap with no significant reduction in the SSI rates (OR 0.92; 95% CI = 0.8-1.04). Although recommendations on preoperative bathing in relation to time of administration and the most effective protocol for perioperative bath remains an unresolved issue, it is advisable to take at least 2 baths pre-operatively. Countries with high incidence of MDRO may want to consider the use of an antiseptic instead of plain soap as a preoperative bath. Further studies are needed to validate the efficacy of antiseptic preoperative shin preparations. In some Asian countries where allergy to CHG is common or CHG is not available, alternative agents such as octenidine may be used.

Recommendations:

2. It is necessary for patients who will undergo surgery to have at least 1 preoperative bath with soap (antimicrobial or non-antimicrobial). (IIB)

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Mechanical bowel preparation (MBP) and oral antibiotics for elective colorectal surgery in Adults

Oral antibiotics have been used to decrease the luminal bacterial load since the 1930s. However, MBP preparation only or no preparation was the common practice until the 2000s. Recently, the combination of MBP and oral antibiotic preparation has been increasingly used. Mechanical bowel preparation alone does not decrease SSI. Similarly, oral or intravenous antibiotics alone showed suboptimal effects. Many studies have shown beneficial results with a combination of MBP and oral antibiotics bowel preparations, which includes decreased rate of SSI, anastomotic leakage, *C. difficile* colitis, and postoperative paralytic ileus. Use of a combination preparation also reduces hospital stay and is related to lower readmission rates. In the WHO guidelines, eleven randomised controlled trials RCTs including 2416 patients and comparing preoperative MBP with the oral antibiotics vs. MBP alone were reviewed. Preoperative MBP with oral antibiotics reduces the occurrence of SSI when compared to MBP only (OR: 0.56; 95% CI: 0.37–0.83). There is neither benefit nor harm in the rate of anastomotic leak (OR: 0.64; 95% CI: 0.33–1.22). A 2014 Cochrane review also recommended that antibiotics should be administered both orally with mechanical bowel preparation and intravenously in 1 hour before surgery to reduce SSIs.

Recommendation

1. Combination mechanical bowel preparation and oral antibiotic preparation are recommended for all elective colorectal surgery in adults. (IA)

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Hair removal

There are several methods to remove hair at the surgical site preoperatively. Hair removal by shaving and the night before an operation is associated with and increased risk of SSI. Shaving and/or clipping can cause microscopic cuts in the skin that later serve as foci for bacterial multiplication. A meta-analysis performed by the WHO guideline development group showed that clipping resulted in a statistically significantly lower risk of SSIs than shaving (OR 0.51, 95% CI 0.29 to 0.91). A low to very low quality of evidence shows that clipping has neither benefit nor harm related to the reduction of SSI when compared to no hair removal (OR 1.00, 95% CI 0.06-16.34). A recently published meta-analysis showed no significant difference in the risk of SSI between no hair removal and clipping (OR 0.97, 95% CI 0.51-1.82). WHO and CDC strongly recommend no hair removal or, if necessary, hair removal by clipper.

Hair removal the day before surgery does not affect the SSI rate compared to hair removal on the day of surgery (OR: 1.22; 95% CI: 0.44-3.42). CDC recommends hair removal on the day of the surgery, whereas WHO does not recommend the timing of hair removal.

Recommendations

1. Hair removal should be avoided unless hair interferes with the operative procedure. (IIIB)
2. If hair removal is necessary, a razor should be avoided and an electric clipper should be used. (IA)
3. No recommendation regarding the timing of hair removal by clipper is made. (IIIC)

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Methicillin-resistant *Staphylococcus aureus* (MRSA) screening and decolonization

In the USA, the incidence of methicillin-resistant *Staphylococcus aureus* (MRSA) infection after major surgical procedure is estimated at only 1% overall. It is well recognized that MRSA colonization is associated with worse outcomes and a higher risk for both MRSA SSI and overall SSI. Information on the incidence of MRSA nasal carrier in Asia Pacific is limited; with one Thai study suggesting that the nasal carriage of MRSA was at 3.6% (9 of 149 screened patients). MRSA nasal carriage occurred among patients with a history of contact with healthcare facilities and low-level mupirocin resistant was detected in 2 patients (22%; 2 of 9 patients). The relatively low prevalence of MRSA carriage and the relative high prevalence of mupirocin resistant among hospitalized patients suggest that a routine search and destroy strategy may not be cost-effective in all settings. Thus, a search and destroy strategy should be stratified to groups at high risk for MRSA SSI (e.g., advanced age, overall SSI risk, and treatment with vancomycin antibiotic during surgery). In general, detection of MRSA nasal carriage can be performed using a standardized culture or using PCR method, as has been described. The use of MRSA bundle comprising of screening, decolonization, contact precautions, and vancomycin-containing antibiotic prophylaxis was associated with decreased rates of SSI where there was high compliance with the bundle strategies. Typical preoperative decolonization protocol includes the use of 2% nasal mupirocin bid for 5 days and bathing with chlorhexidine gluconate at days 1, 3, and 5 preoperatively. It should be cautioned that the widespread use of nasal mupirocin may result in the development of resistance. Alternatives to intranasal mupirocin may include octenidine or povidone-iodine. WHO recommends that patients who are undergoing cardiothoracic and orthopaedic surgery who have been identified with nasal carriage of *S. aureus* by screening undergo nasal mupirocin decolonization.

Recommendation

1. Hospitals should evaluate their SSI, *S. aureus* and MRSA rates, and mupirocin resistant rate, if available, to determine whether implementation of a screening program is appropriate. (IIB)
2. Patients undergoing cardiothoracic and orthopaedic surgery with known nasal carriage of *S. aureus* should receive perioperative intranasal application of mupirocin 2% ointment with or without a combination of CHG body wash. (IA)

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Surgical hand/forearm preparation

The objective of cleaning hands and forearms prior to surgery is to reduce the bioburden of bacteria on the skin of the surgical team. The second objective is to inhibit the growth of bacteria. Hands and forearms should undergo a surgical scrub with a surgical antiseptic. WHO has recently recommended that the use of alcohol-based hand rub (ABHR) (those that fulfil the EN 12791 standard) is also a good alternative for use. A 2016 Cochrane review showed no evidence that one is better than the other in reducing SSIs. Published systematic reviews have not shown any difference between surgical hand/forearm rubbing with a recommended ABHR preoperatively and hand/forearm washing and scrubbing with a surgical antiseptic agent in reducing SSI.

When using alcohol-based hand rub (ABHR) solutions containing 60–80% alcohol are recommended. Water quality may be compromised with the use of tap aerators where these are known to be easily colonized with non-fermentative Gram negative bacteria e.g. *Pseudomonas aeruginosa, Acinetobacter baumannii*, etc. Hence, where there are issues with the quality of water used in rinsing hands after hand scrubbing, hand rubbing with ABHR agent is a suitable alternative.

The WHO Guidelines on Hand Hygiene in Health Care recommend the practice of keeping nails short and removal of all jewellery, artificial nails and nail polish before surgical hand preparation. The product selected for hand/forearm preparation preoperatively should be used according to the manufacturer's instructions.

Disposable or clean towels should be made available for staff to use to dry their hands. Where the quality of water used is not assured, ABHR is recommended. In this case, a sufficient amount of ABHR should be applied to dry hands and forearms for 1.5-3 minutes (see Figure 1). They should be allowed to dry before the user dons sterile gown and gloves.

The ABHR agent used in surgical hand preparation should have proven efficacy i.e. compliance with EN 12791 and ASTM E-1115 standards. Non-touch or elbow-operated dispensers are recommended in the surgical scrub area of operating suites services.

Recommendations

1. Surgical hand preparation is to be performed either by scrubbing with a suitable antiseptic soap and water or a suitable ABHR before donning sterile gown and gloves. (IA)

2. ABHR used in surgical hand preparation should comply with EN 12791 or ASTM E-1115 standards. (IIIA)

3. Where the quality of water used is not assured, surgical hand rub with ABHR is recommended. (IIIB)

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Figure 1   Surgical hand preparation using alcohol based hand rub (Ref: WHO Guidelines on Hand Hygiene in Healthcare)

The handrubbing technique for surgical hand preparation must be performed on perfectly clean, dry hands.
On arrival in the operating theatre and after having donned theatre clothing (cap/hat/bonnet and mask), hands must be washed with soap and water.
After the operation when removing gloves, hands must be rubbed with an alcohol-based formulation or washed with soap and water if any residual talc or biological fluids are present (e.g. the glove is punctured).

Surgical procedures may be carried out one after the other without the need for handwashing, provided that the handrubbing technique for surgical hand preparation is followed (Images 1 to 17).

1 Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the dispenser

2 Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds)

3 Images 3–7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

4 See legend for Image 3

5 See legend for Image 3

6 See legend for Image 3

7 See legend for Image 3

8 Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser

9 Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds)

10

Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

11

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps re-presented in Images 12-17 are followed (20-30 seconds)

12

Cover the whole surface of the hands up to the wrist with alcohol-based handrub, rubbing palm against palm with a rotating movement

13

Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa

14

Rub palm against palm back and forth with fingers interlinked

15

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement

16

Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa

17

When the hands are dry, sterile surgical clothing and gloves can be donned

Repeat the above-illustrated sequence (average duration, 60 sec) according to the number of times corresponding to the total duration recommended by the manufacturer for surgical hand preparation with an alcohol-based handrub.

Skin antiseptic

Current evidence suggested that alcohol-based preparations are more effective in reducing SSI than aqueous preparations, and should be used, unless contraindicated. Alcohol has a rapid bactericidal effect, albeit with the lack of persistent antibacterial effect. The benefit of iodine or chlorhexidine and alcohol solutions is prolonged bactericidal activity. Based on available studies, the comparison of alcohol-based antiseptic solutions versus aqueous solutions on skin flora was performed. Significant benefit in reducing skin flora was observed with CHG in alcohol-based solution compared to povidone-iodine (PVP-I) in an aqueous solution. No significant difference was found between alcohol-based versus aqueous PVP-I solutions. Note that no study has demonstrated the superiority of alcohol containing chlorhexidine over iodine and alcohol preparations with regard to SSIs. Most studies use isopropyl alcohol at a concentration of 70-74%, iodophor of 0.7-.1% and CHG of 0.5-4%. Given the wide range of the concentrations studied, it is difficult to include a statement about the concentration of the antiseptic compound in the recommendation.

Recommendations

1. Alcohol based skin antiseptic preparations should be used, unless contraindicated. (IA)

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Surgical Prophylaxis

Current guidelines suggest the use of narrow spectrum antibiotics, such as cefazolin for most surgical procedures, or cefoxitin for abdominal surgery, as surgical antimicrobial prophylaxis. In situations where the incidence of MRSA-associated SSI is high or in case/s of penicillin allergy, vancomyin or fluoroquinolone can be used as an alternative. Current evidence supports the administration of an antimicrobial for surgical prophylaxis within 1 hour before incision or before inflation of a tourniquet in orthopaedic procedures, or within 2 hours for vancomycin or fluoroquinolones, because of their recommended infusion times.

In most cases, it is recommended that a single dose of surgical antimicrobial prophylaxis is adequate. However there are studies which show that certain procedures, such as in implant-based breast reconstruction, some orthopaedic and cardiac procedures, would benefit from more than one dose, althoughthe optimal durations remain unknown. More studies are needed in the setting of high antimicrobial resistance in the region. Prophylactic antimicrobial dosing should be adjusted based on patient's weight and should be re-dosed during surgery to maintain adequate tissue levels based on the agent's half-life where the antimicrobial of choice will depend on local epidemiology.

It is important that clinicians are aware of the common pathogens associated with SSI in their institution as well as the patterns of antimicrobial resistance (e.g., hospital antibiograms) to help determine the optimal choice of antimicrobial prophylaxis. In general, the use of broad spectrum antimicrobials is discouraged except where clearly indicated. Each country/hospital is encouraged to develop its own local guidelines, based on local epidemiology.

Recommendations

1. Administration of prophylaxis antimicrobials should only be performed when indicated. (IA)
2. Prophylactic antimicrobials should be administered within 1 hour before incision for all antimicrobials except vancomycin and fluoroquinolones where it should be administered within 2 hours. (IA)
3. Re-dosing should be considered to maintain adequate tissue levels based on agent half-life. (IA)
4. A single dose of antimicrobial prophylactic is adequate for most surgical procedures. (IA)

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Nutrition

Changes in host immunity may increase a patient's susceptibility to SSIs and malnutrition may contribute to poor surgical outcomes, including delayed recovery, morbidity and mortality, prolonged hospital stay, increased health care costs and readmission. Meta-analysis and randomized controlled studies do not consistently show either benefit or harm when comparing standard versus enhanced nutritional support in reducing the risk of SSIs. Underweight patients undergoing major surgical procedures, especially oncology and cardiovascular operations, however, may benefit from enhanced nutritional support.

Recommendation

1. Underweight patients undergoing major surgical procedures, especially oncology and cardiovascular operations, may benefit from the administration of oral or enteral multiple nutrient-enhanced nutritional formulas for the purpose of preventing SSI. (IIIC)

References

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Glycaemic Control

Diabetes mellitus (DM) is a systemic disease which affects the nervous, vascular, immune and musculoskeletal systems. Neutrophils from people with diabetes show reduced chemotaxis and oxidative killing potential compared to non-diabetic controls. This state favours bacterial growth and compromises fibroblast function and collagen synthesis, interferes with wound healing and increases the incidence of postoperative wound infections. In surgical patients, the stress response to surgical insult results in insulin resistance, and decreased pancreatic beta-cell function causes decreased insulin production, adding to stress-induced hyperglycaemia.

One of the commonest surgical complications in patients with pre-existing DM and hyperglycaemia is infection, with superficial surgical site infections (SSIs), deep wound infections and surgical space abscesses, urinary tract infections (UTIs), and pneumonia (PNA) accounting for a large percentage of infectious complications.

Since diabetes has an adverse effect on surgical outcomes, and glycosylated haemoglobin reflects long-term regulation of blood glucose, it has been suggested that optimizing a patient's preoperative glycaemic control (<7% glycosylated haemoglobin) may reduce post-operative infections. The benefit of good glucose control preoperatively is indisputable, but more studies need to be done to identify a direct link between a good level of HbA1C control and SSI.

It is known that patients with diabetes have elevated blood glucose levels and therefore, increased risk of SSIs. However, hyperglycaemia in non-diabetes patients also exposes them to elevated risks of SSIs. In order to have better glycemic control in both patient groups, there are many glycaemic control protocol variations ranging from tight or strict to conventional. Tight or strict glycaemic control is usually practiced for the critically ill patient. However a review of pre- and post-operative glycaemic control protocols concluded that there is still insufficient evidence to determine what role strict glycaemic control plays in reducing SSIs and other relevant post-operative infections, particularly as it is associated with an increase in moderate and severe hypoglycaemia. To reduce the risk of hypoglycaemia, a regular or conventional protocol should be sufficient for patients admitted to a general ward where frequent glucose monitoring may not be guaranteed. The target blood glucose level post-operatively should be maintained between 140-200 mg/dL (7.8-11.1 mmol/L) in all surgical patients.

To optimize the care of the patient with diabetes and reduce the risk of complications, a team-oriented approach to treatment is highly recommended.

Recommendations

1. Preoperative HbA1C levels should be less than 8%. (IIIC)

2. It is recommended to maintain blood glucose levels between 140-200 mg/dL (7.8-11.1 mmol/L) in patients with and without diabetes undergoing surgery (IA)

3. Where it is hard to control diabetes, a team-oriented approach including a surgeon and physician is recommended (IIB)

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Surgical Attire

Although most SSIs are caused by the patient's endogenous flora, operating theatre (OT) staff may be a source of bacterial contamination. Bacteria are shed from the body and so, new scrub suits are used at each entry into the operating theatre suite. Although there is evidence suggesting that tucked, cuffed, cotton-polyester-blend scrubs that cover the legs are more effective than all-cotton scrubs in reducing OT contamination, no study has shown a relationship between the use of scrubs and the prevalence of SSI. Neither is there evidence to advocate that non-scrubbed staff are to put on long sleeves whilst in restricted areas.

Several studies have demonstrated that hair and ears can harbour *S. aureus,* and hair, ears, and scalp are potential sources of contamination in the OT. However no studies have clearly showed whether the use of these head coverings influences the rate of SSI. Nevertheless, it is expected that scrubbed personnel wear appropriate PPE, including head and beard covers for those who are bearded.

Surgical gowns, either disposable or reusable, are used as personal protective equipment (PPE). In general, permeable cotton gowns and drapes are inferior to impervious gown and drape materials in the prevention of SSI. Thus far, no study has shown any difference between these materials in the prevention of SSIs. However, the use of linen gowns is discouraged because of the presence of lint, which may potentially be a source of SSI

Sterile gloves must be used by the surgical team to ensure maintenance of aseptic technique during the procedure. Double gloving has been advocated since the 1980s primarily to help reduce the risk of blood borne pathogens in the event of a needlestick or sharps injury. To date, there is no strong evidence to support the use of double gloving to specifically prevent SSI. Rapid multiplication of skin bacteria occurs under surgical gloves if antimicrobial soaps or appropriate disinfectants are not used. Hence, the spectrum of antimicrobial activity for surgical hand preparation selected should be as broad as possible against bacteria and fungi. The practice of changing of gloves during the course of an operation may decrease the incidence of bacterial contamination inside the gloves. However, there is inadequate evidence to recommend changing of gloves throughout the surgical procedures unless the gloves are torn or punctured.

The use of a surgical mask has always been considered as part of the surgical attire for the surgical team although there are few studies supporting the efficacy of their use. Nevertheless, standard precautions require the use of surgical masks as part of PPE for scrubbed personnel and will protect staff in the event of a splash. Similarly, the use of a face shield or other form of eye protection as PPE will also protect staff in the event of a splash.

The issue of whether to allow OT personnel to step out of the OT in scrub suits has been a common debateable issue for OT. Rationale for allowing it in some facilities in developed countries is that the facility has an environmental hygiene program and generally the wards and other areas of the facility are clean.

All reusable scrub attire should be laundered in a health care accredited laundry facility after each daily use and when soiled or contaminated.

Recommendations

1. Personal protective equipment (PPE) (gloves, gowns, masks, protective eyewear,) is available and must be worn in accordance with the facility guidelines. (IIIC)
2. All reusable scrub attire should be laundered in a health care accredited laundry facility after each daily use and when soiled or contaminated. (IIB)

References

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OT traffic

The OT suite is generally divided into three designated areas that are defined by the physical activities performed in each area:

1. <u>Unrestricted area</u> includes a central control point that monitors the entrance of patients, personnel, and materials. Street clothes are permitted in this area, and traffic is not limited. However, the entrance to the OT suite should be restricted to authorized personnel based on organizational policies.

2. <u>Semi-restricted area</u> includes the peripheral support areas of the OT suite. These are designated storage areas for clean and sterile supplies, work areas for reprocessing instruments and equipment, scrub sink areas, and corridors leading to restricted areas of the surgical suite. Traffic in this area is limited to authorized personnel and patients. Personnel are required to wear surgical attire and cover all head and facial hair.

3. <u>Restricted area</u> includes OT rooms, procedure rooms, and the sterilizing services area. Surgical attire and hair coverings are required. Masks are required where opening sterile supplies or when scrubbed as part of the surgical team.

With increased awareness of the role of the environment in hospital acquired infections, there has been interest in frequency of door opening as a risk factor for SSI. There is mounting evidence relating to increased SSI with increased OT door openings. However, the presence of additional OT personnel has not been independently associated with increased odds of SSIs. The number of persons in the operating room should be limited to ensure adequate space for good work practices.

Recommendation

1. Limit the number of people in the OT room to ensure adequacy in space for work to be carried out safely. (IIIC)

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Intra-operative preventive measures

Normothermia

Exposure of large surfaces of skin to cold temperatures in the operating room can cause hypothermia. Hypothermia results in patients waking with chills and shivering, and also raises the risk for other complications such as SSI. To avoid these complications, warming systems to transfer heat to a patient's body are used. Several different methods are available, including a forced-air warming system, water bed system, and passive warming system such as blankets.

Meta-analysis using the results from 3 randomized controlled trials revealed that active warming reduces surgical site infection (RR 0.36, 95% CI 0.20 to 0.66). One study was performed on patients undergoing elective hernia repair, varicose vein surgery, and breast surgery. The other studies were on patients undergoing elective gastrointestinal surgery, including laparoscopic surgery.

Recommendation

1. Maintain perioperative normothermia by using active warming devices. (IB)

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Normovolemia

Hypovolemia and reduced cardiac output theoretically trigger musculocutaneous and splanchnic vasoconstriction, causing hypoperfusion and tissue hypoxia. Hemodynamic goal-directed therapy (GDT) is a treatment based on the titration of fluid and inotropic drugs infused to physiologic flow-related end points. This regimen was originally applied in surgical patients with the aim of reaching normal or supranormal values of cardiac output and oxygen delivery to manage the perioperative increase in oxygen demand and to prevent organ failure. The therapy includes monitoring of blood pressure, body temperature and saturation of arterial oxygen. In some cases, cardiac output monitoring by transcardiac catheter may be beneficial. The targeted value in each indicator is not yet determined.

A systematic review and meta-analysis assessed the effect of hemodynamic GDT on surgical site infection and other infectious complications. GDT was defined as perioperative monitoring and manipulation of hemodynamic parameters to reach normal or supraoptimal values by fluid infusion alone or in combination with inotropic therapy within 8 hours after surgery.

The meta-analysis of 14 trials at low risk of bias (3,255 subjects) revealed that GDT significantly reduced surgical site infections (OR 0.50, 95% CI 0.36 to 0.70). It also significantly reduced postoperative pneumonia (OR 0.71, 95% CI 0.55 to 0.92), urinary tract infections (OR 0.44, 95% CI 0.22 to 0.88) and all infectious episodes (OR 0.40, 95% CI 0.28 to 0.58), but not catheter-related bloodstream infections.

This intervention is associated with maintaining optimal oxygenation, and should be understood in that context.

Recommendation

1. Hemodynamic goal-directed therapy is recommended to reduce surgical site infection. (IA)

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Irrigation

Wound irrigation is considered to be one of the most useful SSI prevention methods by many surgeons. Up to 97% of surgeons perform wound irrigation during surgery in their regular practice.

For wound irrigation, normal saline is generally used. However, as to the preventive effect on SSI, there is inadequate data yet to recommend normal saline. Based on the RCT showing no significant difference between saline irrigation and no irrigation (OR: 1.09; 95%CI: 0.44-2.69; P=0.85), the World Health Organization (WHO) found insufficient evidence to recommend for or against saline irrigation of incisional wounds before closure for the purpose of preventing SSI. Moreover, the National Institute for Health and Care Excellence (NICE) SSI prevention guideline opposes performing wound irrigation.

From one meta-analysis of five RCTs that have evaluated the effect of antibiotic irrigation on wounds, there was no significant difference compared with the group without irrigation (OR : 1.16, 95% CI:0.64-2.12; P=0.63). Due to the potential risk of antimicrobial resistance, WHO recommended against using antibiotic irrigation for SSI prevention.

Recently, povidone-iodine irrigation has gained support in various guidelines and reviews. Fournel and colleagues in a meta-analysis of various RCTs reported a significant protective effect of povidone-iodine irrigation (RR : 0.64; 95%CI: 0.51-0.82). In this analysis, numerous sub-groups analyses were undertaken. Povidone-iodine irrigation was statistically significant in various types of surgeries, including neurosurgery, and SSI rates for the surgeries including povidone-iodine irrigation were consistently low for all other subgroups but not statistically significant. In the WHO guideline, povidone-iodine irrigation was more effective than saline irrigation in the meta-analysis which included seven RCTs (OR: 0.31; 95%CI: 0.13-0.73; P=0.007). Thus, consideration of using aqueous povidone-iodine irrigation before closure was recommended, particularly in clean and clean-contaminated wounds, but with conditional strength. Likewise, the CDC recommended considering intraoperative irrigation of deep or subcutaneous tissues with aqueous iodophor solution for the prevention of SSI, but with a weak recommendation. NICE guidelines noted that povidone-iodine solution irrigation may reduce SSI. Since povidone-iodine was only licensed for the use on intact skin, they did not make any recommendations to use povidone-iodine irrigation for surgical incisional wound before closure for SSI prevention.

Though clinical signs of iodine toxicity were not reported in the studies quoted by the WHO, concerns still exist for allergic reactions and metabolic adverse events due to iodine uptake. Based on *in vitro* studies, there also remains concern about the potential toxic effects of povidone-iodine on fibroblasts, the mesothelium and the healing of tissue.

Considering the quality of the data available, and current controversies we do not make any conclusion for this particular practice.

Recommendations

1. There is insufficient evidence to recommend for or against saline irrigation of incisional wounds before closure for the purpose of preventing SSI. (IIC)

2. Avoid using antimicrobial agents to irrigate the incisional wounds before closure to reduce the risk of SSI. (IA)

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Antimicrobial impregnated sutures

The body of evidence evaluated was only moderate in quality. This quality was reduced by:

1. Mixed results.
2. Variations in surgical procedures and patient samples.
3. Confounding factors as the authors did not report the use of antibacterial sutures was part of a surgical care bundle in some studies.

There are several meta-analysis of RCTs which deny the benefit of Triclosan coated sutures in the prevention of clean-contaminated and contaminated surgeries (esp. abdominal surgeries) while the effect on clean surgeries seem moderate at best. The latest meta-analysis (Leaper et al) focusing on the cost savings from SSI prevented with addition of antimicrobial sutures as a preventive measure (used in all classes of surgeries) suggests significant benefits.

Recommendation

Where there are high SSI rates in clean surgeries, in spite of basic preventive measures, individual centres may consider the use of antimicrobial impregnated sutures. (IIB)

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Drapes

Microbial contamination during a surgical procedure is a precursor of SSI. Bacteria that cause infections are considered to be inoculated into the wound during surgery and at the time of insertion of prosthesis and implants. In addition, the dose of contaminating microorganisms required to produce infection might be much lower when foreign material is present at the surgical site. Antiseptics that are currently available do not eliminate microorganisms, and it is understood that residual skin bacteria quickly recolonize after disinfection. Thus, compared to clean-contaminated surgery, the importance of skin recolonization rises for in clean surgery where implants are used, and additional contamination rarely occurs during procedures.

Adhesive drapes are categorized into those containing iodine and those that do not. Several studies have documented the role of iodine-impregnated adhesive incise drapes, which will allow iodine to permeate deep layers of the skin, possessing sufficient antimicrobial effects against normal bacterial flora residing in the deeper layers of the skin as well as other major causative bacteria for SSI. There is no controversy regarding the view that iodine-impregnated adhesive drapes inhibit residual skin bacteria recolonization.

Adhesive antiseptic impregnated drapes for the purpose of SSI prevention are included in various guidelines. The National Institute for Health and Clinical Excellence (NICE) guidelines note a meta-analysis reporting non iodine-impregnated adhesive incise drapes showed a significantly higher SSI risk than the group with no drapes (RR 1.20; 95%CI: 1.02-1.43; p=0.03). This was also reported in the 2015Cochrane review. On the other hand, NICE and CDC had conducted the same meta-analysis on iodine-impregnated adhesive incise drapes containing 2 RCTs (N=1113). In these analyses, no significant difference was observed between the groups that used iodine-impregnated adhesive incise drapes and the group that did not use an adhesive drapes (RR: 1.03; 95%CI: 0.66-1.60; p=0.89). However, the studies quoted in this analysis were over 15 years old, with a different SSI definition, as well as different disinfection methods preceding the use of adhesive drapes, leaving concern about data heterogeneity.

In Asia, a Japanese study by Kotani and colleagues reported that the SSI rate for total joint arthroplasties (hip and knee) when using the non-iodine impregnated adhesive incise drape was 3.14% (4/159 cases), and significantly decreased after using iodine-impregnated adhesive incise drape (0%, 0/184 cases). In the study, iodine-impregnated adhesive incise drapes were applied to total joint arthroplasties (hip and knee) in the following manner:

1) Applied after the disinfectant dried
2) Without wrinkles
3) With no air bubbles, and

4) Not removing drapes until the wound was closed.

With this method, when used properly, the effects from the application of iodine-impregnated adhesive incise drapes may be maximized. Furthermore, Bejko and colleagues conducted a study on 2 groups of cardiac surgical patients with propensity score matching, reporting that there was a significant decrease (71%) in SSI rate in the iodine impregnated incise compared with the non-antimicrobial incise drape (p=0.001). In addition, there was a reduction in medical costs of €773,495 when using the iodone incise drape.

In various guidelines, it is generally accepted not to recommend non iodine-impregnated adhesive incise drapes, since it is associated with SSI risk. On the other hand, the SSI prevention effects of iodine-impregnated adhesive incise drapes are still not clear. Yet, from several observational studies especially in clean surgeries, marked SSI preventative effects have been reported with the proper use of iodine-impregnated drapes. Considering the promising effect of controlling skin recolonization, and the fact that bacterial wound contamination may be directly linked to SSI, we believe that the use of iodine-impregnated adhesive incise drapes may be beneficial. Based on the above evidence, we do recommend their use when necessary, especially in orthopaedic and cardiac surgeries. This area of research is deficient of high quality studies, and the available evidence shows high overall heterogeneity. Furthermore, iodine-impregnated adhesive drapes may be expensive in some countries. Their cost-effectiveness may vary depending on country. Further studies will be necessary to address these issues.

Recommendations

1. When using adhesive incise drapes, do not use non-iodophor-impregnated drapes for surgery as they may increase the risk of surgical site infection. (IE）

2. In orthopaedic and cardiac surgical procedures where adhesive incise drapes are used, consider using an iodophor-impregnated incise drape, unless the patient has an iodine allergy or other contraindication. (IIB)

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Wound protectors

Surgical drapes are commonly used to demarcate the aseptic surgical area and to cover the wound edges in an effort to reduce SSI. Wound protectors are available as non-adhesive plastic sheaths attached to a single or double rubber ring that firmly secures the sheath to the wound edges. These primarily facilitate the retraction of the incision during surgery with the objective of reducing wound-edge contamination to a minimum during abdominal surgical procedures. In the WHO Global Guidelines for the prevention of SSI, the expert panel concluded that the use of a wound-protector device (single-ring or double-ring) was associated with a significantly lower risk of SSI than with conventional wound protection (OR 0·42; 95% CI 0·28–0·62). Unfortunately, the quality of evidence was too low to justify a recommendation to routinely use wound protectors. In resource limited countries, these single use devices may be financially prohibitive.

Recommendation

1. Careful evaluation of wound protectors needs to be done before introducing the use of wound protectors as a routine measure to reduce SSI. (IIIC)

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Vancomycin powder

The effectiveness of topical vancomycin (VCM) powder for the purpose of reducing SSIs has been evaluated in various studies, especially in spine surgery. In 2011, Sweet and colleagues reported a retrospective study including 1732 spinal surgeries, with an average of 2.5 years follow-up. The SSI rate declined significantly from 2.1% to 0.2% after adding 2g of VCM powder intraoperatively into the wound (P＜0.01), without any difference in adverse events. The ease and simplicity of adding VCM powder intraoperatively, and from the high protective value against SSI led rapidly to the use of this technique throughout the world. Now, it has become an era of systematic review and meta-analyses. In most studies, the effect of VCM powder seems to be effective for preventing SSIs, but most supportive data have come from observational studies. The only RCT which has been published did not show any difference in SSI comparing VMC powder intraoperatively into the wound with no VCM powder（OR 0.96, 95％CI 0.34-2.66). Grading of Recommendations Assessment, Development and Evaluation (GRADE) of the studies included in these meta-analyses shows low quality of evidence, including the RCT. Most of the meta-analyses concluded the need for further high quality evidence. On the other hand, the safety evaluation for its VCM powder is considered to be poor, with very low quality of evidence according to the GRADE evaluation. These adverse events are additionally considered to be underestimated, including a chance of circulatory collapse; and not enough is known about the possible toxic effects to the surrounding tissues due to the high local VCM concentration. Mostly important, there remains concern about unnecessary resistance pressure leading to vancomycin resistant Staphylococcus aureus (VRSA). Considering the worldwide concern about antimicrobial resistance (AMR) and the importance of this issue in our region, the use of VCM powder for the prevention of SSIs needs to be evaluated with carefully.

The recent Japanese Practical Guideline for the Adequate use of Antimicrobial Prophylaxis concluded that although there is ample evidence indicating the advantages of VCM powder, there is no clear evidence by RCT, and the evidence for its safety is still lacking. In the guideline from the National Institute for Health and Care Excellence (NICE), concern about the risk of resistance with widespread use of vancomycin powder has been raised, since VCM is still important for treating MRSA. On the other hand, in their latest guideline, the Centers for Disease Control and Prevention (CDC) strongly recommended not to apply antimicrobial agents (i.e. ointments, solutions, or powders) to the surgical incision for the prevention of SSI. The use of VCM powder for the purpose of reducing SSI has been reported in various observational studies. Though many studies provide supportive results, several serious concerns exist regarding their study designs, including the RCT. Moreover,

the lack of high quality studies has been criticized in various reviews and guidelines. The reports for its safety are also considered insufficient, and the toxic effects of high VCM concentration to the surrounding tissues are not fully understood. Additionally, VCM is still the gold standard for treating MRSA infection in our region, and the unnecessary threat of AMR is a global concern which cannot be ignored. Therefore, the guideline development group would not recommend using VCM powder for the purpose of preventing SSIs at this point, including spinal surgery.

Recommendation

1. Do not apply vancomycin powder into the surgical site for prevention of surgical site infection, including spine surgery. (IC)

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Laminar air flow

The importance of clean air technology has been recognized since Sir Charnley's report clearly demonstrating the exponentially fall of SSI rate with improvement in air quality. The importance of maintaining high air quality throughout the surgery is imperative.

Laminar air flow (LAF) was used in some operating theatres following studies comparing air quality when using laminar air flow (LAF) versus conventional air flow systems. Less air contamination was observed in LAF, and could be lower if operating teams used occlusive garments. Charnley showed in an observational study which included more than 8000 orthopaedic implant surgeries, a lower deep SSI rates in those undergoing surgery in OTs with LAF and surgical teams wearing body exhaust suits compared to those undergoing the same procedures in operating rooms with conventional air flow system and no use of exhaust body suits.

Recently some concerns have been raised in this area. Firstly, all previously cited studies were more than 20 years old, and antimicrobial prophylaxis (AMP) was not routinely used in that period. Secondly, the general SSI prevention methods adopted in the previous studies may have been different from what we do in our current practice. Thirdly, AMP is now the most important SSI prevention method worldwide, and has been adopted on a regular basis in most hospitals. Fourthly, the air quality in a conventional air system has also been improved along with the improvement of clean air technology, and high efficiency particulate air (HEPA) filters may be placed in an operating theatre without LAF, further promoting high air quality. From all these changes, the impact of LAF on SSI prevention may be different from what it was in the previous studies.

A large registry data analysis was reported by Brandt et al in 2008. From a multivariate analysis, the SSI risk for LAF was significantly higher than that of a conventional air flow system in hip arthroplasties (RR 1.63, 95%CI 1.06~2.52). Moreover, from an analysis of a hip and knee arthroplasty registry by Hooper et al, which covers 98% of all arthroplasties done in New Zealand, SSI risk for LAF was higher than that of conventional air system (P<0.001). In the WHO meta-analyses covering these studies, the cumulative risk of LAF was significantly higher for both hip and knee arthroplasties. In the latest meta-analysis from the WHO, with some additional studies, the risk for deep SSI in association with LAF showed no significant difference compared with a conventional air flow system, with OR: 1.08(95%CI 0.77-1.52, p=0.65) for knee arthroplasty, OR: 1.29 (95%CI 0.98-1.71, p=0.07) for hip arthroplasty, and OR: 0.75(95%CI 0.43-1.33, p=0.33) for abdominal and open vascular surgeries. Therefore, WHO has suggested LAF is not required to reduce the risk of SSI for patients undergoing total arthroplasty surgery, and LAF is not required in new operating rooms.

Limitations of the studies included in the meta-analyses were; all studies were observational studies, and were obtained mostly from no standardised surveillance systems and registry data. Secondly, the data used were not initially planned to evaluate the effectiveness of LAF, nor the SSI risks of targeted procedures. Therefore, the definitions and follow-up period of included variables were different, introducing a chance of inadequate adjustment in the final analyses due to lack of adequate confounders. Thirdly, some of the studies in arthroplasties showed an opposite (supportive) effect for LAF. This trend was seen in colon and gastric surgeries, with a significant protective effect for LAF, with a clear inconsistency of its effect among procedure types. Fourth, the data relied heavily on arthroplasty procedures. From the heterogeneity of the included data, and the inconsistency of its effect among procedures, the results of LAF need to be interpreted with caution.

In several cost-effectiveness analyses, LAF are found to be more expensive than conventional ventilation systems. Moreover, inclusion of LAF is accompanied with more expense for the validation of its ventilation systems. The threshold limit of ultra-clean air was arbitrarily defined by Lidwell and colleagues as less than ten colony-forming units per m³, and has been used as the standard ever since. But, this threshold was established without having any scientific evidence of the relationship between contamination of the air and risk of SSIs.

In clean surgery, performing a RCT for the evaluation of LAF might not be realistic due to the low incidence of SSIs. Therefore, nationwide databases might provide the best affordable information. The available data, however, do not provide internationally standardised information about the risk factors and confounders. Furthermore, the surveillance data were not based on internationally standardised definitions. At this point, due to the lack of high studied, the heterogeneity of the available data, and lack of standardisation in the surveillance methods and registers, it is difficult to conclude for or against the use of operating theatres equipped with LAF for the purpose of reducing SSIs. And, due to the high expense, LAF is not considered necessary for installation in new operating rooms, unless supportive sufficient clinical evidence has been provided.

Recommendations

1. Installation of laminar airflow is not required in new or renovated operating rooms to prevent SSIs. (IIC)

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Post-Operative Wound Management

There are no high quality studies comparing various strategies of post-OP operative wound management and this is an area for further focused research. However, from the available low quality studies the key information which we can derive is as follows:

1. No difference in SSI rates with staplers versus sutures
2. Early removal of dressing (< 48 hours) versus late removal did not impact SSI rates
3. Primary vacuum dressings or Negative Pressure Wound Therapy (ie clean-contaminated and contaminated surgeries) and silver based dressings have mixed results and individualised decisions on their use are suggested
4. Aseptic technique should be used when undertaking wound dressings and wound management

5. Choose the dressing on the basis of patient and wound needs, i.e. exudate level, wound depth, need for conformability, antimicrobial efficacy, odour control, ease of removal, safety and patient comfort.

Recommendation

1. Primary vacuum dressings or Negative Pressure Wound Therapy (i.e. for clean-contaminated and contaminated surgeries) and silver based dressings have mixed results and individualised decisions on their use are suggested. Routine use for prevention of SSI is not recommended. (IIC)

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Appendix: Categories for strength of each recommendation

Categories for strength of each recommendation	
CATEGORY	**DEFINITION**
A	Good evidence to support a recommendation for use.
B	Moderate evidence to support a recommendation for use.
C	Insufficient evidence to support a recommendation for or against use
D	Moderate evidence to support a recommendation against use.
E	Good evidence to support a recommendation against use.
Categories for quality of evidence on which recommendations are made	
GRADE	**DEFINITION**
I	Evidence from at least one properly randomized, controlled trial.
II	Evidence from at least one well-designed clinical trial without randomization, from cohort or case-controlled analytic studies, preferably from more than one centre, from multiple time series, or from dramatic results in uncontrolled experiments.
III	Evidence from opinions of respected authorities on the basis of clinical experience, descriptive studies, or reports of expert committees.