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Review Article

Surgical Site Infections is the Concerning Issue in Pakistan: A Review Article

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Abstract: *Surgical Site Infections (SSIs) are a significant healthcare-associated infection, particularly in low- and middle-income countries (LMICs) like Pakistan. This review article evaluates the incidence, prevalence, risk factors and role of medical devices in surgical site infections. A literature review was conducted to assess the incidence, risk factors, and preventive strategies for SSIs. Studies comparing povidone-iodine (PI) and chlorhexidine gluconate (CHG) for skin antisepsis, normothermia and data on the effectiveness of sterile surgical attire and negative pressure wound therapy were analysed. SSI rates in LMICs range from 8-30%, compared to 1-4% in high-income countries. Risk factors include patient-related variables (e.g., malnutrition, immunosuppression), surgical factors (e.g., contamination, poor sterilisation), and physiological factors (e.g., postoperative hypoxia). CHG combined with alcohol-based preparations is more effective than PI. Maintaining normothermia, proper sterilisation, and using disposable medical equipment can reduce SSI rates. Preventive strategies include training on CHG use, mandatory disposable sterile drapes and gowns, adherence to AST and AORN guidelines for surgical attire, and continuous education for perioperative staff. Implementing comprehensive CHG combined with alcohol-based preparations, normothermia, negative pressure wound therapy, ongoing education programs, and robust preventive strategies are essential to reduce SSIs, especially in LMICs, improving patient outcomes and healthcare sustainability.*
Keywords: Incidence, Prevalence, SSI, AMR, CHG, Medical device, AORN, Pakistan

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Introduction

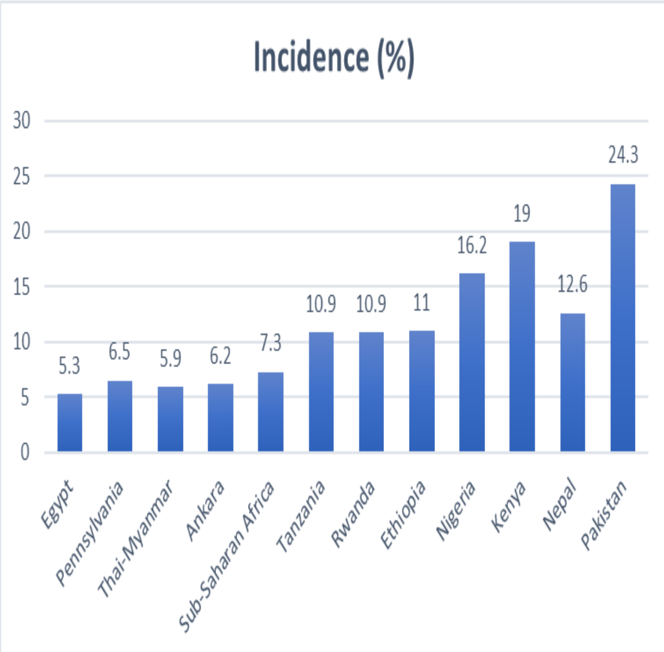
The Centers for Disease Control and Prevention (CDC) defines a Surgical Site Infection (SSI) as an infection occurring within 30 days after surgery. SSIs are classified into three categories: superficial incisional infections (primary and secondary), deep incisional infections (primary and secondary), and organ/space infections. (Kim et al., 2022). The Lancet Infectious Diseases reported that surgical site infections (SSIs) pose a major global challenge to healthcare systems and insurance providers. These infections are a leading postoperative complication worldwide, causing substantial patient morbidity and mortality and significantly increasing costs. Despite being highly preventable, SSIs impose a heavy financial burden on both patients and healthcare systems. (World Health Organization, 2011). Individuals with SSI experience pain, impairment, inadequate healing that increases the risk of hernias and wound collapse, prolonged healing periods, and psychological difficulties that result in increased resource utilisation (Badia et al., 2017). Even after considering patient and operation risk factors, patients in low- and middle-income countries (LMICs) are disproportionately impacted by greater incidence of SSI as compared to those in high-income countries. (Bhangu et al., 2018).

SSI Prevalence in Global:

Mortality within 30 days of surgery is the third largest contributor to global deaths (Nepogodiev et al., 2019). Surgical Site Infection (SSI) is linked to 38% of deaths in patients with SSI.(Monahan et al., 2020). The incidence rate of SSIs is significantly higher in low- and middle-income countries (LMIC) than it is in Western Europe's comparatively high-income countries (HICs) (Bowley et al., 2018) Here, the patient bears most of the hospital care cost. (Mills, 2014). Hospital-acquired infections (HAIs) that are preventable by recognised methods include surgical site infections (SSIs) in low- and middle-income countries (LMICs). Healthcare-associated infections are a significant threat to patient health globally, with surgical site infections (SSIs) being the most commonly reported. A meta-analysis analysed 43 articles across 39 countries, finding a global pooled SSI incidence of 2.5%. The highest incidence was in the African region at 7.2%. The findings underscore the need for improved safety measures and interventions to reduce SSIs and enhance patient safety. (Mengistu et al., 2023). SSI rates are falling in high-income nations with efficient operations, averaging 1-4 per cent. (Monahan et al., 2020). This reduction in SSI rates is not reflected in LMICs. SSI rates in LMICs range from 8 to 30% (Biccard et al., 2018).

Different rates of SSI post-cesarean section were reported in many countries: 16.2% in Nigeria (Monahan et al., 2020), 10.9% in Tanzania (Mpogoro et al., 2014), 19% in Kenya (Aiken et al., 2013) and 9.7% in Vietnam (Viet Hung et al., 2016). Also, SSI complicated 14.4% of CSs in Jordan (Abdel Jalil et al., 2017), 6.2% in Turkey (Çınar et al., 2016), 4.5% in Saudi Arabia (Alsareii, 2021) 10.9% in Rwanda (Mukagendaneza et al., 2019), 12.6% in Nepal (Shrestha et al., 2014), 11% in Ethiopia (Wodajo et al., 2017) and 24.3% in Pakistan (Jabbar et al., 2016) graphical representation of LMICs showed in figure 1. However, lower rates were reported in Israel at 3.7% (Salim et al., 2012) and in China at 3.34% (Lin et al., 2024). Meanwhile, in another study, this rate was found in 48.2% of cesarean deliveries (CDs) at a referral centre in Tanzania (De Nardo et al., 2016). In LMICs, Pakistan is the most affected country of SSI. There are many contributing factors, such as the lack of proper sterilisation of instruments, the CSSD department of a hospital not working correctly, the use of reusable linen surgical gowns, lack of knowledge about surgical attires, and lack of infection prevention training programs.

Figure: 1 Incidence of Surgical site infection in different countries



SSI Prevalence in Pakistan:

In Pakistan, the study conducted at Ayub Teaching Hospital found a 33.68% SSI rate among 95 patients, with higher rates in older, urban, obese, and diabetic patients and those with co-morbidities. Major risk factors included age, urban residency, obesity, diabetes, type and duration of surgery, and anaemia. Targeted interventions are essential to reduce SSIs in these high-risk groups. (Sattar et al., 2019). The study found a 9.6% SSI rate after cesarean sections among 874 women. Risk factors included older age, obesity, medical complications, labour during surgery, and multiple PV examinations. The majority of infections were superficial. Obstetricians should take precautions to mitigate these risks and reduce the incidence of SSIs (Bukhari et al., 2022).

Despite advancements, SSIs continue to increase morbidity and mortality. Effective prevention involves improving operating theatre environments, treatment, and patient factors. SSI surveillance and maintaining high operation theatre standards are crucial, though further research is needed to enhance infection control and surveillance practices (Fayyaz et al., 2023). According to this study, in a large Pakistan public hospital, 412 patients had a 29.8% SSI rate. Hospital-related variables, surgical procedures, and patients were important risk factors. The majority of SSIs occurred during exploratory laparotomies. Adherence to surgical protocols, hospital-based antimicrobial stewardship, and enhanced patient education and care at the ward level are all necessary to effectively prevent surgical site infections. (Khan, Fang, et al., 2020).

In a Pakistan tertiary care hospital, general surgery cases had an 8.84% SSI incidence, according to this study. Older patients, those with more extended preoperative hospital stays, longer surgical times, emergency surgeries, and higher ASA indices all had increased risks of surgical site infections (SSIs). The high rates can be attributed to inadequate resources, disregard for infection control recommendations, and inadequate sterilising procedures. (Ansari et al., 2019). Among 83 patients, the Lahore General Hospital study revealed a 27.71% SSI rate. Advanced age, urban residency, elective surgeries, obesity, co-morbidities, and anaemia were all linked to higher SSI rates. These high-risk groups should be the primary target of efforts to lower SSIs through enhanced patient care plans and infection control practices. (Nasir UB , Jawaid SN, Kharl RAK, Riaz N, Ullah MK, 2024). This multicentre prospective cohort study in Pakistan aims to determine the prevalence and risk factors of surgical site infections (SSIs) after elective procedures in nine subspecialties. The trial monitors 30-day SSIs and secondary outcomes, such as antibiotic-resistant infections and mortality, excluding patients with preoperative illnesses or emergency procedures. The findings will influence nationally adopted evidence-based guidelines for SSI prevention. (PakSurg Collaborative, 2023). Among 240 patients, the Bolan Medical Complex Hospital study revealed a 9.16% SSI rate. Older age, diabetes, wound type, length of surgery, hospital stay, and drain presence were important risk factors. Compared to clean wounds (3.57%), infections were substantially more common in dirty wounds (22.22%). Reducing SSIs requires addressing these issues. (Saeed et al., 2022).

SSI Risk Factors:

Pre-existing medical conditions, malnutrition, obesity, low serum albumin levels, age, smoking, and factors like immunosuppression (such as diabetes mellitus and radiation therapy) are key patient-related factors that increase the risk of secondary infections (Ansari et al., 2019). Surgery-related issues include contamination during the procedure, emergency surgeries, extended operation times, inadequate sterilisation, mishandling of instruments, and inadequate antiseptic preparation of the surgical site. (Isaacson et al., 2020). Physiological factors that increase the risk of surgical site infections (SSI) include severe trauma, hemodynamic instability, shock, extensive blood transfusions during surgery, and postoperative conditions such as hypoxia, hypothermia, and hyperglycaemia. (Ansari et al., 2019). Other independent predictors of SSI include abdominal surgeries, contaminated procedures, and three or more diagnoses upon hospital discharge. (Emil et al., 2015). Treatment costs and hospital stays are increased when SSI is not well managed and is not recognised promptly. Patients with SSI are more likely to die than those without SSI. (Khan, Khan, et al., 2020). Risk factors are highlighted in Figure 2.

Role of Medical Devices (Surgical attires) in SSI

In the operating room (OR), surgical site infections (SSI) are an ongoing source of concern. Patients who have skin incisions made for surgical procedures face the risk of getting serious or even deadly skin infections. (Spagnolo et al., 2013). Using disposable medical equipment can significantly lower the rate of surgical site infections. Let us examine SSIs in detail and discuss how single-use medical equipment might help prevent them. Clean surgical attire reduces bacterial contamination and SSI rates. Conflicting evidence exists on single-use vs. reusable gowns. Double gloving and surgical headgear can also reduce bacterial contamination. Further research is needed. (McHugh et al., 2014). Despite implementing stringent operating room attire policies, SSIs did not decrease. SSI rates increased post-implementation, with key predictors being preoperative infection, longer operative times, and contaminated wounds. Proving a significant SSI reduction through further study is impractical (Farach et al., 2018). The updated AORN “Guideline for Surgical Attire” emphasises the importance of wearing antimicrobial scrub attire, covering arms in restricted areas, managing personal items, and adequately laundering reusable attire. Adhering to these guidelines helps protect patients from microorganisms shed by perioperative personnel. (Cowperthwaite & Holm, 2015).

Healthcare personnel (HCP) attire plays a role in the cross-transmission of pathogens. Balancing professional appearance and practicality, this article reviews perceptions, evidence, and policies on HCP attire and offers recommendations, emphasising education and appropriately designed studies (Bearman et al., 2014). AORN's "Recommended practices for surgical attire" guide perioperative RNs in selecting, wearing, and laundering attire, emphasising evidence-based practices, proper laundering, and collaboration with vendors and managers for appropriate execution (Braswell & Spruce, 2012). This guide addresses OR protocols for diverse religious and cultural practices, including hijab, natural hair, and beards, aiming to update medical education while ensuring patient safety and considering COVID-19-specific PPE changes (Abdelwahab et al., 2021).

Al-Aamri et al. found insufficient evidence to suggest that healthcare workers wearing scrubs outside the operating theatre increases the incidence of surgical site infections, with no definitive support for or against the practice based on the available data. (Al-Aamri et al., 2024). Modern surgical gowns made from disposable materials mitigate bacterial strikethrough issues associated with cotton gowns, enhancing patient protection. Surgeons often use dual gloves in orthopaedic procedures to reduce intraoperative perforation risks, with outer gloves changed before incising to minimise fingertip contamination post-skin preparation. (Manley & McNamara, 2011).

This multicentre, cluster-randomised trial demonstrated that routinely changing gloves and instruments before abdominal wound closure significantly reduced surgical site infection (SSI) rates from 18.9% to 16.0%. This practice, showing robust benefits, should be widely implemented globally to improve surgical outcomes and reduce SSI incidence. (Ademuyiwa et al., 2022).

Stepping motion significantly increases airborne dust contamination in orthopaedic operating rooms, exceeding NASA100 cleanliness standards. Using non-dedicated shoes and unsterilised scrub uniforms poses a risk for surgical site infections. Further research is needed to validate the efficacy of dedicated footwear and sterilised clothing in preventing SSIs (Tateiwa et al., 2020).

The exposure of surgical instruments and fluids to a contaminated operating-room environment, inadequate sterilisation and disinfection practices, and breaches in aseptic technique can all contribute to developing surgical site infections. Adherence to evidence-based infection prevention and control measures is crucial to mitigate these risks. (Ronghe et al., 2023).

Role of chlorhexidine gluconate (CHG) in SSI

Implementing a preoperative bathing regimen with 4% chlorhexidine gluconate (CHG) reduced surgical site infection (SSI) rates from 7.2% to 3.5% per 1,000 surgeries on a military medical-surgical unit, suggesting potential infection control benefits warranting further research. (Scallan et al., 2020). Preoperative chlorhexidine reduces surgical site infections after total knee arthroplasty, especially in moderate and high-risk patients, but not significantly in low-risk individuals. While promising, further high-quality randomised controlled trials are necessary to strengthen these findings and establish definitive recommendations. (Wang et al., 2017).

Povidone-iodine combined with alcohol demonstrated superior effectiveness against anaerobic flora, including *Cutibacterium acnes*, in shoulder skin preparation compared to chlorhexidine-alcohol, emphasising its potential in preventing surgical site infections, though further clinical validation is needed. (Dörfel et al., 2021). Springel et al. conducted a randomised trial; chlorhexidine-alcohol and povidone-iodine showed comparable efficacy in preventing caesarean-related surgical site infections. Both preparations yielded similar infection rates, indicating povidone-iodine remains a viable option for preoperative skin antisepsis in caesarean deliveries. (Springel et al., 2017). A randomised controlled experiment comparing povidone-iodine with chlorhexidine gluconate (CHG) was carried out by Kunkel et al. The study showed that positive cultures with povidone-iodine incidence were seven times higher in the povidone-iodine group than in the CHG group. (Kunkle et al., 2015).

Role of Negative pressure wound therapy (NPWT) for the prevention of SSIs

Negative pressure wound therapy (NPWT) promotes wound healing by applying a vacuum to reduce inflammatory exudate and stimulate granulation tissue formation. This method is primarily utilised for complex wounds, such as diabetic foot ulcers and skin grafts, that either are not healing or are at risk of not healing. (Zaver & Kankanalu, 2023). In a multicentre randomised trial, incisional negative pressure wound therapy (iNPWT) did not lower the rates of surgical site infections (SSIs) following lower extremity bypass surgery. However, it significantly reduced wound dehiscence compared to standard dressings. No severe adverse events related to iNPWT were observed. (Rezk et al., 2024). A retrospective study of patients undergoing cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) for peritoneal malignancy revealed that negative pressure wound therapy (NPWT) notably decreased the rates of surgical site infections (SSIs) compared to standard postoperative dressings.

Multivariate analysis further validated the effectiveness of NPWT, emphasising its potential advantages for this patient group. (Nabata et al., 2024). A thorough meta-analysis of 13 studies with 8,495 cardiac surgery patients found that negative pressure wound therapy (NPWT) substantially decreases surgical site infections and shortens hospital stays compared to standard dressings. However, NPWT did not show a significant effect on superficial wound infections. Additional research is required to verify these results. (Tao et al., 2024)A meta-analysis revealed that the Grading of Recommendations Assessment, Development and Evaluation (GRADE) evaluation provides strong evidence that negative pressure wound therapy (iNPWT) effectively reduces surgical site infections (SSIs).

Trial sequential analysis (TSA) suggests that additional studies will unlikely alter the current reliable effect estimate. (Groenen et al., 2023). Costa et al.'s randomised clinical trial found no significant difference in deep surgical site infection rates at 30 or 90 days between incisional negative pressure wound therapy and standard wound dressings for lower limb fractures resulting from significant trauma. The results do not support negative pressure wound therapy in this scenario. (Costa et al., 2020).

Preventive strategies for SSI in Pakistan

- According to the Association of PeriOperative Registered Nurses (AORN) guidelines, microbial contamination of the surgical site can be decreased when perioperative nurses follow AORN guidelines (AORN 2014).
- Ensure proper sterilisation of instruments and adherence to aseptic techniques during surgeries to prevent contamination and subsequent infections.
- Address patient-related risk factors such as malnutrition, obesity, smoking, and diabetes through preoperative assessment and optimisation to reduce the likelihood of SSIs.
- In Pakistan, perioperative nurses used scrubs-based povidone-iodine (PI) to disinfect the skin. This surgical preparation was unable to make SSI alleviation.
- Maintaining normothermia during surgery further contributes to infection control, as does proper sterilisation and disinfection of the surgical environment.
- Adhering to the Association of Surgical Technologists (AST) Guidelines for surgical attire and drapes in the operating theatre is essential for minimising contamination and reducing SSI.

Develop and implement policies for continuous monitoring and adherence to infection control practices, including evidence-based protocols for surgical attire and antiseptic use.

Figure: 2 Risk factors of surgical site infection

Figure: 3 Role of surgical attires in SSI prevention.

Figure: 4 Preventive strategies for the prevention of SSI in Pakistan

Recommendation:

- Organize training sessions to decrease surgical site infections (SSI) in Pakistan by adhering to guidelines from the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), the Occupational Safety and Health Administration (OSHA), and the Association of Perioperative Registered Nurses (AORN).
- Conduct regular workshops and training sessions for perioperative nurses on the importance and techniques of using chlorhexidine gluconate (CHG) combined with alcohol-based skin preparation agents. Emphasise the efficacy of CHG over povidone-iodine in reducing microbial presence and preventing SSIs.
- Develop a policy mandating using disposable, sterile drapes and gowns in the operating theatre. Ensure that all surgical staff are trained on properly using and disposing of these items to minimise contamination and infection risks.
- Adopt the Association of Surgical Technologists (AST) Guidelines for surgical attire, including sterile gowns, gloves, and face masks. Regularly train surgical staff on proper donning and doffing techniques to maintain asepsis and reduce the incidence of SSIs.
- Continuous education is essential for preventing surgical site infections (SSIs). Regular training and workshops should be mandated for all perioperative staff to stay updated on the latest SSI prevention protocols, including proper aseptic techniques, effective use of antiseptics like chlorhexidine gluconate, and adherence to sterilisation standards.

Implementing a comprehensive, ongoing education program will ensure that healthcare professionals maintain high infection control standards, ultimately reducing the incidence of SSIs.

Conclusion

Surgical site infections (SSIs) are a significant global burden, particularly in low- and middle-income countries (LMICs). Patient risk factors include pre-existing medical conditions, malnutrition, and immunosuppression. Surgical factors like contamination and poor sterilisation also increase SSI risk. Preventive strategies include using chlorhexidine gluconate, maintaining normothermia, and proper sterilisation. Implementing negative pressure wound therapy and disposable medical equipment can further reduce SSI rates. Organise and conduct comprehensive training and workshops for perioperative staff, following guidelines to reduce surgical site infections (SSIs).

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Declarations

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All data generated or analysed during the study are included in the manuscript.
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The authors declared the absence of a conflict of interest.

Author Contribution

All authors contributed equally

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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