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Original Article

Survey of surgical site infections at Peltier general hospital (Djibouti): risk factors and prevention practices

Talal Mohamed Abdoul-Latif[1,2], Mustapha Elhanine[1], Alaeddine Lakhrissi[1], Fatouma Mohamed Abdoul-Latif[3], Zineb Benhadi[1], Tarik Ainane[4], Nadira Abdallah[2], Ayoub Ainane[4], Naoufal Himmouche[1], Abderraouf Hilali[1], Jawad Bouzid[1*]

[1]Health Sciences and Technologies Laboratory, Higher Institute of Health Sciences, Hassan First University, Settat, Morocco. [2]Institut Supérieur des Sciences de la Santé (ISSS), Djibouti City, Djibouti. [3]Medicinal Research Institute, Center for Research and Study of Djibouti, Djibouti City, Djibouti. [4]Superior School of Technology, University of Sultan Moulay Slimane, Khenifra, Morocco.

Correspondence: Jawad Bouzid, Health Sciences and Technologies Laboratory, Higher Institute of Health Sciences, Hassan First University, Settat, Morocco. jawad.bouzid@uhp.ac.ma

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ABSTRACT

Surgical site infections (SSIs) have been identified as a major problem at Peltier General Hospital, a medical facility in Djibouti known for its management of complex surgical cases. This study was conducted to assess the incidence of SSIs in different surgical departments, identify associated risk factors, and review infection prevention practices. A descriptive cross-sectional study was conducted among 417 patients and 55 nurses between September and December 2023. The incidence of SSIs was observed to vary across departments, with a rate of 26.8% in urology and 6.8% in orthopedics. Among the main risk factors identified, diabetes was associated with a 3.5-fold increased risk, while chronic diseases increased this risk by 2.8 times. The analysis revealed deficiencies in infection prevention practices, particularly regarding hand hygiene and management of invasive devices. Logistic regression showed that diabetes, chronic diseases, and complex surgical procedures were significant independent risk factors. This study highlighted the importance of implementing targeted prevention strategies, improving the training of medical staff, and reinforcing the application of strict protocols in high-risk departments. These results provide valuable information for improving infection management in healthcare settings, particularly those with limited resources. Further research was recommended to refine SSI prevention practices.

Keywords: Surgical site infections, Risk factors, Infection prevention, Postoperative care, Medical practices, Incidence study

Introduction

Peltier General Hospital, located in central Djibouti, represents a leading reference in the national healthcare system. This university hospital plays a fundamental role in providing specialized medical care, with particular attention paid to the management of complex surgical cases. As a high-level healthcare center, Peltier Hospital serves not only the local population but also patients from neighboring regions, who seek care ranging from routine surgeries to specialized and high-risk procedures. However, within this demanding medical environment, surgical site infections (SSIs) are a frequently encountered and particularly concerning complication in surgical practice [1].

Surgical site infections occur when a pathogen infects the skin incision or deep tissues treated during surgery. They are responsible for significant postoperative morbidity, contributing to longer hospital stays, the need for additional treatments, and a substantial increase in healthcare costs [2]. These infections, when poorly controlled, can impair surgical outcomes, increase

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the risk of serious complications, and, in some cases, cause systemic infections such as sepsis, with potentially fatal consequences [3]. Therefore, their prevention and management are top priorities in any hospital.

At Peltier General Hospital, where pressure on medical and human resources is particularly high, controlling surgical site infections becomes even more essential. Rigorous management of these complications would not only preserve patient health, but also control costs and optimize available resources. SSI prevention therefore becomes a central objective for maintaining the quality of care in this institution, while ensuring rational use of hospital infrastructure. Studying the incidence of postoperative infections in the hospital is of paramount importance. Such an analysis would provide a better understanding of the scope of the phenomenon in this specific context, identify risk factors inherent in the population being treated, and assess the effectiveness of existing infection prevention and control practices [4]. The local data obtained would be used to formulate recommendations tailored to the hospital's reality, contributing to the development of more effective prevention strategies and the continuous improvement of surgical practices.

Surgical site infections are a common complication in hospitals, both in well-equipped facilities and those with more limited resources, such as Peltier General Hospital [5]. Their impact on patient health is considerable. They can lead to serious complications, such as delayed healing, the need for additional surgical interventions, and even systemic infections that can lead to death [6]. Furthermore, these infections often require prolonged treatment, including the administration of additional antibiotics, intensive wound care, and, in some cases, extended hospital stays. These treatments, in addition to causing patients physical suffering, also prolong recovery time and affect their postoperative quality of life.

Economically, surgical site infections represent a considerable financial burden for healthcare systems. Direct costs are high, including the therapeutic management of infections, increased use of human resources for managing complications, and prolonged hospital stays [7]. In addition, significant indirect costs are generated by patients' lost productivity due to prolonged absence from work, as well as potential legal claims related to medical errors. In fragile healthcare systems, such as Djibouti's, these additional costs can quickly become unsustainable.

Surgical site infections also have a significant impact on the reputation of healthcare facilities. High infection rates can reduce public confidence in healthcare services, which could decrease hospital attendance, thus affecting the overall performance of the healthcare system [8]. It is therefore essential to implement robust infection prevention and control strategies to protect patient health and maintain public trust. In this context, the objective of this study is to collect valuable local data on the incidence of surgical site infections at Peltier General Hospital, identify risk factors specific to this institution, and formulate recommendations for improving infection prevention and management practices.

The study will focus in particular on quantifying the incidence of surgical site infections within the hospital's various surgical departments. This approach will not only identify the departments with the highest infection rates but also assess the effectiveness of current prevention practices. The study will focus particularly on the practices of nurses and surgeons, who play a central role in the management of postoperative care. Identifying gaps in knowledge and application of preventive measures will allow recommendations to be made regarding training and adjustment of care protocols [9]. In addition, a comparative analysis of care practices between different surgical departments, such as urology, orthopedics, visceral surgery, ENT-maxillofacial, and neurology, will allow for the targeting of specific interventions for each risk area. The study will adopt a cross-sectional methodology, collecting data on the incidence of SSIs, patient characteristics, and prevention practices. A descriptive analysis will be performed, taking into account various contextual factors that may influence the incidence of infections.

Materials and Methods

Research hypotheses

The proposed study is based on several overarching hypotheses to better understand the determining factors in the incidence of surgical site infections (SSIs). The first hypothesis posits that the incidence of SSIs varies across surgical departments. This variability could result from differences in the nature of surgical procedures, postoperative protocols applied, and department-specific characteristics. For this situation, departments performing complex surgical procedures or having a heavier workload, with patients presenting with a heterogeneity of pathologies, could be more exposed to higher infection rates. This situation could be explained by the diversity of patients treated, the high volume of procedures, and the complexity of the care required in these settings [10].

The second hypothesis explores the idea that comorbidities, such as diabetes, are a major risk factor in the development of SSIs. Diabetes, for example, impairs wound healing mechanisms and increases patients' vulnerability to postoperative infections due to prolonged hyperglycemia, which can reduce the immune response. Thus, assessing patients' comorbidities is a basic element in the infection risk management strategy and the personalization of preventive measures [11].

Finally, the third hypothesis addresses the influence of healthcare professionals', particularly nurses', adherence to infection prevention practices. Strict adherence to infection prevention protocols, including hand hygiene, management of invasive devices, and wound care, is essential to limit the incidence of postoperative infections. Indeed, the systematic application of these best practices is a fundamental pillar for ensuring patient safety post-surgery [12]. The objective of this study is to test these hypotheses through rigorous statistical analyses, while providing recommendations to optimize surgical care

management and strengthen infection prevention strategies at Peltier General Hospital.

Study design

The study was designed as a descriptive cross-sectional survey to analyze the incidence of surgical site infections (SSIs) among patients undergoing surgery in the various surgical departments of Peltier General Hospital. At the same time, the study evaluates the infection prevention practices adopted by healthcare staff, particularly nurses, to identify practices that influence the incidence of SSIs. The objective is to collect relevant data on the incidence of SSIs, characterize the associated risk factors, and analyze prevention practices to provide a solid basis for improving infection prevention protocols and clinical practices. The cross-sectional approach, ideal for assessing the frequency of pathologies at a given time, provides an immediate overview of the infection situation in the hospital without requiring long-term follow-up. This methodology is therefore particularly suited to an initial study aimed at establishing an overview of postoperative infections in a hospital setting such as Peltier General Hospital [13, 14].

Sample analysis and inclusion criteria

The study included 417 patients operated on in the surgical departments of Peltier General Hospital. No sampling was performed to ensure exhaustive and representative coverage of SSI incidence. In addition, 55 nurses working in these departments were also included in the study to assess their infection prevention practices. This approach provided a comprehensive overview of infection risks and the prevention strategies implemented in the hospital [15]. The inclusion criteria were as follows: patients who underwent surgery in the surgical departments of Peltier General Hospital during the study period and who gave their informed consent. Patients who refused to participate or who underwent surgery in other institutions were excluded to reduce bias and ensure the representativeness of the results in relation to the reality of this hospital.

Data collection and analysis

Specific tools were used to collect detailed information on patient demographics and medical characteristics, such as type of surgery, presence of comorbidities (such as diabetes), medical and surgical history, and postoperative care received. The incidence of surgical site infections was recorded for each patient, allowing for an in-depth analysis of risk factors. At the same time, a questionnaire was administered to nurses to assess their knowledge, attitudes, and practices regarding SSI prevention, focusing on aspects such as hygiene training, protocol compliance, and risk perception in their wards [16].

Data were collected over a four-month period, from September to December 2023. This period ensured complete coverage of all surgical wards and allowed for the identification of temporary factors that could influence the incidence of infections, such as seasonal variations.

Data analysis involved estimation of the incidence of SSIs by department, expressed as a percentage, followed by bivariate analysis using the Chi-square test to explore the relationships between risk factors and the incidence of infections. A logistic regression model was then applied to determine independent risk factors, analyzing the relationships between variables and the incidence of infections through odds ratios [17].

Results and Discussion

Data analysis began by assessing the incidence of surgical site infections (SSIs) in each surgical ward to determine the frequency of postoperative infections. This first step identified the most affected wards and highlighted possible variations between them. At the same time, bivariate and multivariate analyses were performed to explore the relationships between various risk factors, such as the presence of comorbidities, such as diabetes, and the likelihood of developing SSI. The results provide an overview of the current SSI situation in the hospital, with comparisons between departments and interpretations of the factors influencing the risk of infection. These data are essential for understanding the magnitude of the problem and making recommendations to improve infection prevention practices and the quality of postoperative care.

SSIs in different surgical departments

The analysis revealed significant variations in the incidence of SSIs between different surgical wards. For example, in the urology department, the incidence is 26.8%, linked to the complexity of the interventions and the frequent use of invasive devices. In orthopedics, the incidence is lower (6.8%), probably due to effective prevention protocols. The visceral surgery department has a rate of 15.9%, linked to the complexity of abdominal surgeries. The other departments also show variable rates, highlighting the importance of adapted clinical practices and strict infection management [18].

Table 1. Infection Rates of Surgical Site Infections (ISO) by Service, Patient Type, and Incidence Rate.

Category	Urology	Orthopedics	Visceral Surgery	ENT-Maxillofacial	Neurology	Total
Total Patients	41	117	176	39	44	417
ISO Positive	11	8	28	4	6	57
Incidence (%)	26.8	6.8	15.9	10.2	13.6	13.6
Diabetic Patients (Total)	8	9	22	6	4	100
Diabetic ISO Positive	6	3	14	2	2	30
% Diabetic ISO Positive	54.5	37.5	50.0	50.0	33.3	52.6
Non-Diabetic Patients (Total)	33	108	154	33	40	317

Non-Diabetic ISO Positive	5	5	14	2	4	27
% Non-Diabetic ISO Positive	15.2	4.6	9.1	6.1	10	8.5

Analysis of SSI risk factors

Analysis of risk factors for surgical site infections (SSIs) shows that several factors play a key role in the development of these infections. First, diabetes is identified as a major risk factor, with an SSI incidence of 30.0% in diabetic patients compared to 8.5% in non-diabetics [19]. This result was confirmed by a statistical test, showing a p-value significantly lower than 0.05. This suggests that diabetes impairs wound healing capacity and induces a state of low immunity, making patients more vulnerable to infections. The graphs in the analysis, including the bar chart and pie chart, illustrate this difference. The bar chart clearly shows that diabetics have a higher infection rate, despite a lower number of patients compared to non-diabetics. The pie chart highlights that, although there are more non-diabetic patients, diabetic patients represent a significant proportion of infection cases. Furthermore, a line graph comparing the number of positive and negative SAI cases between the two groups shows that, despite a higher number of non-diabetic patients, diabetics have a disproportionate number of infections. These results highlight the importance of strict diabetes management in surgical patients, particularly in terms of blood glucose control and increased monitoring for signs of infection [20].

Regarding medical history, the analysis reveals that patients with a history of abdominal surgery have a 20.0% incidence of SAI, compared to 10.5% for those without such a history. Similarly, patients with chronic conditions have a 20.0% incidence, while those without chronic conditions have only a 6.7% incidence. Although the association between abdominal surgery and SAI was not statistically significant ($p = 0.13$), chronic diseases showed a significant correlation with the development of SAI ($p = 0.01$) [21]. These results suggest that medical history and chronic diseases increase the risk of infection, justifying closer monitoring of affected patients during the postoperative period. Associated graphs, such as **Figure 1** showing the incidence of SAI by medical history and **Figure 2** detailing the number of positive and negative SAI cases by medical history, reinforce this analysis by highlighting the increased risks in these patients [22].

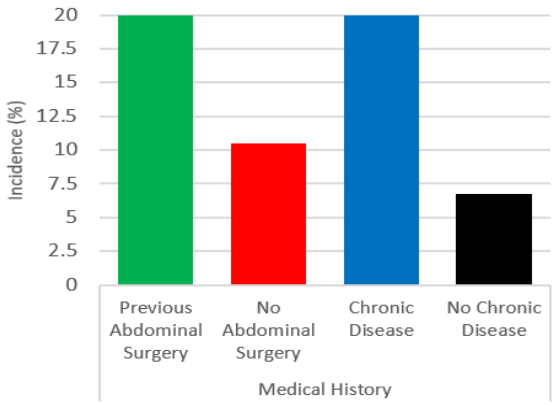

Figure 1. Incidence of SSIs by Medical History

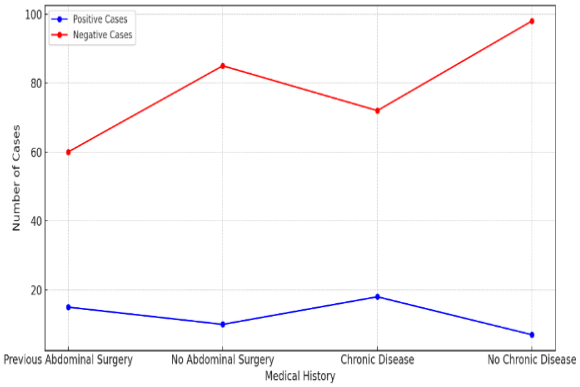

Figure 2. Number of SSI Positive and Negative Cases by Medical History

Studying the relationship between the number of dressing changes and the risk of infection shows that an increased risk of SAI occurs after multiple dressing changes, particularly after the second or third dressing change. This trend could be related to excessive wound handling, thus increasing the risk of contamination. These results highlight the importance of following strict protocols to minimize wound manipulation and maintain optimal sterility during postoperative care [23]. Taken together, these analyses suggest that diabetes, medical history, and postoperative care practices are one of risk factors for the development of ISC. Careful attention to these factors would improve infection prevention strategies and the quality of surgical care at Peltier General Hospital.

Questionnaire for nurses

The evaluation of the nurse questionnaire highlights the significant impact of hygiene training, perception of surgical site infection (SSI) risks, and adherence to preventive practices on optimizing prevention strategies in surgical departments. Regarding hygiene training, 70% of nurses reported having received hygiene training in the past three years, demonstrating institutional commitment to preventing nosocomial infections. This training is an important lever for improving professional practices. Indeed, 85% of trained nurses consistently adhere to infection prevention protocols, compared to only 60% of nurses who had not recently received training. A statistically significant correlation between training and adherence to protocols shows that hygiene training is essential for strengthening nursing practices and reducing the risk of infections [24].

The perception of SSI risk varies among nurses: 40% consider this risk to be "low," 35% "real," and 25% "major." This perception directly influences vigilance and daily preventive behaviors. A positive correlation ($r = 0.65$) between the perception of SSI risk and actual SSI rates observed in different departments suggests that nurses' perceptions correspond to the observed clinical reality [25].

Regarding adherence to preventive practices, 75% of nurses regularly follow recommended practices, and a significant negative correlation ($r = -0.72$) between adherence to preventive practices and SSI rates indicates that departments where nurses strictly adhere to protocols have lower infection

rates (**Figure 3**). These results highlight the importance of rigorously applying preventive measures, particularly hand hygiene, to limit surgical site infections [26].

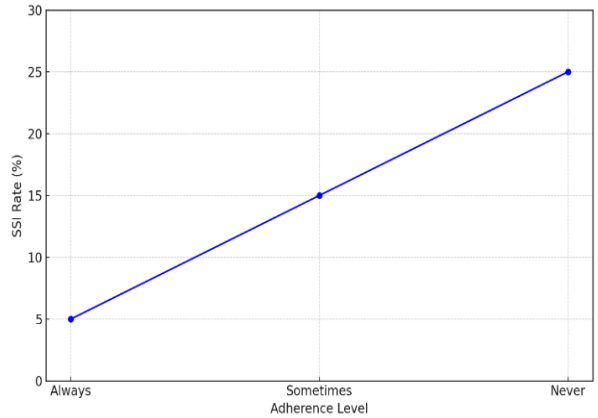

Figure 3. Adherence to Hand Hygiene Practices and Its Correlation with SSIs.

Multivariate analysis

Logistic regression model

Multivariate analysis using a logistic regression model identified independent risk factors associated with surgical site infections (SSIs). Variables considered in this model included conditions such as diabetes, medical history (including chronic diseases), patient age, type of surgery (complex or simple), and surgical department. The objective of this analysis was to assess the specific impact of each factor while controlling for other variables [27, 28].

The results showed that diabetes, history of chronic diseases, and surgical complexity were significant risk factors for the development of SSIs. Although patient age and surgical department showed less pronounced associations, these variables remain important in risk assessment [29].

Odds ratios (ORs) were used to estimate the risk of developing SSIs for each identified risk factor. Diabetic patients thus have a 3.5 times higher risk of developing ISC compared to non-diabetic patients, highlighting the major impact of diabetes on the probability of infection. Similarly, patients with a history of chronic diseases, such as cardiovascular or respiratory pathologies, have an increased risk with an odds ratio of 2.8, indicating that these underlying pathologies significantly increase the risk of infection [30].

Regarding the type of surgery, patients who underwent complex procedures are exposed to a 2.2 times higher risk of ISC than those who underwent simpler procedures [31]. This result highlights the need for enhanced preventive measures, particularly for high-risk surgeries. In contrast, patient age, although having a relatively moderate effect, has an odds ratio of 1.1, suggesting that advanced age does not significantly increase the risk of infection in this model [32]. Finally, the surgical department where the procedure took place showed an odds ratio of 1.3, indicating moderate variation in the risk of AIS by department. Although this association was less marked than that of other factors, it highlights the importance of specific protocols and increased vigilance within different departments to reduce the risk of infection. Adjustment for confounding variables, such as age and type of surgery, was essential to isolate the specific effect of each risk factor on the development of AIS. Although age did not show a strong direct association with AIS, it was necessary to adjust for it to prevent the results observed for diabetes and chronic diseases from being biased by an unequal distribution of ages between groups. Adjustment for surgery type confirmed that complex procedures, which inherently carry a higher risk, significantly contribute to the incidence of surgical site infections, independent of other factors such as diabetes or medical history.

The results of this multivariate analysis confirm that diabetes and a history of chronic diseases are significant independent risk factors for SSI. The high odds ratio for diabetes (3.5) highlights the importance of careful management of this condition in surgical patients, while the increased risk associated with chronic diseases (OR = 2.8) suggests that these patients require increased monitoring and tailored preventive measures. Surgery type, particularly for complex procedures, remains a determining factor, justifying the implementation of specific prevention protocols for these high-risk procedures. On the other hand, although age and surgical department have weaker associations with the occurrence of SSI, these variables should be considered in a comprehensive infection prevention strategy. Adjustment for confounding variables in this model allowed the isolation of the specific effects of the main risk factors, ensuring reliable and robust conclusions. These results provide clear indications for targeting preventive interventions, particularly for patients identified as high risk, and reinforce the need for management and prevention strategies tailored to each identified risk factor [33, 34].

Comparison with hypotheses

The results of this study validate some initial hypotheses while challenging others. A key hypothesis suggested that surgical departments had significantly different rates of ISC. This hypothesis was confirmed by the data, which revealed notable variations between departments. For example, the Department of Urology had the highest incidence of ISC (26.8%), while the Department of Orthopedics had the lowest rate (6.8%). These differences may be attributed to the complexity of surgical procedures, patient profiles, and clinical practices specific to each department [35].

Another key hypothesis posited that diabetes was a major risk factor for ISC. The results showed that diabetic patients indeed had a substantially higher risk of developing ISC, with an incidence of 30.0% compared to 8.5% in non-diabetic patients. This association, confirmed by a statistically significant chi-square test, supports the hypothesis that diabetes is an important risk factor for SSI [35].

Finally, the hypothesis regarding the influence of surgical and medical history on the risk of SSI was partially validated. Patients

with a history of abdominal surgery or chronic diseases showed a higher incidence of surgical site infections, although the association with previous abdominal surgery was not statistically significant [36].

Data analysis revealed several significant trends. The Department of Urology stands out for the highest incidence of SSI, probably due to the invasive nature of its procedures and the increased predisposition of patients, especially those with comorbidities such as chronic urinary tract infections [37-41]. The Department of Visceral Surgery follows with an incidence rate of 15.9%, probably due to the complexity of abdominal surgeries, which involve significant manipulation of internal organs and an increased risk of contamination. In contrast, the Orthopedics Department reported the lowest incidence rate, suggesting that its infection prevention protocols are well implemented. This positive trend could serve as a model for other departments, particularly in terms of strict adherence to aseptic protocols and the use of antibiotic prophylaxis [42].

Comparison of observed and predicted AIS rates provides good information on the hospital's infection control practices and the reliability of its predictive models. A close correlation between observed and predicted rates suggests that the hospital's predictive models are accurate and effective, indicating that patient risk factors, type of surgery, and adherence to infection prevention protocols are adequately taken into account to reflect real-life conditions [43].

The analysis of surgical site infections (SSIs) at Peltier Hospital provides results comparable to those of other international studies, while highlighting notable differences. The infection rates observed at this institution are consistent with global trends, particularly in low- and middle-income countries, where rates range from 5% to 30% depending on the type of surgery and local conditions. This underscores the importance of comparing local rates with those of international studies. If rates at Peltier hospital are similar to or lower than those observed elsewhere, this demonstrates the effectiveness of prevention practices. Higher rates, however, could indicate inadequacies in protocols, requiring a reevaluation of existing practices [44].

The results also allow for analysis of the influence of local factors, such as antimicrobial resistance and cultural postoperative care practices, which may influence infection rates. Antimicrobial resistance, present in the region, may explain higher infection rates and advocates for stricter antibiotic stewardship strategies [45]. This comparative analysis enriches the understanding of ISC, particularly in resource-limited settings such as Djibouti, and allows for the adaptation of local strategies to improve infection management [46].

The study highlights the need to strengthen infection management protocols in certain departments, particularly in the visceral and urological surgery departments, where infection rates are high, particularly due to the complexity of procedures and comorbidities, such as diabetes [47]. The latter factor increases patients' vulnerability to infection. In contrast, the orthopedic and ENT-maxillofacial surgery departments have lower infection rates than those reported in other studies, which may be attributable to more rigorous management of preventive measures, better staff training, and favorable local conditions. These departments demonstrate that appropriate and rigorous practices can significantly reduce infection rates [48-50].

The data from this study are relevant to Djibouti, where the prevalence of SSI is comparable to that of other resource-limited countries. However, local specificities, such as the high proportion of diabetic patients, influence these rates. This underscores the importance of developing specific strategies for the management of diabetes, a major risk factor for postoperative infections. The results can also be generalized to other African countries facing similar challenges in hospital care management and infection prevention [51].

The study confirms that prevention protocols must be adapted to local realities, particularly by taking into account patient comorbidities, the complexity of procedures, and environmental conditions. In Peltier, some departments have successfully reduced infection rates through rigorous risk management, staff training, and strict protocol enforcement. In the orthopedics and ENT departments, these practices have led to more satisfactory results, which could serve as a model for other facilities facing similar conditions [52, 53].

The results of this study confirm several hypotheses from the scientific literature. The incidence of infections varies across surgical departments, particularly in visceral and urological surgery departments, where infection rates are higher due to the complexity of procedures and comorbidities, including diabetes [54, 55]. The study also confirmed the impact of preventive practices, showing that departments that strictly adhere to sterility protocols have lower infection rates. However, gaps in protocol implementation were identified, particularly regarding the management of invasive devices and hand hygiene among healthcare staff, highlighting the importance of ongoing training and adherence to protocols to reduce infections [56-58].

Conclusion

This study aimed to examine the incidence of surgical site infections (SSIs) within Peltier General Hospital, analyzing the variations between different surgical departments. The results revealed significantly different incidence rates, with the urology department and the visceral surgery department recording high rates of 26.8% and 15.9%, respectively, while the orthopedics department had the lowest rate (6.8%). These results highlight the impact of surgical complexity and patient characteristics on the occurrence of SSIs. Risk factors identified include diabetes, which is strongly associated with an increased incidence of SSIs, and medical history, including chronic diseases. The analysis also highlighted variations in the implementation of infection prevention practices among nursing staff, with gaps in training and adherence to prevention protocols. The study partially validated the initial hypotheses, confirming the differences in SSI incidence between surgical departments and the correlation between diabetes and increased risk of infections. However, the hypotheses regarding the impact of surgical history and the effectiveness of nurses' prevention practices require further

research. The results of this study provide some informations to improve SSI prevention protocols, particularly in low- and middle-income countries. Future research should focus on longitudinal studies to better understand long-term risk factors and the effectiveness of specific interventions in high-risk departments. This study also provides a framework to adjust clinical practices and health policies, with an emphasis on the management of comorbidities such as diabetes and ongoing staff training.

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