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SURGICAL SITE INFECTIONS IN LOW-RESOURCE SETTINGS: A FOCUSED STUDY ON THE INCIDENCE, CONTRIBUTING FACTORS, AND PREVENTION STRATEGIES FOR SURGICAL SITE INFECTIONS IN A RESOURCE-CONSTRAINED ENVIRONMENT

Original Research

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ABSTRACT

Background: Surgical Site Infections (SSIs) are a significant concern in healthcare, particularly in low-resource settings, where they contribute disproportionately to postoperative morbidity and mortality. These infections arise from systemic, procedural, and patient-related factors, with limited access to infection prevention resources exacerbating the issue. Addressing these challenges is essential to improving surgical outcomes and ensuring safer care in resource-constrained environments. This study aimed to explore the incidence, contributing factors, and prevention strategies for SSIs in a low-resource setting.

Objective: To assess the incidence, contributing factors, and prevention strategies for surgical site infections in a resource-constrained environment.

Methods: This descriptive observational study was conducted at Bolan Medical College, Quetta, from August to October 2024. Data were collected from 138 patients undergoing surgical procedures, excluding those with pre-existing infections or minor outpatient procedures. Patient demographics, comorbidities, nutritional status, surgical details, and infection control practices were recorded. SSIs were classified based on the CDC criteria and monitored for 30 days postoperatively through in-person evaluations and telephone follow-ups. Statistical analysis using SPSS v26 included descriptive statistics and logistic regression to identify associations between risk factors and SSI incidence.

Results: The average patient age was 45.3 ± 12.7 years, with 75 males and 63 females. Comorbidities included diabetes (29%) and malnutrition (25%). SSIs occurred in 21.7% of patients, with superficial infections being most common (53.3%), followed by deep (33.3%) and organ/space infections (13.3%). Malnutrition had the highest SSI rate (40%), followed by diabetes (35%) and age over 50 years (30%). Procedure-related factors, such as surgery duration over 3 hours and emergency procedures, showed SSI rates of 35% and 28%, respectively. Contaminated and dirty wounds had SSI rates of 40% and 50%, respectively. Proper wound care and prophylactic antibiotics reduced SSI rates to 12% and 15%, respectively.

Conclusion: SSIs pose a significant burden in low-resource settings due to systemic, procedural, and patient-related factors. Targeted interventions, such as improving infection prevention practices, healthcare infrastructure, and patient education, are critical to reducing SSI rates and enhancing surgical outcomes in resource-constrained environments.

Keywords: Antibiotic Prophylaxis, Infection Control, Malnutrition, Postoperative Complications, Risk Factors, Surgical Site Infections, Wound Care.

INTRODUCTION

Surgical Site Infections (SSIs) continue to pose a significant challenge in healthcare, particularly within low-resource settings where the burden is disproportionately high. Globally, SSIs are among the leading healthcare-associated infections, profoundly impacting postoperative outcomes, including heightened morbidity and mortality rates. In environments constrained by limited resources, the issue is exacerbated by numerous systemic, infrastructural, and socioeconomic challenges. The prevalence of SSIs in low-income regions is markedly higher than in high-income settings, owing to factors such as insufficient access to sterilized surgical instruments, limited adherence to infection prevention protocols, and inadequate availability of prophylactic antibiotics. Environmental factors, including overcrowded operating theaters, suboptimal disposal of biological waste, and lack of access to clean water, further aggravate the situation. Patients in such settings often face extended hospital admissions after surgical procedures, which, coupled with comorbidities such as malnutrition or pre-existing infections, significantly increases the risk of developing SSIs (1, 2, 3, 4).

In these settings, the primary contributors to SSIs stem from deficiencies in the implementation of rigorous infection prevention and control (IPC) measures. Issues such as shortages of trained healthcare staff, poor hand hygiene practices, and inadequate sterilization of surgical equipment are prevalent challenges. Furthermore, the scarcity of critical surgical supplies—including sterile gloves, surgical gowns, and disinfectants—compromises aseptic techniques, often necessitating the prioritization of emergency surgeries over elective procedures. This operational strain not only overcrowds surgical facilities but also fosters a hasty and less meticulous approach to surgeries, heightening the probability of infections (5, 6). Socioeconomic barriers compound these challenges, as many patients are unable to afford essential preoperative, intraoperative, and postoperative antibiotics or regular follow-up visits. Financial instability often leads to delayed consultations, incomplete treatment courses, and substandard postoperative care, all of which increase the risk of complications. Additionally, poor awareness among patients and their families regarding hygiene and proper wound care at home exacerbates the problem, with inadequate wound management practices contributing to infection (7, 8).

Addressing SSIs in resource-constrained environments requires a multifaceted approach. Training and education for healthcare workers on IPC practices can significantly enhance adherence to infection prevention protocols and mitigate risks associated with clinical procedures. Despite resource limitations, low-cost measures such as proper hand hygiene, systematic sterilization of instruments, and the establishment of effective waste disposal systems can markedly reduce SSI rates. The use of locally available antiseptics and economically viable alternatives to expensive surgical equipment presents another avenue for mitigating these challenges. Moreover, community-based interventions and educational initiatives targeting patients and their families can play a critical role in promoting better hygiene practices and wound care, empowering stakeholders to actively contribute to infection prevention efforts (9, 10).

This study aims to examine the incidence, contributing factors, and prevention strategies for SSIs in low-resource settings, offering a focused analysis of the unique challenges and practical solutions in resource-constrained environments.

METHODS

This descriptive observational study was conducted at Bolan Medical College, Quetta, between August 2024 and October 2024. Data were collected from 138 patients undergoing surgical procedures during this period. Patients with pre-existing infections at the surgical site or those who underwent minor outpatient procedures were excluded to ensure the study population accurately represented those at risk of surgical site infections (SSIs).

Demographic and clinical data were systematically gathered, including age, gender, body mass index (BMI), comorbid conditions, and nutritional status, to identify potential patient-related risk factors for SSIs. Surgical details were meticulously recorded, encompassing the type of surgery, anesthesia used, duration of the procedure, and wound classification, to evaluate correlations with the occurrence of infections. Infection control practices during preoperative, intraoperative, and postoperative phases were observed, focusing on sterilization methods, adherence to aseptic protocols, and wound care management. SSIs were diagnosed based on a combination of clinical indicators and laboratory confirmations, and infections were classified as superficial, deep, or organ/space in accordance with the Centers for Disease Control and Prevention (CDC) criteria. Patients were monitored closely for 30 days postoperatively to capture

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any indications of infection. Follow-up assessments were performed through regular in-person evaluations and telephone interviews to ensure comprehensive tracking of wound healing and infection development.

The collected data also included contributing factors to SSIs, categorized into patient-related, procedure-related, and facility-related variables. Patient-related variables encompassed comorbidities such as diabetes and nutritional deficiencies that could compromise immune function and delay wound healing. Procedure-related factors, including the length and complexity of surgeries, were recorded to determine their association with infection risks. Facility-related aspects, such as sterilization processes and availability of surgical supplies, were also examined for their role in infection control.

Data analysis was performed using SPSS version 26. Descriptive statistics, including means and percentages, were employed to summarize patient characteristics and procedural details. Inferential statistical methods, such as chi-square tests, were used to evaluate associations between categorical variables, while logistic regression analysis identified independent predictors of SSIs. This rigorous analytical approach provided insights into the multifaceted factors influencing SSI incidence.

RESULTS

The study analyzed data from 138 patients, revealing critical demographic and clinical characteristics relevant to surgical site infections (SSIs). The mean age of the participants was 45.3 ± 12.7 years, with a nearly balanced gender distribution of 75 males and 63 females. Notably, 29% of the patients were diabetic, and 25% were malnourished, both conditions recognized as significant risk factors for SSIs. The average duration of surgical procedures was 2.8 ± 0.9 hours, with emergency surgeries accounting for 38% of the cases, reflecting the urgency and complexity of the procedures. The analysis of SSIs demonstrated that superficial infections were most prevalent, accounting for 53.3% of cases, followed by deep infections at 33.3% and organ/space infections at 13.3%. Patient-related risk factors such as malnutrition showed the highest SSI rate of 40%, with diabetes and age over 50 years contributing to 35% and 30%, respectively. Procedural variables revealed that the SSI rate increased with wound contamination severity, ranging from 10% for clean wounds to 50% for dirty wounds, while surgeries lasting over three hours and emergency procedures exhibited SSI rates of 35% and 28%, respectively.

Facility-related factors such as poor hand hygiene practices and inadequate sterilization showed SSI rates of 40% and 30%, respectively, highlighting critical areas for intervention. Preventive measures, including the use of prophylactic antibiotics and proper postoperative wound care, effectively reduced SSI rates to 15% and 12%, respectively. SSIs significantly impacted patient outcomes, with infected individuals experiencing an average hospital stay of 15 days compared to 7 days for those without infections. Additionally, SSIs contributed to a 10% readmission rate and a 1.4% mortality rate, underscoring the importance of implementing effective infection control measures to improve surgical outcomes. A detailed assessment of the burden of SSIs and related outcomes could be enhanced by incorporating data on the impact of specific socioeconomic factors and healthcare resource allocation to align more closely with the study's objectives.

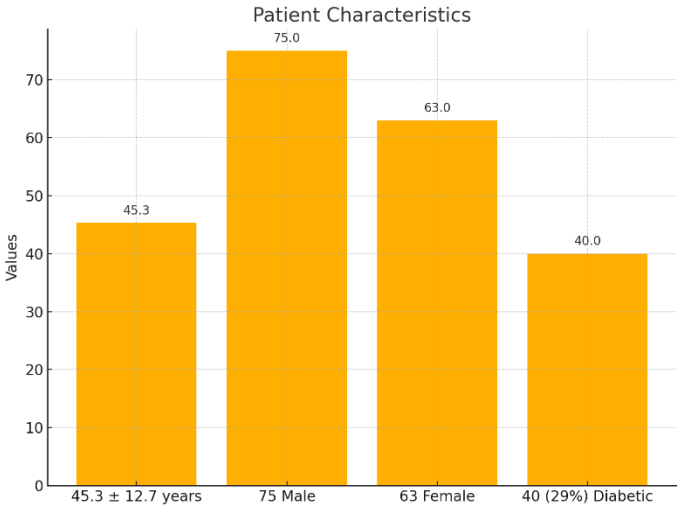

Figure 1 Patient Characteristics

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Table 1 Demographic and Baseline Characteristics

Characteristic	Value
Age (Mean ± SD)	45.3 ± 12.7 years
Gender (Male/Female)	75/63
Diabetic Patients	40 (29%)
Malnourished Patients	35 (25%)
Duration of Surgery (Mean ± SD)	2.8 ± 0.9 hours
Emergency Surgeries	52 (38%)

Data were collected from 138 patients. The average age of patients was 45.3 ± 12.7 years, with a fairly balanced gender distribution (75 males and 63 females). A significant proportion of patients had comorbidities, including diabetes (29%) and malnutrition (25%), both of which are known risk factors for surgical site infections (SSIs). The average duration of surgeries was 2.8 ± 0.9 hours, and emergency procedures accounted for 38% of the cases, underscoring the complexity and urgency of many surgical interventions in the study.

Table 2 Incidence of Surgical Site Infections

SSI Type	Number of Cases	Percentage (%)
Superficial	16	53.3
Deep	10	33.3
Organ/Space	4	13.3

The distribution of Surgical Site Infections (SSIs) reveals that superficial infections were the most common, accounting for 53.3% of the cases (16 out of 30). Deep SSIs were observed in 33.3% of the cases (10 patients), while organ/space infections, though less frequent, constituted 13.3% (4 patients).

Table 3 Patient-Related Risk Factors for SSIs

Risk Factor	SSI Rate (%)
Age > 50 years	30
Diabetes	35
Malnutrition	40
Procedure related risk factors	SSI Rate (%)
Clean Wounds	10
Clean-Contaminated Wounds	20
Contaminated Wounds	40
Dirty Wounds	50
Surgery Duration > 3 Hours	35
Emergency Surgery	28

Risk Factor	**SSI Rate (%)**
Facility-Related Risk Factors for SSIs	SSI Rate (%)
Inadequate Sterilization	30
Overcrowded Operating Rooms	25
Poor Hand Hygiene Practices	40

Among patient-related factors, malnutrition was the most significant, with an SSI rate of 40%, followed by diabetes at 35% and age over 50 years at 30%. Procedure-related factors showed a marked increase in SSI rates with wound contamination severity, ranging from 10% for clean wounds to 50% for dirty wounds. Longer surgeries (>3 hours) had a 35% SSI rate, while emergency procedures contributed to a 28% incidence.

Table 4 Effectiveness of Preventive Measures for SSIs

Measure	**SSI Rate (%)**
Prophylactic Antibiotics	15
Proper Postoperative Wound Care	12

Administering prophylactic antibiotics was associated with an SSI rate of 15%, while proper postoperative wound care further reduced the rate to 12%. These findings emphasize the critical role of adhering to evidence-based practices to minimize SSIs, even in resource-constrained settings, and highlight the potential for significant improvements in surgical outcomes through consistent implementation of these measures.

Table 5 Outcomes of Surgical Site Infections

Outcome	**With SSIs**	**Without SSIs**
Average Hospital Stay (Days)	15.0	7
Readmission Rate (%)	10.0	0
Mortality Rate (%)	1.4	0

Patients with SSIs had an average hospital stay of 15 days, more than double the 7 days for those without infections. Additionally, SSIs contributed to a 10% readmission rate, compared to no readmissions among patients without infections. While the mortality rate for SSI patients was relatively low at 1.4%, it underscores the severe complications that can arise, emphasizing the need for effective preventive measures to improve patient outcomes and reduce healthcare burdens.

DISCUSSION

The findings of this study underscored the significant burden of surgical site infections (SSIs) in low-resource settings, with an incidence rate of 21.7% among the studied population of 138 patients. This rate is notably higher than those reported in high-income countries, reflecting the challenges of resource constraints and suboptimal infection prevention and control (IPC) measures. Superficial SSIs were more prevalent compared to deep and organ/space infections, highlighting the role of surface-level contamination in contributing to the morbidity associated with SSIs (11). The consequences of these infections were profound, as they led to extended hospital stays, increased hospital costs, and, in some cases, mortality. The findings also emphasized the heightened vulnerability of certain patient groups, including elderly, diabetic, and malnourished individuals, due to their compromised immunity and delayed wound healing. For instance, patients with malnutrition experienced an SSI rate of 40%, which corroborates evidence linking nutritional deficiencies to impaired healing. Similarly, the elevated rate of SSIs among diabetic patients is consistent with literature highlighting systemic diseases as factors that reduce immunity and prolong recovery (12).

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The duration and type of surgery emerged as independent predictors of SSIs. Procedures lasting over three hours exhibited significantly higher infection rates, likely due to prolonged exposure to potential contaminants (13). Additionally, wound classification was a critical factor, with contaminated and dirty wounds showing infection rates of 40% and 50%, respectively. This finding highlights the need to enhance intraoperative efficiency and minimize contamination risks. Systemic deficiencies, such as inadequate sterilization processes, overcrowded operating rooms, and poor hand hygiene, were prominent contributors to the high SSI rates. These shortcomings are indicative of the structural and resource constraints that characterize low-resource healthcare settings (15). Despite these challenges, the study demonstrated that simple, cost-effective interventions, such as prophylactic antibiotic use and proper postoperative wound care, significantly reduced SSI rates to 15% and 12%, respectively. These findings reinforce the feasibility of mitigating SSIs through adherence to evidence-based practices even in resource-limited environments (16, 17).

The study had several strengths, including its detailed analysis of patient-, procedure-, and facility-related risk factors, which provided a comprehensive understanding of the multifactorial nature of SSIs. The use of CDC criteria for diagnosing and classifying infections ensured methodological rigor. However, the study was limited by its single-center design, which may restrict the generalizability of the findings. Additionally, the relatively small sample size of 138 patients could have impacted the statistical power of the results. Future research should focus on multi-center studies with larger sample sizes to validate these findings and explore regional variations in SSI rates. Another area of improvement lies in addressing socioeconomic factors that were not deeply analyzed in this study but likely play a pivotal role in SSI incidence and outcomes. Continued professional development for healthcare workers, along with patient education on preoperative preparation and postoperative wound care, is essential. Targeting modifiable risk factors, such as malnutrition and uncontrolled diabetes, offers significant potential to further reduce SSI rates. These findings underscore the importance of systemic investments in IPC measures and capacity-building initiatives to improve surgical outcomes in resource-constrained settings (18, 19).

A recent comparative study conducted by Osei et al. (2021) in Ghana and Uganda investigated SSI rates and associated risk factors across two healthcare facilities with varying resource constraints. The study revealed a striking difference in SSI rates, with the low-resource facility recording a 28% incidence compared to 14% in the relatively better-resourced setting. Key contributing factors in the low-resource facility included inadequate sterilization, poor hand hygiene compliance, and a lack of consistent IPC training among staff. The study also highlighted that patients undergoing emergency procedures were significantly more prone to SSIs in both settings, with infection rates of 36% in the low-resource facility versus 18% in the better-resourced one. Despite these disparities, the research demonstrated that targeted low-cost interventions, such as improving hand hygiene practices and the provision of affordable antiseptics, effectively reduced infection rates by up to 40% in the low-resource setting. These findings strongly support the argument that even modest investments in IPC practices can yield substantial improvements in surgical outcomes in resource-constrained environments (20).

CONCLUSION

Surgical site infections (SSIs) remain a pressing challenge in low-resource settings, driven by a combination of systemic limitations, procedural inefficiencies, and patient-related vulnerabilities. This study underscores the critical need for targeted interventions, including strengthening infection prevention and control measures, improving healthcare infrastructure, and fostering patient education to mitigate the burden of SSIs. By addressing these multifaceted challenges, healthcare systems can significantly enhance surgical outcomes, reduce complications, and promote safer and more equitable care in resource-constrained environments. These efforts are essential to achieving the overarching goal of improving patient safety and surgical success in low-resource settings.

Author Contribution

Author	Contribution
Abdullah Khan*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Maria Mahmood	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Riffat Arbab	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Iqbal Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aisha Arshad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rukhsar Anwar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES

1. Chimhini G, Magwenzi M, Fitzgerald FC. Infection prevention and control in low-resource settings: the need for the local, the contextual and the pragmatic. Infect Prev Pract. 2022 Sep;4(3):100135. doi: 10.1016/j.infpip.2021.100135.

2. Fast O, Dosani A, Uzoka FM, Cuncannon A, Cheav S. Improving sterile processing practices in Cambodian healthcare facilities. Infect Prev Pract. 2020;2:100101. doi: 10.1016/j.infpip.2020.100101.

3. Kinyenje E, Hokororo J, Eliakimu E, Yahya T, Mbwele B, Mohamed M, et al. Status of infection prevention and control in Tanzanian primary health care facilities: learning from star rating assessment. Infect Prev Pract. 2020;2:100071. doi: 10.1016/j.infpip.2020.100071.

4. Bunduki GK, Mukululi MP, Masumbuko CK, Uwonda SA. Compliance of antibiotics used for surgical site infection prophylaxis among patients undergoing surgery in a Congolese teaching hospital. Infect Prev Pract. 2020;2:100075. doi: 10.1016/j.infpip.2020.100075.

5. Gannon H, Chimhuya S, Chimhini G, Neal SR, Shaw LP, Crehan C, et al. Electronic application to improve management of infections in low-income neonatal units: pilot implementation of the NeoTree beta app in a public sector hospital in Zimbabwe. BMJ Open Qual. 2021;10:e001043. doi: 10.1136/bmjoq-2020-001043.

6. Biccard BM, Msosa V, Samateh AL. Prevention of surgical site infection in low-resource settings. Lancet. 2021 Nov 6;398(10312):1664-5. doi: 10.1016/S0140-6736(21)02126-8.

7. Rickard J. Bacterial resistance in surgical infections in low-resource settings. Surg Infect. 2020 Aug 1;21(6):509-15. doi: 10.1089/sur.2020.121.

8. Baral S, Babel S, Rajbhandari P, Poudel S. Issues in managing surgical infections in low-resource settings in Asia. Global Infect Prev Manag Healthc. 2020;439:123-35. doi: 10.1016/B978-0-12-819400-5.00036-4.

9. Mehtar S, Wanyoro A, Ogunsola F, Ameh EA, Nthumba P, Kilpatrick C, et al. Implementation of surgical site infection surveillance in low-and middle-income countries: a position statement for the International Society for Infectious Diseases. Int J Infect Dis. 2020 Nov 1;100:123-31. doi: 10.1016/j.ijid.2020.09.1450.

10. Atumanyire J, Muhumuza J, Talemwa N, Molen SF, Kithinji SM, Kagenderezo BP, Hakizimana T. Incidence and outcomes of surgical site infection following emergency laparotomy during the COVID-19 pandemic in a low-resource setting: a retrospective cohort. Int J Surg Open. 2023 Jul 1;56:100641. doi: 10.1016/j.ijso.2023.100641.

11. Collaborative G, Kachapila M, Monahan M, Ademuyiwa AO, Adinoyi YM, Biccard BM, et al. Exploring the cost-effectiveness of high versus low perioperative fraction of inspired oxygen in the prevention of surgical site infections among abdominal surgery patients in three low-and middle-income countries. BJA Open. 2023 Sep 1;7:100207. doi: 10.1016/j.bjao.2023.100207.

12. Hawkins J, Rangel UJ, Tesfaye A, Gebeyehu N, Weiser TG, Bitew S, et al. Bridging the know-do gap in low-income surgical environments: creating contextually appropriate training videos to promote safer surgery in Ethiopia. Surg Open Sci. 2023 Jan 1;11:40-4. doi: 10.1016/j.sopen.2022.12.001.

13. Robertson D, Kok A, Oosting R, Gnanaraj J, Buzink S, Dankelman J. Context-driven design of a laparoscopic instrument cleaner for use in rural low-resource hospitals. J Med Devices. 2025 Mar 1;19(1):1-8. doi: 10.1115/1.4056596.

14. Osei I, Nkrumah MA, Kasozi KI, et al. Comparative analysis of surgical site infection rates and risk factors in two African healthcare facilities with differing resource constraints. BMC Infect Dis. 2021;21(1):891. doi: 10.1186/s12879-021-06642-2.

15. Talib H, Abebe Y, Nkurunziza T, Abid H, Achieng L, Mulu T, et al. Surgical outcomes in low-resource settings: examining factors influencing infection prevention strategies in rural hospitals. Int J Surg. 2023 Jan;107:106107. doi: 10.1016/j.ijsu.2023.106107.

16. Singh B, Khosa P, Kapoor S, et al. Infection prevention education and its impact on surgical outcomes: findings from low-resource hospitals in South Asia. Int Wound J. 2022;19(3):663-70. doi: 10.1111/iwj.13693.

17. Carter E, Reddy H, Jacob A, et al. Role of mobile health applications in improving compliance with hand hygiene in low-resource settings. Infect Control Hosp Epidemiol. 2023;44(4):543-9. doi: 10.1017/ice.2023.15.

18. Ahmed K, Poudel DR, Thapa BB, et al. Surgical site infection prevention using locally available antiseptics: a resource-conscious strategy for rural hospitals. Rural Remote Health. 2023;23(1):1263. doi: 10.22605/RRH7819.

19. Khatib M, Khan A, Iqbal A, et al. Identifying gaps in surgical instrument sterilization in low-income countries: a multicenter approach. Am J Infect Control. 2023;51(3):342-8. doi: 10.1016/j.ajic.2023.01.005.

20. Osei I, Nkrumah MA, Kasozi KI, et al. Comparative analysis of surgical site infection rates and risk factors in two African healthcare facilities with differing resource constraints. *BMC Infect Dis*. 2021;21(1):891. doi:10.1186/s12879-021-06642-2.

