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Original Article

Risk factors linked to surgical site infections: a prospective survey on an Albanian population following abdominal surgery

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Abstract

Introduction: Despite global improvements in perioperative care, surgical site infections (SSIs) continue to pose a significant burden, and data from Albania remain limited. This study aimed to determine the incidence of SSIs following abdominal surgery in an Albanian tertiary hospital and identify associated risk factors, microbiological profiles, and antimicrobial resistance patterns.

Methodology: A prospective observational study was conducted at the University Hospital Centre "Mother Theresa" in Tirana. A univariate and multivariate logistic regression adjusted for confounders was performed to identify factors associated with the development of SSIs.

Results: 1179 patients were enrolled in the study, with a mean age of 57.80 ± 16.16 years (range, 19-92 years), and 51.23% were male. 64 patients (5.43%) developed surgical site infections following abdominal surgery. The most frequently isolated microorganisms from infected surgical wounds were *Escherichia coli* and *Enterococcus faecalis*, identified in 39.0% and 22.0% of cases, respectively. The rate of SSIs was higher in patients undergoing lower gastrointestinal surgery compared to those having upper gastrointestinal procedures. As risk factors for developing SSIs in univariate regression analysis, age ≥ 50 years (OR: 2.69, 95% CI: 1.25–5.78), comorbidities (OR: 2.71, 95% CI: 1.53–4.83), and type 2 diabetes mellitus (OR: 2.98, 95% CI: 1.59-5.56) were identified.

Conclusions: Although the rate of SSIs after abdominal surgery has decreased, it remains a significant concern in Albania. Age, comorbidities, and lower gastrointestinal surgery are important risk factors. The findings emphasise the need for improved infection control and antimicrobial stewardship to reduce postoperative complications.

Key words: healthcare-associated infections; surgical site infection; abdominal surgery; risk factors; comorbidities; antimicrobial resistance.

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Introduction

Healthcare-associated infections (HAIs) remain a significant challenge in modern medicine, with a prevalence of 7.1% in European acute care hospitals [1], placing a substantial burden on both patients and healthcare systems [2,3]. Recent reviews and studies show that the prevalence of healthcare-associated infections varies significantly across regions, from 3.2% in the United States to as high as 27% in the WHO African Region [3].

Among the various types of HAIs, surgical site infections (SSIs) are among the most common, making up 16.1% of HAIs in hospitalised patients [1] and about 20% of all nosocomial infections in hospitalised patients undergoing surgery [4,5]. In African populations, they account for 41.6% of healthcare-associated infections [3].

A recent review showed that the rate of surgical site infections after abdominal surgery ranged from 4.09% to 26.7%, which is higher compared to other types of surgery [6]. The risk of SSIs following abdominal surgeries is increased because the risk of contamination is greater due to the proximity to the gastrointestinal tract [7].

Despite advances in surgical techniques, sterilisation practices, and antimicrobial prophylaxis, SSIs continue to compromise patient safety and clinical outcomes worldwide [8].

The consequences of SSIs are considerable: they are associated with prolonged hospital stays, increased postoperative complications, higher rates of hospital readmission, and even increased mortality [8]. Moreover, SSIs impose a substantial economic burden on healthcare systems, with treatment costs rising significantly in affected patients compared to those without infections [8,9].

Accurate surveillance and assessment of SSIs in abdominal surgery are crucial for reducing infection rates, and understanding the local epidemiology of SSIs provides an essential foundation for improving surgical quality, patient safety, and hospital performance metrics [10].

Additionally, SSI surveillance helps to reduce healthcare costs and optimise the utilisation of limited resources [8,11].

According to the ECDC Annual Epidemiological Report 2021–2022, surgical site infections remain a significant healthcare concern across European countries, emphasising the importance of ongoing surveillance and effective prevention strategies [2]. However, Balkan countries were not included in this surveillance, and neighbouring EU states such as Greece and Italy also did not participate, creating a significant gap in reported data for the Western Balkans and surrounding regions. This lack of information highlights the need for regional studies to better understand SSI epidemiology. Previous research on the prevalence of surgical site infections (SSIs) among Albanian surgical patients reported an SSI rate of approximately 13.3% [12]; however, in Albania, comprehensive assessments of SSI trends over the past fifteen years have been limited.

To address this, we surveyed to evaluate whether SSI incidence has changed over time, particularly following recent modifications to sterilisation protocols in surgical departments, which may have influenced postoperative infection rates [13]. Surgical instruments are now sterilised in a specialised, centralised centre serving the entire hospital, replacing the previous practice of autoclave sterilisation within individual surgical clinics. Monitoring SSI trends after these centralisation changes is crucial to assess their impact, identify potential gaps, and guide improvements in infection prevention strategies. Although our findings originate from a single tertiary care centre, they provide valuable insights that help fill the current gap in SSI surveillance in Albania and contribute essential data for the wider Western Balkans.

This study aimed to ascertain the incidence of surgical site infections (SSIs) in patients undergoing abdominal surgery and to identify the associated risk factors. The secondary aim involved analysing the microbiological profile and antibiotic sensitivity patterns of SSIs in this patient group.

Methodology

This prospective, observational study was approved by the National Agency for Scientific Research and Innovation (AKKSHI). It also received approval from the University of Medicine's Ethics Committee. The research was conducted at the University Hospital Centre "Mother Theresa" within the Department of General and Digestive Surgery III, during one year (October 2023-October 2024).

The study was conducted in accordance with the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent amendments. All data were anonymised before analysis.

The study involved consecutive patients who underwent abdominal surgery at the third clinic of the Department of General and Digestive Surgery during the study period. Informed consent was obtained from all participants before their surgery. Patients suspected of preoperative infections or those receiving antibiotic therapy at the time of surgery were excluded from the study.

Data were collected on patients' demographics, primary disease requiring surgery, other comorbidities (including diabetes mellitus, cardiovascular conditions, respiratory illnesses, and renal diseases), malignancies, type of surgery, and hospital length of stay.

All patients in our study received antibiotic prophylaxis in accordance with established hospital protocols. For elective procedures, patients underwent an antiseptic bath with chlorhexidine gluconate solution the night before surgery. If hair removal was necessary, it was performed in the operating theatre. Skin preparation was carried out using either topical chlorhexidine gluconate or iodine.

All enrolled patients were prospectively monitored for surgical site infections, microbiological culture results, and the microorganisms involved. Whenever an infection was clinically suspected after surgery, microbiological samples were taken from the wound or surgical drains. Antibiotic susceptibility was assessed using an antibiogram. The definition and classification of surgical site infections followed the CDC criteria [14].

Statistical analyses

Continuous variables were summarised as mean ± standard deviation (SD), while categorical variables were presented as counts (n) and percentages (%). To analyse the association between surgical site infections and other variables, univariate analysis and multivariate logistic regression adjusted for confounders were performed. Associations were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs). Chi-square tests were used to compare categorical data between groups, whereas Student's *t*-test or appropriate non-parametric tests were applied for continuous variables. Statistical significance was set at $p \leq 0.05$, and all tests were two-tailed. Data analysis was carried out using SPSS version 20.0.

Results

A total of 1179 patients were included in the study, comprising 48.77% females and 51.23% males, with a mean age of 57.80 ± 16.16 years (range, 19-92 years) (Figure 1).

A total of 64 patients (5.43%) developed surgical site infections following abdominal surgery, consisting of 37 males and 27 females.

Table 1 shows the demographic and clinical features of the patients with surgical site infections. Of them, 45 (70.31%) had comorbidities: 40.63% had one comorbidity and 29.68% had two or more.

The most common comorbidities were arterial hypertension, followed by type 2 diabetes mellitus. Additionally, 21 patients (32.81%) with SSIs were diagnosed with malignant diseases.

The most commonly isolated microorganisms from infected surgical wounds were *Escherichia coli*, found in 39.06% of SSI cases, and *Enterococcus faecalis*, present in 23.44% of cases.

The incidence of surgical site infections was higher in patients undergoing lower gastrointestinal surgery compared to those having upper gastrointestinal procedures. 57.81% of SSIs occurred after lower gastrointestinal surgery, while 42.19% occurred after upper gastrointestinal procedures.

Figure 2 shows that the average age of patients who developed SSIs was higher than that of patients who did not experience this postoperative complication, at 66.18 ± 14.85 (27-88) and 57.03 ± 16.06 (19-92) years, respectively ($p < 0.0001$).

Age ≥ 50 years was identified as a risk factor for developing SSIs in univariate regression analysis, OR: 2.69, 95% CI: 1.25–5.78, $p = 0.01$.

Patients with comorbidities faced a higher risk of developing SSIs; OR: 2.71, 95% CI: 1.53-4.83, $p = 0.0007$. Patients with type 2 diabetes mellitus had a greater risk of surgical site infections, OR: 2.98, 95% CI: 1.59-5.56, $p = 0.0006$.

Patients aged 50 years or older had higher odds of associated comorbidities compared to those younger than 50 years old, OR: 19.59, 95% CI: 11.39-33.71, $p < 0.0001$.

Males had a higher risk of developing SSIs compared to females, although this difference was not statistically significant; OR: 1.47, 95% CI: 0.90-2.41, $p = 0.12$.

In univariate regression analysis, age ≥ 50 years, comorbidities, and the presence of type 2 diabetes mellitus were linked to a higher risk of SSIs. However,

Table 1. Demographic information of patients who developed surgical site infections (SSIs) following abdominal surgery.

SSIs patients' data	n	%
Female	27	42.19%
Male	37	57.81%
Co-morbidities	45	70.31%
Arterial Hypertension	41	64.06%
Diabetes mellitus	18	28.12%
Cancer	21	32.81%
Lower GI surgery	37	57.81%
Upper GI surgery	27	42.19%
Microorganisms isolated from the SSI		
E. coli	25	39.06%
Enterococcus Faecalis	15	23.44%
Klebsiella pneumoniae	6	9.37%
Staphylococcus epidermidis	4	6.25%
Pseudomonas aeruginosa	3	4.69%
Staphylococcus Hominis	3	4.69%
Enterobacter cloacae	2	3.13%
Staphylococcus aureus	1	1.56%
Staphylococcus capitis	1	1.56%
Staphylococcus caprae	1	1.56%
Streptococcus B haemolyticus	1	1.56%
Citrobacter	1	1.56%
Corynebacterium	1	1.56%

Figure 1. Distribution of patients who developed surgical site infections according to age group.

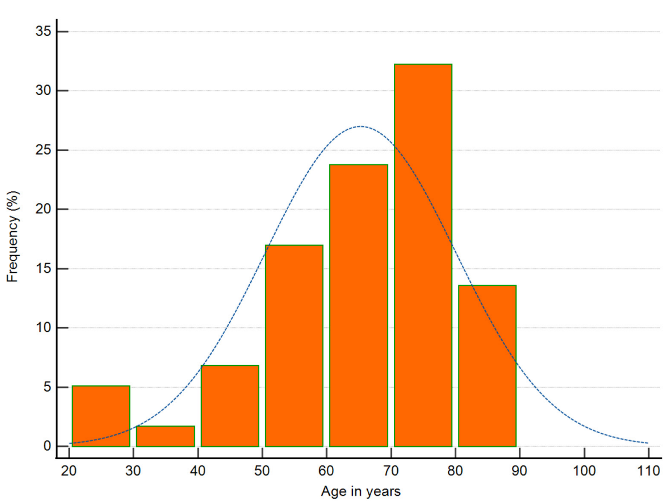
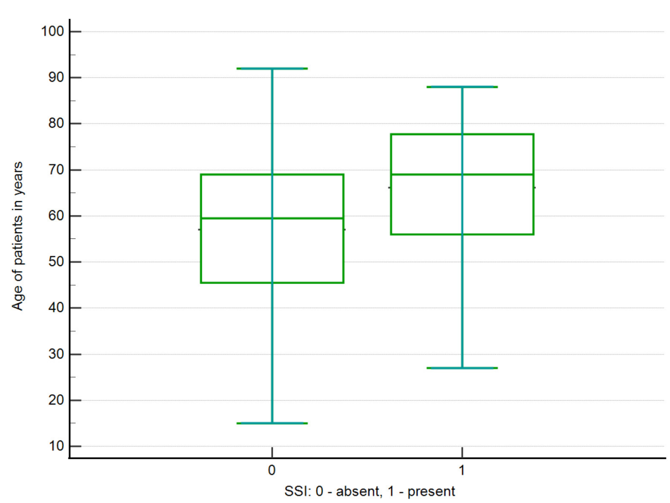


Figure 2. Comparison of patient ages according to the presence or absence of surgical site infections (SSI).

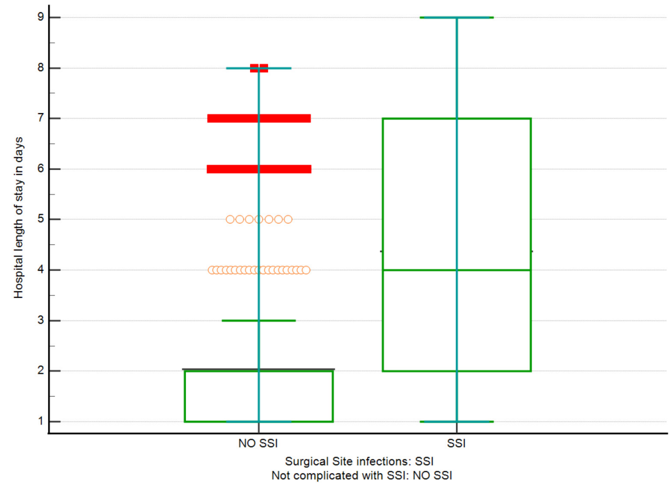


none of these variables remained statistically significant in the multivariate logistic regression model adjusted for confounders.

In 34.37% of the antibiograms of microorganisms isolated from surgical site infections, the causative agents exhibited resistance to Ciprofloxacin. Other antibiotics with significant microbial resistance included Trimethoprim-sulfamethoxazole (Bactrim) in 31.25% of cases, as well as Cefazolin and Levofloxacin, each with resistance detected in 29.69% of cases. Amoxicillin-clavulanate (Augmentin) showed resistance in 25% of cases, and Ceftriaxone in 18.75% of cases, with SSI. Conversely, the antibiotics demonstrating the lowest resistance levels were Tetracycline, Nitrofurantoin, Penicillin, and Fosfomycin, each with resistance observed in only 3.13% of postoperative SSI cases.

Patients who developed SSIs had more extended hospital stays compared to those who did not, with an average of 4.36 ± 2.93 (1-9) days versus 2.04 ± 1.83 (1-8) days, $p < 0.0001$ (Figure 3). The surgical site infections were not further detailed.

Figure 3. Hospital length of stay based on whether surgical site infections develop or not.



Discussion

In this prospective study, 64 patients (5.43%) who underwent abdominal surgery developed surgical site infections (SSIs). The incidence observed in our cohort was lower than that reported in previous studies from Albania and other international settings (13.3%–20%) [4,12,15,16]. However, it exceeded the incidence described in a meta-analysis of the Chinese population (roughly 4.5%) [17], as well as that reported in Nordic countries, where the overall SSI rate across all surgical procedures was 1% (range 0–9.5%) in 2022 [18].

Comprehensive data on SSI rates for all surgical procedures remains unavailable for Albania, the Western Balkans, and other South-Eastern European countries, as indicated by the World Health Organization's European Health Information Gateway [18]. This absence of standardised surveillance hinders regional comparisons and makes it difficult to assess broader epidemiological trends in SSI burden within these populations.

Nonetheless, comparisons with data from neighbouring European countries provide valuable insights. An Italian survey reported an SSI incidence of 5.2% (95% CI 4.4–6.0) [19], while the National Nosocomial Infections Surveillance system in Greece documented a rate of 5.3%, with nearly half of the infections (47.3%) diagnosed after hospital discharge [20].

Although these findings are not recent, they remain relevant, emphasising regional comparability and indicating that the incidence of SSI in our study population aligns with that observed in similar healthcare settings.

The current study identified male gender, age over 50 years, presence of comorbidities, type 2 diabetes mellitus, and lower gastrointestinal surgery as factors associated with an increased risk of surgical site infections. Although these variables did not act as independent predictors of SSIs in our cohort, they may still contribute to a higher susceptibility to such infections.

The rate of surgical site infections was higher among male patients, although this difference did not achieve statistical significance in our survey. Several studies have reported a greater incidence of SSI in male patients [21]. Biological differences, such as variations in skin pH, thickness, and sebum production, may influence skin colonisation and contribute to sex-related disparities in infection rates [22].

Numerous studies indicate that the risk of surgical site infections (SSIs) increases significantly in elderly patients compared to younger patients, supporting our findings [17,23,24].

Elderly patients often exhibit reduced immune responses and typically have multiple comorbidities, which can complicate both surgical procedures and postoperative recovery, thereby raising the risk of surgical site infections [3]. The present survey showed that patients aged ≥ 50 years have a greater likelihood of having comorbidities compared to their younger counterparts, affecting the postoperative outcome with a higher incidence of SSIs.

The presence of comorbidities, especially diabetes mellitus and hypertension, increased the risk of developing surgical site infections in our patients. Previous studies identified diabetes as a predisposing factor for SSIs [23-25], which was also confirmed in our study population, where patients with type 2 diabetes mellitus had 20 times higher risk of developing SSIs compared to those without diabetes mellitus.

In the current study, patients undergoing lower gastrointestinal surgery experienced a higher incidence of SSIs, as seen in other studies [23,24]. A systematic review indicated that surgeries involving colorectal procedures are consistently linked with increased rates of SSIs due to endogenous bacterial contamination [23]. The SSI rate following open colon surgery was reported as 9.6% in the Surgical Site Infections Annual Epidemiological Report for 2021–2022 [2].

The distribution of pathogens responsible for surgical site infections (SSIs) has changed over time, with *Escherichia coli*, *Enterococcus faecalis*, and *Staphylococcus aureus* recognised as the main microbes linked to SSIs after abdominal surgery [25,26]. In our study, the most frequently identified organisms from patients with SSIs were *Escherichia coli* and *Enterococcus faecalis*, in line with other reports [5,21]. Conversely, *Staphylococcus aureus* was among the less common microorganisms found in infected surgical wounds.

Furthermore, our results showed that most of these pathogens exhibited resistance to several classes of commonly used prophylactic antibiotics, highlighting a concerning trend also observed in previous studies [4,21].

The European Centre for Disease Prevention and Control (ECDC) has reported a rising trend in antimicrobial resistance across several European countries [27]. Understanding the antibiotic susceptibility patterns of bacteria isolated from surgical site infections is essential for optimising prophylactic antibiotic regimens and reducing the emergence and spread of multidrug-resistant organisms. A careful reassessment of prophylactic antibiotic selection is necessary, especially in high-risk patient groups. Although antimicrobial prophylaxis protocols are well-established in our university clinic, this study highlights the need for ongoing postoperative surveillance and the adoption of targeted infection prevention strategies to effectively lower the rate of SSIs [28].

SSIs not only increase morbidity but also significantly impact healthcare resource use through more extended hospital stays [21,29], additional treatments, and delayed recovery. Although this study did not evaluate the economic burden of surgical site infections, it demonstrated that patients who developed SSI experienced longer hospital stays than those without these complications, suggesting that the extended postoperative hospitalisation associated with SSIs likely results in higher healthcare costs [8,29].

Limitations of the study

This study is among the few conducted within the Albanian population to evaluate the incidence and associated risk factors of surgical site infections (SSIs) following abdominal surgery, thus addressing a significant gap in national and regional surgical infection surveillance. It also offers insights into the local microbial environment and antibiotic resistance patterns, providing valuable evidence to guide antimicrobial stewardship and infection prevention efforts.

A key limitation is that the study was conducted at a single centre, which may restrict the generalisability of the findings. Nevertheless, the results highlight significant SSI trends in Albania and underscore the necessity for multicentre surveillance networks to verify these findings, enhance representativeness, and guide targeted infection control strategies across the wider Balkan region.

Another limitation is that the types of SSIs were not classified in our study. According to European surveillance data, only 38% of SSIs are superficial, with the majority being deep or organ/space infections [2]. The absence of SSI classification in our cohort restricts the ability to assess related complications, hospital readmissions, and long-term outcomes. Future research should include detailed SSI categorisation to enhance understanding of their clinical and epidemiological significance.

Finally, post-discharge surveillance was not carried out, which may have resulted in an underestimation of SSI incidence, as many infections occur after hospitalisation [20]. Implementing long-term follow-up after discharge would provide more accurate estimates of the actual SSI burden and aid in better evaluating the effectiveness of preventive measures.

Conclusions

This study identified a surgical site infection (SSI) rate of 5.43% among patients undergoing abdominal surgery, with a slightly higher prevalence in males. Older age (≥ 50 years), presence of comorbidities, type 2 diabetes mellitus, and lower gastrointestinal procedures were linked to an increased risk of SSI development in the Albanian surgical population. The primary pathogens isolated were *Escherichia coli* and

Enterococcus faecalis, highlighting the importance of targeted antimicrobial prophylaxis and customised management strategies, especially for high-risk patients.

These findings emphasise the importance of multicentre surveillance and systematic post-discharge monitoring to obtain more precise estimates of SSI incidence, enhance infection prevention measures, and guide the development of evidence-based guidelines for surgical care in the region.

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Conflict of interest
No conflict of interest is declared.

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