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A COMPREHENSIVE REVIEW ON SURGICAL CARE IMPROVEMENT AND POST OPERATIVE WOUND CARE TO REDUCE SURGICAL SITE INFECTION

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ABSTRACT

IMPORTANCE: SSIs occur either during or up to 30 days after a surgical procedure, largely avoidable with proper infection control measures. SSIs often need to be treated with additional antibiotics, and may require interventional procedures or even re-operation. SSIs can lead to major complications, including death, as well as significantly increase the cost of care. This review focuses on postoperative strategies specifically aiming to prevent SSI, rather than other surgical site incidences or complications.

OBJECTIVE: On completion of this article, the reader should be able to understand and summarize surgical care improvement and post-operative wound care to reduce surgical site infection.

METHODS: A vigorous, maximum sensitive and online search of the literature was performed in published articles in the last 24 years (JUNE 2000–JUNE 2024). The databases searched were MEDLINE (via PubMed) and Cochrane Library.

CONCLUSION: Largely avoidable with proper infection control measures, SSIs occur either during or up to 30 days after a surgical procedure. SSIs often need to be treated with additional antibiotics, and may require interventional procedures or even re-operation. SSIs can lead to major complications, including death, as well as significantly increase the cost of care. It is estimated that, at the very least, 5% of patients who undergo surgery develop a surgical site infection (SSI). There has been much interest in the use of negative pressure wound therapy (NPWT) as a prophylactic treatment to reduce the risk of SSI. Evidence suggests it can accelerate healing times, reduce both the length of hospital stay and the frequency of dressing changes, and improve patients' quality of life.

IMPORTANCE

SSIs occur either during or up to 30 days after a surgical procedure, largely avoidable with proper infection control measures. SSIs often need to be treated with additional antibiotics, and may require interventional procedures or even re-operation. SSIs can lead to major complications, including death, as well as significantly increase the cost of care. This review focuses on postoperative strategies specifically aiming to prevent SSI, rather than other surgical site incidences or complications.

INTRODUCTION

An SSI is a post-surgical infection that can affect either the incision or deep tissue at the operation site. It is an infectious process present at the site of surgery. These are the third most commonly reported type of healthcare-associated infection as well as the most costly, representing a burden to individuals, their families and health services. [3]

The probability of a patient developing a postoperative SSI is influenced by selected intrinsic and extrinsic risk factors present at the time of surgery. It is estimated that between 750 000 and 1 000 000 SSIs occur in the USA each year, utilizing 3.7 million extra hospital days and costing more than US$1.6 billion in excess hospital charges each year.[1] If the infection becomes systemic, SSIs can be potentially life-threatening, resulting in significant patient morbidity and mortality. Rates of inpatient SSI have been established by high-quality studies and prospective surveillance.[3] The cornerstones for reducing the risk of SSI include exquisite surgical technique, timely and appropriate antimicrobial prophylaxis, effective and persistent skin antisepsis and identification of adjunctive strategies for reducing wound contamination while promoting wound healing[1]

However, incidence rates of SSI in the community are less clear. This may be due to the trend for earlier hospital discharge, or lack of reporting and documentation. Under-reporting, or reporting of composite endpoints such as ‘wound complications’ or ‘surgical site incidences’ (e.g. wound breakdown, seroma, haematoma), means that post-surgical complications may not be captured in hospital-based surveillance studies, particularly if infections are relatively minor and are not reported by the patient to their GP, or by the GP to the surgical team. Therefore, the true cost of SSIs to the patient, family and organisation may be grossly underestimated in the community. [3]

METHODS

A vigorous, maximum sensitive and online search of the literature was performed. The search strategy was limited to published articles in the last 24 years (JUNE 2000–JUNE 2024) to include the most recent, up-to- date data that reflect the current clinical practice. The databases searched were MEDLINE (via PubMed) and Cochrane Library. The search terms used were , “surgical site infection”, “surgical wound infection”, “post-operative wound care”, and “innovative surgical techniques” combined with “AND” and “OR” operators as appropriate. The reference lists of the included studies were also searched manually to exhaustively retrieve additional relevant articles. The first stage of screening was performed based on the titles and abstracts. Eligible studies were screened based on the full text in the second stage.

DISCUSSION AND OBSERVATIONS

NATIONAL WOUND CARE STRATEGY PROGRAMME

Following the results of the seminal paper by Guest et al (2015), the Burden of Wounds Study, the National Wound Care Strategy Programme (NWCSP) was created to develop strategies to improve wound care in England. ‘Surgical wounds’ is one of the clinical work streams and, at the time of writing, the NWCSP is working to generate a generic clinical navigation tool to form the basis for specialist customization and referral pathways according to local protocols. The NWCSP will also make recommendations to support optimal implementation of existing guideline recommendations for preventing and treating post-surgical wound complications. [3]

SURGICAL SITE INFECTION; HOW WE DO IT

Many proven and potentially valid methods are employed to prevent SSI. Coordinated and standardized protocols with good data collection can assist the multi-disciplinary efforts to reduce SSI within the unique practices of a given institution.

Preventive antibiotics are established measures. A case can be made for increasing the dose in patients with a large body mass, and antibiotics probably should be re-administered during procedures lasting longer than 3 h. Chlorhexidine showers for the patient are not proven; however, they are inexpensive and of potential benefit. Hair removal is always done with clippers and in the operating room at the time of the procedure. No scientific case can be made specifically for using antiseptic at the surgical site before the incision. Keeping the blood glucose

concentration and the core body temperature near normal probably are important, but how close to normal is unclear. Transfusion enhances SSI, but leukocyte reduction of transfused blood may be of benefit. Some evidence supports the value of antibacterial suture in preventing SSI. [7]

APPROPRIATE WOUND CARE

Each surgical speciality has its own protocol for post-surgery dressing removal, which depends on the risk factors of the patient group and surgery type. Individual dressing wear time also applies. Surgical dressings should be kept undisturbed for a minimum of 48 hours after surgery (up to 4 days if possible), unless there are signs and symptoms indicating that earlier inspection is warranted For closed, clean incision wounds (or caesarean clean-contaminated), dressing removal post-surgery can take place at anywhere between 2 and 7 days. Serous exudate can be a normal part of surgical wound healing; however, it is important to be aware of any changes in exudate that may signify deterioration of the wound, or that healing has stalled. Observation and clinical judgment are key – frequent dressing changes and maceration of the surrounding skin and tissue breakdown should be avoided. [3]

PDCA CYCLE TO REDUCE SSI

PDCA cycle 1: To clarify current knowledge, the multidisciplinary team members met and researched the possible causes of surgical site infection. In light of this, the team planned the following:

1. Communicate the project aim and objectives to all key stakeholders of surgical service
2. Revise the clinical practice guidelines about surgical antimicrobial prophylaxis based on scientific evidence
3. Educate all surgical specialties about the recommended clinical practice guidelines
4. Implement the hospital-approved antimicrobial prophylaxis guidelines and monitor compliance
5. Review the intraoperative practice about surgical scrub and site preparation
6. Develop SSI bundle, and educate all surgical service members on the bundle
7. Implement the bundle, evaluate and monitor compliance
8. Develop preoperative education material for surgical patients
9. Report and feedback monthly SSI rate to surgical specialties
10. Carry out root cause analysis (RCA) for reported SSI.[5]

The following prevention strategies were implemented:

1. Preoperative screening to ensure patients is medically fit for surgery
2. Reinforcement of the preoperative patient education regarding hair removal using clippers (if hair removal is required) and the use of an antiseptic agent for bathing (i.e., chlorhexidine gluconate) prior surgery
3. Observation of the skin preparation technique followed pre surgery in the operating room (OR)
4. Administration of antimicrobial prophylaxis in accordance with evidence based standards and guidelines
5. Limit OR traffic when operative procedure is ongoing
6. Maintenance of normothermia of all post-operative patients in the pre holding area, intra operatively and during the recovery phase
7. Improve communication of SSI rates with key stakeholders
8. Performing surgical wound dressing under strict aseptic technique.[5]

PDCA cycles 2 to 4: Over a six week period, the initiated interventions were monitored, prompt feedback on SSI rates was provided to relevant surgical specialties, and recommendations to comply with clinical practice guidelines and SSI bundle were consistently reinforced. Gradually, the strategies were implemented to all patients undergoing operative procedures. [5]

PDCA cycle 5: An educational session for all surgeons was organized to raise awareness of the prevention of SSI using evidence-based strategies. Electronic SSI bundle compliance tool was developed. [5]

PDCA cycle 6: SSI rates feedback and factors of non-compliance were made as standing item during the department meeting and in the agenda for OR Committee. All new surgical healthcare workers (physicians, anaesthetists and nurses) were oriented about SSI bundle during induction. All reported SSI was discussed in the mortality and morbidity committee. Throughout the whole process, data were continually collected and collated by the infection prevention and control team. [5]

SURGICAL CARE IMPROVEMENT PROJECT INITIATIVES APPLY TO THE PERI-OPERATIVE PERIOD:

After operation, wound hygiene is crucial. The gold standard is 'non-touch' techniques, i.e. avoiding touching wounds and dressings with bare hands. Sterile saline should be used for rinsing the wound. After 48 h postoperatively, the patient should take a shower and wash his or her body with soap. It is not recommended to use local antimicrobial products to reduce the infection risk [8]

1. Prophylactic antibiotics should be received within 1 h prior to surgical incision.
2. Be selected for activity against the most probable antimicrobial contaminants.
3. Be discontinued within 24 h after the surgery end-time.
4. Euglycemia should be maintained, with well-controlled morning blood glucose concentrations on the first two post-operative days, especially in cardiac surgery patients.
5. Hair at the surgical site should be removed with clippers or by depilatory methods, not with a blade.
6. Urinary catheters are to be removed within the first two post-operative days.
7. Normothermia should be maintained peri-operatively.[6]

SURVEILLANCE DEFINITIONS FOR SSI

1. Surveillance definitions must be established and consistently applied over time to make comparisons within and between institutions meaningful.
    A. NHSN definitions for SSI are widely used for public reporting, interfacility comparison, and pay-for-performance comparisons, based on selected procedures identified by procedure codes assigned from the International Classification of Diseases, 10th Revision Clinical Modifications/Procedure Coding System (ICD-10-CM/PCS) and/or current procedural terminology (CPT) codes.
    B. Validation of the application of surveillance definitions between data abstractors may be necessary to ensure consistent application.
2. According to widely used CDC NHSN definitions,43 SSIs are classified as follows (Fig. 1):
    A. Superficial incisional (involving only skin or subcutaneous tissue of the incision)
    i. Superficial incisional primary (SIP): SSI identified in a primary incision in a patient with 1 or more incisions.
    ii. Superficial incisional secondary (SIS): SSI identified in the secondary incision in a patient that has had an operation with >1 incision.
    B. Deep incisional (involving fascia and/or muscular layers)
    a. Deep-incisional primary (DIP): SSI identified in a primary incision in a patient who has had an operation with 1 or more incisions.
    b. Deep-incisional secondary (DIS): SSI identified in a secondary incision in a patient who has had an operation with > 1 incision.
    C. Organ-space: Involving any part of the body opened or manipulated during the procedure, excluding skin incision, fascia, or muscle layers.

- Increasing patient mobility as soon as possible after surgery, for example sitting up in a chair the day of surgery and walking in the hallways up to three times as soon as possible, which decreases the risk of infection
- By implementing these infection control strategies, UT Southwestern met their goal of reducing colorectal SSIs by 50%. Additionally, the hospital saved an estimated $540,000 in total costs in 2021 and 2022, compared to 2020, and hospital bed days were reduced by 578 days (46%). [2]

Historically, SSI surveillance was conducted in a retrospective manner, however efforts to implement a timely and effective infection control program requires a prospective interdisciplinary system for

- Identifying selective and non-selective SSIs.
- Rapid implementation of appropriate interventional strategies designed to mitigate risk.

In the USA, national efforts to reduce the morbidity and mortality of SSIs has resulted in the adoption of the Surgical Care Improvement Project, which focuses on four evidenced-based interventional strategies including glycaemic control in cardiothoracic and vascular patients, appropriate hair removal, timely and appropriate antimicrobial prophylaxis, and maintenance of normothermia in colorectal patients. Efforts to reduce the risk of

SSI in the future will require a focused, multidisciplinary commitment, embracing sentinel evidence-based strategies in addition to novel, yet effective, innovative risk reduction technologies. [1]

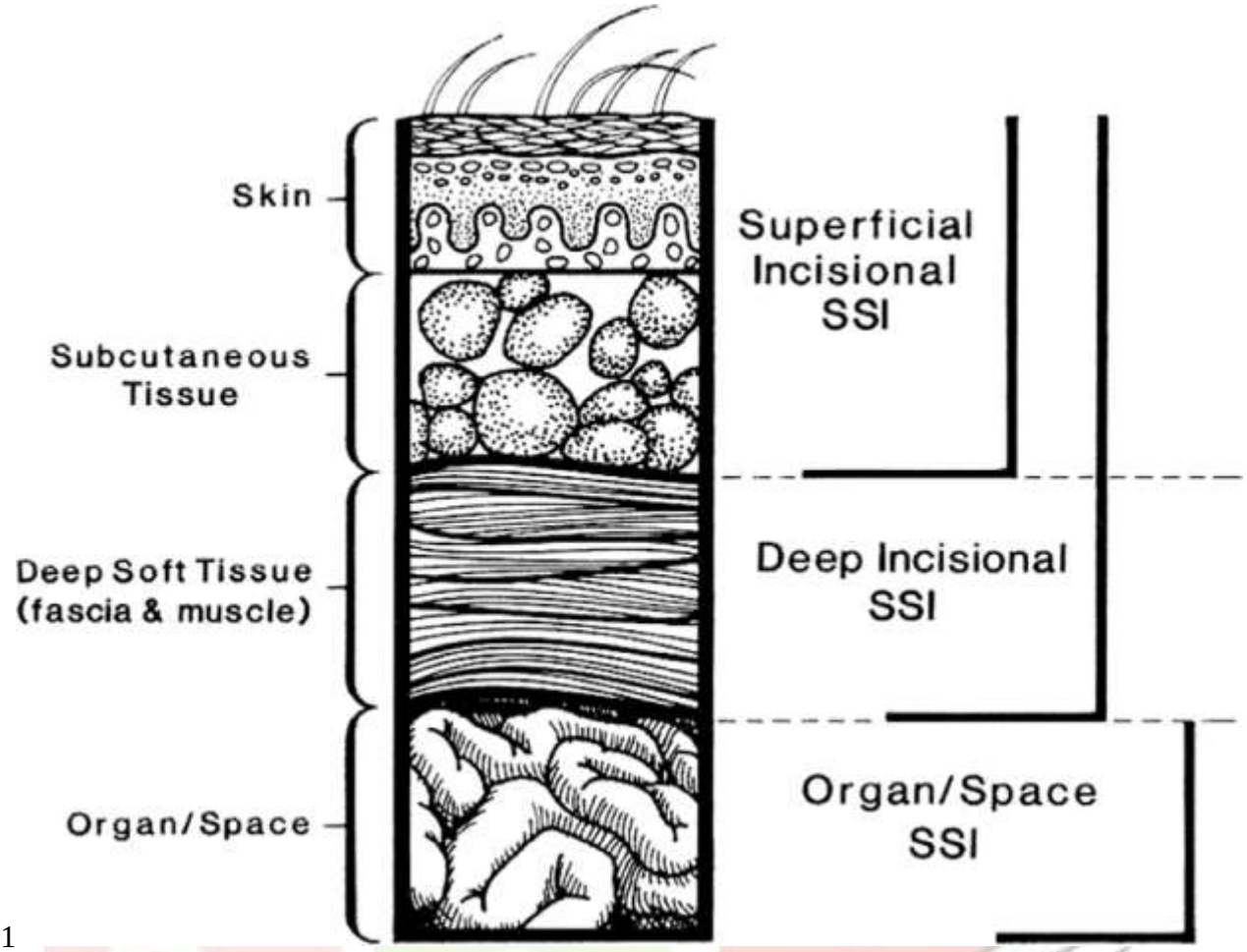

Fig. 1

INFRASTRUCTURE REQUIREMENTS

Facilities performing surgery should have the following elements in place:

1. Trained infection prevention personnel
   - i. Infection preventionists
     - A. Must be specifically trained in methods of SSI surveillance
     - B. Must have knowledge of and the ability to prospectively apply the CDC/NHSN definitions for SSIs
     - C. Must possess basic computer and mathematical skills must be adept at providing feedback and education to healthcare personnel (HCP) when appropriate.
   - ii. Having an increased number of infection preventionists, certified infection preventionists, and a hospital epidemiologist are associated with lower rates of SSI. A specific threshold for staffing has not been defined.

2. Education for HCP
   - a. A surgeon leader or champion can be a critical partner in changing culture and improving adherence to prevention practices.
   - b. Regularly provide education to surgeons and perioperative personnel through continuing education activities directed at minimizing perioperative SSI risk through implementation of recommended process measures.
     - i. Combine several educational components into concise, efficient, and effective recommendations that are easily understood and remembered.
     - ii. Provide education regarding the outcomes associated with SSI, risks for SSI, and methods to reduce risk to all surgeons, anesthesiologists, and perioperative personnel.
   - c. Ensure that education and feedback regarding SSI rates and specific measures that can be used to prevent infection filter down to all frontline multidisciplinary HCPs providing care in the perioperative84 and postoperative settings.

3. Education of patients and families. Provide education for patients and patients' families to reduce risk associated with intrinsic patient-related SSI risk factors.
4. Computer-assisted decision support and automated reminders
    a. Several institutions have successfully employed computer assisted decision support methodology to improve the rate of appropriate administration of antimicrobial prophylaxis (including re-dosing during prolonged cases).
    b. Computer-assisted decision support can be time-consuming to implement, and institutions must appropriately validate computer-assisted decision support systems after implementation to ensure that they are functioning appropriately.
5. Utilization of automated data
    a. Install information technology infrastructure to facilitate data transfer, receipt, and organization to aid with tracking of process and outcome measures.
    b. Consider use of data mining software to identify potential SSIs which can then be further evaluated.
    c. Consider leveraging existing electronic health record capabilities to provide process measure information that informs improvement approaches.[2]

POST OPERATIVE INTERVENTIONS FOR REDUCTION OF RISK OF SURGICAL SITE COMPLICATIONS

A. Covering surgical incisions with an appropriate interactive dressing at the end of the operation
B. Maintenance of the dressing over the incision for at least 48 hours unless there are signs and symptoms indicating earlier inspection is warranted
C. Cryotherapy (i.e. application of ice) and compression for certain wound types
D. Visitor restrictions and hygiene measures (e.g. hand hygiene and protective clothing as appropriate if delivering direct patient care)
E. Monitoring incision for healing progress and signs/symptoms of infection
F. Use of correct dressing removal techniques as per manufacturers' guidance (e.g. do not peel back, look and reapply)
G. Use of Patient Reported Outcome/Experience Measures (PROMS/PREMS) or questionnaires
H. Correct moving and handling of the patient to prevent mechanical stress and dehiscence (using specialist equipment if required)
I. Fostering good communications and training between acute and community working (e.g. comprehensive documentation, Photo at Discharge initiative)

GAS DISINFECTION AFTER SURGERY ON PATIENT WITH INFECTION

Gas disinfection may be implemented, using mobile devices, preprogrammed for the volume of the room, and which is measuring the gas concentration down to 0 ppm—before the room is opened. Dry hydrogen peroxide 5% may be used where high water vapour concentration may damage—corrode— instruments. Three disinfection cycles and spore test are used routinely to check the effects; spores will be killed by the gas. Disinfection time is 3–5 h. No gas type has been proven effective against *Mycobacterium tuberculosis*. [4]

STRATEGIES TO REDUCE SSI RISKS IN THE COMMUNITY

CONTINUITY OF CARE

Continuity of surgical site management post-discharge is key. However, colleagues in primary care and community services often report difficulties in obtaining secondary care surgical expertise following discharge [3]

HEALTHCARE EDUCATION

Guidance for care of complications post discharge from surgical services is required. Infection prevention and control (IPC) pathways and roadmaps can enable all staff to contribute to a healthcare culture in which patient safety is of the highest importance. [3]

REFERRAL

If SSI is suspected once a patient has been discharged, local referral pathways to a relevant outpatient surgical clinic should be considered. [3]

DRESSING CHANGE TECHNIQUE

Ideally, dressing change should be undertaken in a clean area with minimal air disturbance; for example, as opposed to a busy ward at peak activity. Standard infection control precautions for dressing change technique include the use of a medical adhesive remover to reduce pain and skin damage, if necessary. It is important that

clinicians caring for wounds exercise strict asepsis in order to minimize risk of SSI. The Aseptic Non Touch Technique (ANTT) is advised for wounds healing by primary intention. After 48 hours, non-sterile gloves can be used; if the wound is already contaminated, sterile gloves will be redundant. [3]

PATIENT SELF-CARE

Instructions for self-care of the surgical site should be in a suitable format for the patient, taking into account the patient's willingness and capacity for involvement in their own care. Some patient groups may require specific assistance, such as those with wounds in anatomical locations that they would struggle to inspect themselves, or people with cognitive decline who may tamper with dressings and increase infection risk. Where self-management and monitoring is not possible, carer(s) and family member(s) may help to identify the signs and symptoms of infection. [3]

ERAS PROGRAM

The new infection prevention initiative leveraged the strength of the hospital's Enhanced Recovery After Surgery (ERAS) program. An ERAS pathway is an evidence-based protocol that standardizes care to minimize surgical stress and postoperative pain, reduce complications, improve outcomes, decrease hospital length of stay and expedite recovery following elective procedures. Under the umbrella of the ERAS program, UT Southwestern's infection prevention initiative implemented a number of interventions, each targeted at evidence-based causes of SSIs, including:

- Giving oral antibiotics with the patient's mechanical bowel preparation
- Identifying the best antibiotic to use, as well as optimal timing and redosing for colorectal surgery, with the guidance of UT Southwestern's antibiotic stewardship committee
- Using chlorhexidine baths, a cleaning product that kills germs, prior to the surgery and wipes to the abdomen immediately prior to the operating room to decrease bacteria on the skin
- Improving access to critical medications by storing the antibiotics directly in each operating room's "pyxis" machines, which hold and distribute the anesthetic drugs
- Requiring the surgical team and their assistants (scrub techs and residents) to change their gowns and gloves when the surgery was completed and they were about to close the wound, assuring no contamination from the surgical site got into the sterile areas of the wound
- Actively warming patients both prior to and during the surgery, which has been shown to decrease the risk of wound infections
- Increasing patient mobility as soon as possible after surgery, for example sitting up in a chair the day of surgery and walking in the hallways up to three times as soon as possible, which decreases the risk of infection

CONCLUSION

Largely avoidable with proper infection control measures, SSIs occur either during or up to 30 days after a surgical procedure. SSIs often need to be treated with additional antibiotics, and may require interventional procedures or even re-operation. SSIs can lead to major complications, including death, as well as significantly increase the cost of care.

It is estimated that, at the very least, 5% of patients who undergo surgery develop a surgical site infection (SSI). There has been much interest in the use of negative pressure wound therapy (NPWT) as a prophylactic treatment to reduce the risk of SSI. Evidence suggests it can accelerate healing times, reduce both the length of hospital stay and the frequency of dressing changes, and improve patients' quality of life. The efficacy of traditional and portable NPWT systems is similar. However, the latter has an advantage in that it increases patient mobility and does not hinder individuals from carrying out activities of daily living. There are also economic data suggesting that portable NPWT devices are associated with long-term cost saving.[12] Our results suggest that wound protectors reduce rates of SSI after gastrointestinal and biliary surgery.[9]

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