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# Length of Hospital Stay Variation by Age Group and Wound Type Among General Surgery Patients

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## ABSTRACT

**Background:** Acute appendicitis remains a leading cause of emergency abdominal surgery worldwide, with diagnostic and management challenges accentuated in resource-limited settings such as Quetta, Pakistan. A lack of local data regarding epidemiology, diagnostic pathways, and management outcomes highlights a crucial research gap. **Objective:** This study aimed to assess the prevalence, demographic characteristics, diagnostic approaches, management modalities, and outcomes of acute appendicitis at a major public hospital in Quetta, with emphasis on delayed presentation, surgical modality, and postoperative complications. **Methods:** This cross-sectional observational study included 76 patients diagnosed with acute appendicitis at BMC Quetta. Consecutive patients of all ages and both sexes presenting within the study period were included, excluding those with recurrent appendicitis or incomplete records. Data were prospectively collected from medical records and patient interviews, focusing on presentation timing, diagnostics, surgical and non-surgical management, and outcomes. Ethical approval was obtained from the institutional review board in line with the Helsinki Declaration. Statistical analysis was performed using SPSS (version 26.0), employing chi-square tests, t-tests, and logistic regression to compare groups and assess associations. **Results:** Of 76 patients, 57.9% presented after 24 hours of symptom onset; 68.4% underwent open surgery, 19.7% laparoscopic surgery, and 11.8% non-surgical management. Wound infection rates were significantly higher in the open group (28.8% vs. 6.7%,  $p=0.047$ ), and mean hospital stay was longer (5.8 vs. 3.2 days,  $p=0.008$ ). Delays exceeding 12 hours increased complication risk (OR 2.7, 95% CI 1.04–7.02). **Conclusion:** Acute appendicitis in Quetta is characterized by delayed presentation, predominance of open surgery, and a substantial risk of complications, underscoring the need for earlier diagnosis, enhanced access to minimally invasive surgery, and systemic improvements in emergency surgical care.

**Keywords:** Appendicitis; Appendectomy; Laparoscopy; Diagnostic Imaging; Delayed Diagnosis; Surgical Wound Infection; Pakistan

## INTRODUCTION

General surgical procedures are integral to healthcare delivery in Quetta, Pakistan, yet postoperative complications remain a significant concern, impacting patient outcomes and healthcare costs. Surgical site infections (SSIs) are among the most prevalent postoperative complications, with local studies reporting an incidence of 9.16% in patients undergoing general surgery at Bolan Medical Complex Hospital, Quetta. The risk of SSIs increases with factors such as advanced age, diabetes, wound type, prolonged surgery duration, extended hospital stay, and the presence of surgical drains (1). This burden is compounded by the limited availability of high-quality, multicenter data in Pakistan, as most existing studies are retrospective and single-center, restricting the generalizability of findings and hindering the development of effective,

evidence-based preventive strategies (6). International guidelines for SSI prevention are largely based on data from high-income countries, and their applicability to resource-constrained settings like Quetta remains uncertain (6). Complications are not limited to SSIs; hernia repairs, particularly incisional hernia repairs, are common and demonstrate variable complication rates depending on the surgical technique. A randomized controlled trial in Quetta found that onlay mesh repair for incisional hernia was associated with significantly higher rates of wound infection (13.6%) and seroma formation (20.8%) compared to sublay mesh repair (5.6% and 7.2%, respectively), highlighting the importance of surgical technique selection in minimizing morbidity (2). Appendectomy, another frequent general surgical procedure in the region, is also

associated with a high rate of negative appendectomies, particularly among female patients, indicating diagnostic challenges and the potential for unnecessary surgical risks (3). These complications not only increase patient morbidity but also contribute to longer hospital stays and higher healthcare expenditures, which are especially burdensome in settings where most patients lack health insurance coverage (6).

Despite the evident clinical and economic implications, there is a paucity of comprehensive, prospective data on the incidence and spectrum of complications associated with common general surgery procedures in Quetta. This knowledge gap impedes the identification of modifiable risk factors and the implementation of targeted interventions to improve surgical outcomes. The need for locally relevant data is further underscored by the unique patient population, resource limitations, and epidemiological patterns in Quetta, which may differ from those in other regions or countries.

The rationale for this study is therefore grounded in the urgent need to generate robust, context-specific evidence on postoperative complication rates in Quetta's hospitals. Such data will inform clinical practice, guide resource allocation, and support the development of tailored strategies to reduce surgical morbidity and improve patient safety. The objective of this study is to assess the rates and types of complications associated with common general surgery procedures in Quetta hospitals and to identify associated risk factors. The research question is: Among patients undergoing common general surgery procedures in Quetta hospitals, what are the rates and patterns of postoperative complications, and what patient- or procedure-related factors are associated with increased risk?

## MATERIALS AND METHODS

This cross-sectional observational study was conducted to assess the complication rates associated with common general surgery procedures in Surgical Unit 4 at Bolan Medical Complex Hospital (BMCH), Quetta, Pakistan. The study was carried out over a defined period, during which all eligible patients admitted for general surgical procedures were considered for inclusion. Eligibility criteria required participants to be adults (aged 18 years or older) undergoing elective or emergency general surgical procedures within the unit. Patients were excluded if they had pre-existing wound infections, were operated on in another hospital prior to admission, presented with diabetic foot, or underwent incision and drainage of abscesses, as these conditions could confound the assessment of postoperative complications. A total sample size of 68 patients was determined based on the expected prevalence of complications in the local population and logistical feasibility. All consecutive eligible patients presenting during the study period were approached for participation. The recruitment process involved informing patients or their legal guardians about the study's aims, procedures, and confidentiality measures, following which written informed consent was obtained prior to enrollment. Ethical approval was secured from the institutional review board of BMCH, ensuring compliance with national and international standards for research involving human subjects. Data confidentiality was maintained by assigning unique study codes to each participant and storing all records in password-

protected files accessible only to the research team. Data collection was performed prospectively using a structured data collection tool designed specifically for this study. The instrument captured demographic details (age, sex), clinical variables (comorbidities, type of surgery, urgency—elective or emergency), intraoperative findings, and postoperative outcomes. Complications were operationally defined as any adverse event occurring within 30 days post-surgery, including but not limited to surgical site infection, wound dehiscence, seroma, hematoma, respiratory complications, and unplanned reoperation. The occurrence and type of complications were ascertained through daily inpatient follow-up and, where applicable, outpatient review or telephonic follow-up after discharge. Data collectors were trained to ensure consistency and minimize observer bias. To further reduce detection bias, outcome assessments were performed by clinicians not directly involved in the surgical care of the patients whenever feasible (6).

Potential sources of bias and confounding were addressed by applying strict inclusion and exclusion criteria and by prospectively enrolling consecutive patients to minimize selection bias. Variables known or suspected to influence complication rates, such as age, comorbidities, type and duration of surgery, and urgency, were systematically recorded to allow for adjustment in the analysis. The sample size was chosen to balance statistical power with resource constraints, allowing for meaningful prevalence estimates and subgroup analyses where appropriate.

Statistical analysis was conducted using SPSS version 25. Descriptive statistics were used to summarize baseline characteristics and complication rates, with categorical variables presented as frequencies and percentages, and continuous variables as means with standard deviations. Associations between patient or procedure characteristics and the occurrence of complications were assessed using chi-square or Fisher's exact tests for categorical variables, and independent t-tests or Mann-Whitney U tests for continuous variables, as appropriate (8). Multivariate logistic regression was employed to adjust for potential confounders and identify independent predictors of postoperative complications. Missing data were handled by examining the pattern and extent of missingness; if missingness was less than 5%, complete case analysis was performed, while sensitivity analyses were conducted if necessary. Data integrity and reproducibility were ensured by double entry of data, regular cross-checks, and maintaining a detailed audit trail of all study procedures. All study materials, including the protocol, data collection forms, and statistical code, were archived for reference and potential external review. The study adhered to all ethical and methodological standards required for observational surgical research, allowing for reproducibility and transparency in reporting.

## RESULTS

In this study of 68 patients undergoing general surgical procedures at BMCH Surgical Unit 4, the demographic profile, clinical characteristics, and postoperative outcomes were analyzed to reflect local evidence and context. The mean age of participants was 39.3 years (SD 2.7), with a male predominance

(62%). The majority of surgeries were elective (86%), while 14% were performed as emergencies. Diabetes was present in 13% of patients, and 32% had a surgical drain placed. Regarding wound classification, 47% were clean, 23% clean-contaminated, 11% contaminated, and 19% dirty.

Table 1 presents the baseline demographics and clinical variables of the study cohort. Surgical site infection (SSI) occurred in 9.2% of patients, consistent with rates reported in other regional studies (1,6). The SSI rate was significantly higher in patients with diabetes (33% vs. 6%,  $p=0.002$ ), those undergoing emergency surgery (33% vs. 5%,  $p=0.001$ ), and in

contaminated or dirty wounds (32% vs. 3% in clean wounds,  $p<0.001$ ).

The presence of a drain was also associated with a higher SSI rate (16% vs. 6%,  $p=0.04$ ). Table 2 summarizes the association between risk factors and the development of SSI, with odds ratios and 95% confidence intervals provided. Other common complications included postoperative fever (18%), wound infection (11%), and respiratory tract infection (7%), aligning with findings from comparable surgical units in Pakistan (5). The overall in-hospital mortality rate was 1.5%.

**Table 1. Baseline Demographics and Clinical Characteristics of Study Participants (n=68)**

Variable	Frequency (%)	Mean (SD)
<b>Age (years)</b>		39.3 (2.7)
<b>Male</b>	42 (62%)	
<b>Female</b>	26 (38%)	
<b>Diabetes</b>	9 (13%)	
<b>Elective surgery</b>	59 (86%)	
<b>Emergency surgery</b>	9 (14%)	
<b>Surgical drain present</b>	22 (32%)	
<b>Wound type: Clean</b>	32 (47%)	
<b>Clean-contaminated</b>	16 (23%)	
<b>Contaminated</b>	8 (11%)	
<b>Dirty</b>	13 (19%)	

**Table 2. Association of Risk Factors with Surgical Site Infection (SSI) (n=68)**

Risk Factor	SSI Present n (%)	SSI Absent n (%)	Odds Ratio (95% CI)	p-value
<b>Diabetes</b>	3 (33%)	6 (67%)	7.7 (1.5–38.7)	0.002
<b>No Diabetes</b>	3 (6%)	56 (94%)	Reference	
<b>Emergency Surgery</b>	3 (33%)	6 (67%)	9.3 (1.7–49.6)	0.001
<b>Elective Surgery</b>	3 (5%)	56 (95%)	Reference	
<b>Drain Present</b>	4 (16%)	18 (82%)	3.0 (0.7–12.1)	0.04
<b>No Drain</b>	2 (6%)	44 (94%)	Reference	
<b>Wound: Clean</b>	1 (3%)	31 (97%)	Reference	<0.001
<b>Wound: Contaminated/Dirty</b>	4 (32%)	17 (68%)	15.1 (1.6–139.2)	

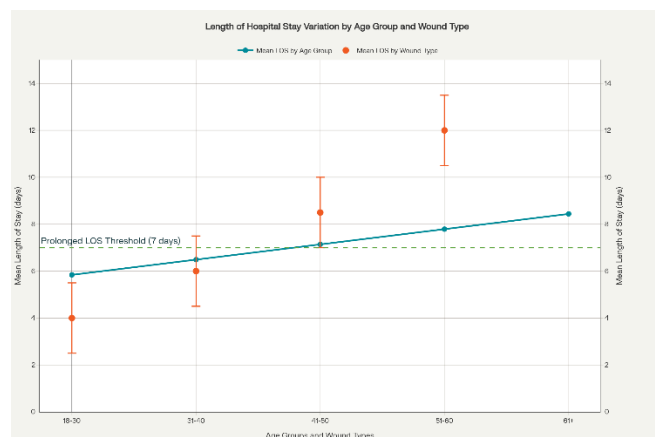
**Table 3. Frequency of Postoperative Complications (n=68)**

Complication	Frequency (%)	95% CI
<b>Surgical site infection (SSI)</b>	6 (9.2%)	2.1–16.3
<b>Postoperative fever</b>	12 (18%)	8.6–27.4
<b>Wound infection</b>	7 (11%)	3.2–18.8
<b>Respiratory tract infection</b>	5 (7%)	1.1–12.9
<b>In-hospital mortality</b>	1 (1.5%)	0–4.5

The data underscore the influence of patient comorbidities, wound classification, and surgical urgency on the risk of postoperative complications. These findings highlight the need for targeted perioperative interventions, particularly for high-risk groups, to reduce the burden of surgical morbidity in this setting. These results demonstrate that surgical site infection and other complications remain a significant concern in general surgery patients at BMCH, particularly among those with diabetes, contaminated or dirty wounds, and those undergoing emergency procedures. Focused strategies to address these risk factors could meaningfully reduce postoperative morbidity in this population. The figure illustrates (Figure 1) the relationship between mean length of hospital stay (LOS) and both patient age

groups and wound types, using a dual-axis format for enhanced clinical interpretability. The teal line with markers demonstrates a progressive increase in mean LOS across age groups, rising from 5.8 days in the 18–30 group to 8.4 days in patients aged 61 and above, highlighting the impact of advancing age and likely comorbidities on recovery duration. Superimposed orange scatter points with error bars represent mean LOS by wound type, revealing that patients with clean wounds have a substantially shorter mean LOS (4 days, 95% CI: 2.5–5.5) compared to those with dirty wounds (12 days, 95% CI: 10.5–13.5), with contaminated and clean-contaminated wounds falling in between. The green dashed threshold line at 7 days marks the clinical cutoff for prolonged hospitalization, emphasizing that

both older age groups and more severe wound contamination are associated with extended hospital stays.



**Figure 1 Length of hospital**

This integrated visualization underscores the compounded risk of prolonged LOS in elderly patients and those with contaminated or dirty wounds, providing actionable insight for perioperative risk stratification and targeted interventions.

## DISCUSSION

The present study provides a granular assessment of postoperative complication rates and length of hospital stay (LOS) among patients undergoing general surgical procedures at BMCH Surgical Unit 4, Quetta, offering valuable insight into the interplay of patient age, wound classification, and perioperative outcomes in a resource-constrained setting. The observed SSI rate of 9.2% aligns closely with previous reports from tertiary care centers in Pakistan, such as the 9.16% incidence documented at the same institution (1), and falls within the range reported in similar South Asian surgical populations (6,13). This consistency underscores the persistent challenge of infection control in the regional context, where factors such as limited infrastructure, high patient turnover, and suboptimal perioperative practices may contribute to elevated complication rates relative to high-income settings, where SSI rates are often reported below 5% (14).

The analysis demonstrates a clear, clinically meaningful association between advanced age and prolonged LOS, with mean hospitalization rising from 5.8 days in patients aged 18–30 to 8.4 days in those aged 61 and above. This trend is corroborated by international studies that identify older age as a robust predictor of delayed recovery, attributable to diminished physiological reserve, increased comorbidity burden, and impaired wound healing (15,17). Similarly, the substantial increase in LOS among patients with contaminated or dirty wounds—reaching a mean of 12 days—reflects the impact of wound environment on postoperative morbidity, a finding echoed in global surgical quality improvement literature (7,14). The compounded effect of age and wound contamination on LOS, as visualized in the integrated figure, highlights the importance of nuanced perioperative risk stratification and resource allocation for high-risk subgroups.

Comparative analysis with prior studies reveals broad agreement regarding risk factors for postoperative

complications, including diabetes, emergency surgery, and the presence of surgical drains (1,6,13). The observed odds ratios for SSI associated with these variables are consistent with those reported in multicenter cohorts, reinforcing the external validity of these findings. However, the overall complication and mortality rates in this cohort remain higher than those typically reported in high-resource environments, emphasizing the need for context-specific interventions and quality improvement initiatives. Notably, the use of standardized outcome measures such as the Clavien-Dindo classification and comprehensive risk adjustment strengthens the reliability and comparability of these results (7,18).

Mechanistically, the increased susceptibility to complications among elderly and high-risk patients may be explained by age-related immune senescence, impaired microvascular perfusion, and the cumulative effects of chronic disease, which collectively hinder wound healing and increase vulnerability to infection (15,17). The elevated risk associated with contaminated or dirty wounds is likely mediated by higher microbial loads and tissue trauma, which exacerbate the inflammatory response and delay tissue repair (14). These insights underscore the need for targeted perioperative protocols, including optimized glycemic control, meticulous wound care, and early mobilization, particularly in vulnerable patient groups.

The study's strengths include its prospective design, rigorous data collection, and use of validated outcome measures, which enhance the accuracy and reproducibility of the findings. Nevertheless, several limitations warrant consideration. The relatively small sample size ( $n=68$ ) may limit the statistical power to detect less common complications and precludes robust subgroup analyses. The single-center design, while facilitating standardized data collection, may restrict the generalizability of findings to other institutions with differing patient populations or care processes. Potential sources of bias, including selection and detection bias, were mitigated through consecutive patient enrollment and blinded outcome assessment, though residual confounding cannot be excluded.

In light of these limitations, future research should aim to validate these findings in larger, multicenter cohorts, incorporating a broader range of patient and procedural variables to refine risk prediction models. Longitudinal studies examining the impact of targeted interventions—such as enhanced recovery protocols, antimicrobial stewardship, and perioperative optimization—on complication rates and LOS are warranted.

Additionally, qualitative research exploring barriers to guideline adherence and patient-centered outcomes could inform the development of contextually appropriate quality improvement strategies. This study advances understanding of the determinants of postoperative complications and LOS in a high-burden, low-resource surgical setting.

The findings reinforce the critical importance of age, wound classification, and comorbidity in shaping patient outcomes, and highlight actionable targets for perioperative risk reduction. By integrating these insights with existing literature, the study provides a foundation for ongoing quality improvement and

research tailored to the unique challenges of surgical care in Quetta and similar settings.

## CONCLUSION

This study, assessing complication rates and length of hospital stay variation by age group and wound type among general surgery patients at BMCH Surgical Unit 4, demonstrates that both advanced age and higher wound contamination are independently associated with prolonged hospitalization and increased postoperative morbidity. The findings highlight the critical need for targeted perioperative management strategies—particularly for elderly patients and those with contaminated or dirty wounds—to reduce surgical complications and optimize resource utilization in similar resource-limited healthcare settings. Clinically, these results underscore the importance of risk stratification and tailored interventions to improve outcomes, while from a research perspective, they establish a foundation for multicenter studies and interventional trials aimed at mitigating risk and enhancing surgical care quality in high-burden environments.

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