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Prevalence and Determinants of Surgical Delay among Elective Surgical Patients at a Tertiary Teaching Hospital in Central Ethiopia: A Cross-Sectional Study

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Abstract

Background

Surgical delay remains a significant challenge in healthcare systems, particularly in low- and middle-income countries, leading to increased morbidity, mortality, and healthcare costs. Understanding the factors contributing to surgical delays is essential for improving surgical service delivery and patient outcomes.

Objective

This study aimed to determine the prevalence and identify factors associated with surgical delay among elective surgical patients at a tertiary teaching hospital in Central Ethiopia.

Methods

A hospital-based cross-sectional study was conducted among 241 elective surgical patients at a tertiary teaching hospital in Central Ethiopia from February to May 2024. Data were collected using a structured questionnaire and medical record review. Binary logistic regression was used to identify factors associated with surgical delay. Variables with p-value < 0.25 in bivariate analysis were entered into multivariate logistic regression. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated, and statistical significance was set at $p < 0.05$.

Results

The overall prevalence of surgical delay was 40.7% (98/241). The most common reasons for delay were patient-related factors (47.9%), professional-related factors (27.7%), equipment-related factors (17.9%), and management-related factors (4.3%). In multivariate logistic regression analysis, patient-related factors (AOR = 2.34, 95% CI: 1.45–3.78, $p < 0.001$), professional-related factors (AOR = 1.89, 95% CI: 1.12–3.19, $p = 0.017$), and equipment-related factors (AOR = 2.67, 95% CI: 1.38–5.17, $p = 0.004$) were significantly associated with surgical delay. Among patient-related reasons, lack of financial clearance (AOR = 3.12, 95% CI: 1.67–5.83, $p < 0.001$) was the strongest predictor. Among professional-related factors, inefficient case scheduling (AOR = 2.45, 95% CI: 1.28–4.69, $p = 0.007$) was significant. Among equipment-related factors, equipment unavailability (AOR = 3.21, 95% CI: 1.52–6.78, $p = 0.002$) was the strongest predictor.

Conclusion

The prevalence of surgical delay in this study was high (40.7%). Patient-related factors, professional-related factors, and equipment-related factors were significant predictors of surgical delay. Interventions targeting financial counseling, improved scheduling practices, and equipment maintenance and availability are recommended to reduce surgical delays and improve surgical service delivery.

1. INTRODUCTION

1.1 Background

Surgical delay, defined as the postponement of a scheduled surgical procedure beyond the planned date or time, is a pervasive problem in healthcare systems worldwide [1]. It represents a significant burden on patients, healthcare providers, and the overall healthcare system, leading to increased morbidity, mortality, prolonged hospital stays, and escalated healthcare costs [2, 3]. In low- and middle-income countries (LMICs), surgical delays are particularly prevalent due to resource constraints, infrastructure limitations, and organizational challenges [4, 5].

Globally, the burden of surgical delay varies widely, with reported rates ranging from 10% to 40% in high-income countries and as high as 60% in LMICs [6, 7]. The causes of surgical delay are multifactorial and can be broadly categorized into patient-related, professional-related, equipment-related, and management-related factors [8]. Understanding the specific causes and their relative contributions in different healthcare settings is crucial for developing targeted interventions to improve surgical service delivery.

In Ethiopia, the healthcare system faces numerous challenges, including limited resources, inadequate infrastructure, and a shortage of trained healthcare professionals [9]. These challenges are compounded by a high burden of surgical diseases and increasing demand for surgical services [10]. Despite the recognized importance of timely surgical care, there is a paucity of data on the prevalence and determinants of surgical delay in Ethiopian healthcare settings, particularly in tertiary teaching hospitals [11].

1.2 Statement of the Problem

Surgical delay is a critical issue affecting surgical service delivery in Ethiopian hospitals. It leads to poor patient outcomes, including increased morbidity and mortality, prolonged hospital stays, and increased healthcare costs [12]. It also affects hospital efficiency, leading to wasted resources, increased patient dissatisfaction, and potential loss of trust in the healthcare system [13]. Despite these consequences, there is limited research on the magnitude and determinants of surgical delay in Ethiopian tertiary hospitals [14].

Previous studies in Ethiopia have focused on specific surgical specialties or limited geographic areas, providing an incomplete picture of the problem [15, 16]. Moreover, most existing studies have not

comprehensively analyzed the multiple factors contributing to surgical delay using appropriate regression models to identify independent predictors [17]. This gap in the literature hinders the development of evidence-based interventions to address surgical delays.

1.3 Significance of the Study

This study aims to provide comprehensive evidence on the prevalence and determinants of surgical delay in a tertiary teaching hospital in Central Ethiopia. The findings will be valuable for hospital administrators, policymakers, and healthcare providers in developing targeted interventions to reduce surgical delays and improve surgical service delivery. By identifying the strongest predictors of surgical delay, this study will inform resource allocation and quality improvement initiatives.

Additionally, the study will contribute to the growing body of literature on surgical delay in LMICs, providing evidence that can inform similar interventions in comparable settings. The findings will also serve as a baseline for future research and monitoring of interventions aimed at improving surgical efficiency.

1.4 Objectives

General Objective:

To determine the prevalence and identify factors associated with surgical delay among elective surgical patients at a tertiary teaching hospital in Central Ethiopia.

Specific Objectives:

1. To determine the prevalence of surgical delay among elective surgical patients
2. To identify the reasons for surgical delay
3. To determine factors associated with surgical delay using multivariate logistic regression analysis

1.5 Research Questions

1. What is the prevalence of surgical delay among elective surgical patients?
2. What are the main reasons for surgical delay?
3. What factors are independently associated with surgical delay?

2. LITERATURE REVIEW

2.1 Concept and Definitions

Surgical delay refers to the postponement of a surgical procedure beyond the originally scheduled date or time [1]. It can be classified as either "start-time delay" (surgery begins later than scheduled on the same day) or "date delay" (surgery is postponed to a later date) [18]. The reasons for surgical delay can

be categorized into patient-related, professional-related, equipment-related, and management-related factors [8, 19].

2.2 Global Prevalence of Surgical Delay

The prevalence of surgical delay varies significantly across different healthcare systems. In high-income countries (HICs), reported rates range from 10% to 40% [6, 20]. For example, a study in the United States reported a delay rate of 27.8% for elective surgeries [21]. In the United Kingdom, the National Health Service reported that 10% of elective surgeries are cancelled or delayed [22]. In contrast, studies from LMICs report higher rates, often exceeding 50% [7, 23]. A study in Nigeria reported a delay rate of 43.7% [24], while studies in Uganda and Kenya reported rates of 52% and 48%, respectively [25, 26].

In Ethiopia, limited studies have examined surgical delay. A study at Tikur Anbessa Specialized Hospital reported a delay rate of 36.5% [15], while a study at Jimma Medical Center reported a rate of 42% [16]. However, these studies were limited to specific specialties or geographic areas.

2.3 Causes of Surgical Delay

2.3.1 Patient-Related Factors

Patient-related factors are among the most commonly reported causes of surgical delay [27]. These include late arrival to the operating room, lack of timely patient preparation, unavailability of consent, lack of financial clearance, last-minute cancellation or no-show, and medical unfitness for surgery [8, 19]. Financial constraints are particularly significant in LMICs, where out-of-pocket payments for surgical care can be prohibitive [28, 29]. A study in Ethiopia identified lack of financial clearance as a major cause of surgical delay [15].

2.3.2 Professional-Related Factors

Professional-related factors include inadequate numbers of staff, delayed seeking of financial clearance, lack of qualified support staff, poor staff coordination, lack of staff punctuality, improper setting up for cases, and inefficient case scheduling [8, 19]. In many LMICs, there is a critical shortage of trained surgical personnel, including surgeons, anesthesiologists, and operating room nurses [30, 31]. This shortage exacerbates delays and compromises surgical quality [32].

2.3.3 Equipment-Related Factors

Equipment-related factors include equipment unavailability, equipment dysfunctionality, inadequacy of specialized equipment, lack of competent staff to maintain equipment, and unavailability of supplies [8, 19]. In LMICs, equipment shortages and poor maintenance are significant barriers to timely surgical care [33, 34]. Studies have reported that equipment-related factors account for 10–20% of surgical delays in resource-limited settings [35, 36].

2.3.4 Management-Related Factors

Management-related factors include inadequate budgetary allocation, poor management support, inadequate number of operating rooms, ineffective policies, lack of acquisition of new equipment, lack of staff training, and lack of adequate staffing [8, 19]. Weak health system governance and management are critical constraints to surgical service delivery in LMICs [37, 38].

2.4 Consequences of Surgical Delay

Surgical delay has significant consequences for patients, healthcare providers, and the healthcare system [2, 3]. For patients, delays lead to increased anxiety, prolonged suffering, increased morbidity and mortality, and prolonged hospital stays [12, 39]. Delays also increase the risk of surgical site infections and other complications [40]. For healthcare providers, delays lead to increased workload, stress, and potential burnout [13]. For the healthcare system, delays result in wasted resources, increased costs, and reduced efficiency [2, 41].

2.5 Factors Associated with Surgical Delay

Several studies have examined factors associated with surgical delay using multivariate regression analysis. A study in Nigeria found that patient age, type of surgery, and financial clearance were independently associated with surgical delay [24]. A study in Uganda identified inadequate staffing and equipment unavailability as independent predictors [25]. In Ethiopia, a study at Tikur Anbessa Specialized Hospital found that lack of financial clearance, inadequate staffing, and equipment unavailability were significantly associated with surgical delay [15].

However, most existing studies have limitations, including small sample sizes, single-specialty focus, and inadequate adjustment for confounders [17]. This study aims to address these gaps by using a comprehensive dataset and appropriate multivariable regression analysis to identify independent predictors of surgical delay.

2.6 Conceptual Framework

This study is guided by a conceptual framework adapted from the World Health Organization's health system framework [42]. The framework posits that surgical delay is influenced by multiple factors operating at different levels: patient level (demographic, socioeconomic, and clinical factors), provider level (staff knowledge, skills, and practices), organizational level (equipment, supplies, and management), and health system level (governance, financing, and policies). These factors interact in complex ways to determine the timeliness of surgical care.

3. METHODS AND MATERIALS

3.1 Study Design and Period

A hospital-based cross-sectional study was conducted from February 1 to May 30, 2024, at a tertiary teaching hospital in Central Ethiopia. The hospital is one of the largest referral hospitals in the region, providing comprehensive surgical services across multiple specialties, including orthopedics, general surgery, obstetrics and gynecology, ophthalmology, and other specialties and sub specialties.

3.2 Population

3.2.1 Source Population

All elective surgical patients scheduled for surgery at the tertiary teaching hospital during the study period.

3.2.2 Study Population

All elective surgical patients scheduled for surgery at the tertiary teaching hospital during the study period who met the inclusion criteria.

3.2.3 Inclusion Criteria

- Adult patients aged ≥ 18 years
- Patients scheduled for elective surgery
- Patients who provided informed consent
- Patients with complete medical records

3.2.4 Exclusion Criteria

- Emergency surgical patients
- Patients with incomplete medical records
- Patients who refused to participate
- Patients under 18 years of age

3.3 Sample Size Determination

The sample size was calculated using the single population proportion formula: $n = (Z\alpha/2)^2 \times p(1-p) / d^2$

Where:

- n = required sample size
- Zα/2 = 1.96 (standard normal distribution at 95% confidence level)
- p = estimated proportion of surgical delay (taken as 50% since no prior similar study in the study area)
- d = margin of error (5%)

$n = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2 = 384$

However, since the study population was limited (all elective surgical patients during the study period), a finite population correction was applied. With an estimated 300 elective surgical procedures during the study period:

n adjusted = 384 / (1 + (384-1)/300) = 384 / (1 + 1.28) = 384 / 2.28 = 168

After adding a 10% non-response rate, the final sample size was 185. However, during the study period, 241 elective surgical patients were identified and included in the study, providing adequate power for the analysis.

3.4 Sampling Technique

A consecutive sampling technique was used to include all eligible elective surgical patients scheduled for surgery during the study period. All patients who met the inclusion criteria were included in the study until the required sample size was achieved and exceeded.

3.5 Data Collection Instruments and Procedures

Data were collected using a structured questionnaire adapted from previous studies [8, 15, 19] and a medical record review checklist. The questionnaire was designed to capture information on:

- Socio-demographic characteristics (age, sex, ethnicity, department)
- Clinical characteristics (diagnosis, admission date, planned surgery date/time, actual surgery date/time)
- Presence and reasons for surgical delay
- Specific factors contributing to delay (patient-related, professional-related, equipment-related, management-related, and other factors)

The questionnaire was initially developed in English and translated into local languages (Amharic and Hadiyyisa) for data collection. Back-translation was performed to ensure accuracy. The questionnaire was pre-tested on 5% of the sample size at a different hospital to assess clarity, consistency, and validity. Modifications were made based on the pre-test results.

Data were collected by trained data collectors (nurses and health officers) who were not involved in patient care. The data collectors received two days of training on the study objectives, data collection procedures, and ethical considerations. Data were collected through face-to-face interviews with patients and review of medical records.

3.6 Study Variables

3.6.1 Dependent Variable

- Surgical delay (yes/no): defined as surgery performed later than the planned date/time (more than 60 minutes delay from the scheduled time or postponement to a later date)

3.6.2 Independent Variables

- Socio-demographic factors: age, sex, ethnicity, department
- Patient-related factors: late arrival to operating room, lack of timely patient preparation, unavailability of consent, lack of financial clearance, last-minute cancellation or no-show, medical unfitness for surgery, other patient-related factors
- Professional-related factors: inadequate numbers of staff, not timely seeking of financial clearance, lack of qualified support staff, poor staff coordination, lack of staff punctuality, improper setting up for cases, inefficient case scheduling, other staff-related factors
- Equipment-related factors: equipment unavailability, equipment dysfunctionality, inadequacy of specialized equipment, lack of competent staff to maintain equipment, unavailability of supplies, other equipment-related factors
- Management-related factors: inadequate budgetary allocation, poor management support, inadequate number of operating rooms, ineffective policies, lack of acquisition of new equipment, lack of staff training, lack of adequate staffing, other management-related factors

3.7 Operational Definitions

- **Surgical delay**: Surgery performed more than 60 minutes after the scheduled time or postponed to a later date [8]
- **Elective surgery**: Non-emergency surgical procedure scheduled in advance [43]
- **Patient-related factors**: Factors attributable to the patient or their family that contribute to surgical delay [8]
- **Professional-related factors**: Factors attributable to healthcare providers that contribute to surgical delay [8]
- **Equipment-related factors**: Factors related to equipment and supplies that contribute to surgical delay [8]

- **Management-related factors**: Factors related to hospital management and administration that contribute to surgical delay [8]

3.8 Data Quality Control

Data quality was ensured through:

- Pre-testing of the questionnaire
- Training of data collectors
- Daily supervision and checking of completed questionnaires for completeness and consistency
- Double data entry to minimize errors
- Regular meetings with data collectors to address challenges

3.9 Data Processing and Analysis

Data were entered using EpiData version 4.6 and exported to SPSS version 26 for analysis. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize the data. The prevalence of surgical delay was calculated as the proportion of patients who experienced delay among all elective surgical patients.

Bivariate logistic regression analysis was performed to identify factors associated with surgical delay. Variables with p-value < 0.25 in bivariate analysis were entered into multivariate logistic regression analysis. Crude odds ratios (COR) and adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated. Statistical significance was set at $p < 0.05$ in multivariate analysis.

Model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test and the omnibus test. Multicollinearity was checked using variance inflation factor (VIF), with VIF < 10 considered acceptable. Results were presented in tables, figures, and text.

4. RESULTS

4.1 Socio-Demographic Characteristics of Study Participants

A total of 241 elective surgical patients were included in the study, with a response rate of 100%. The mean age of participants was 33.2 years (SD ± 17.8). The majority of participants were male (137, 56.8%). The largest proportion of patients were from the Orthopedic ward (156, 64.7%), followed by General Surgery (54, 22.4%), Obstetrics and Gynecology (25, 10.4%), and Ophthalmology (6, 2.5%) (Table 1).

Table 1
Socio-demographic characteristics of elective surgical patients (n = 241)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	33.2 ± 17.8	
Sex	Male	137	56.8
	Female	104	43.2
Department	Orthopedic	156	64.7
	General Surgery	54	22.4
	Obstetrics & Gynecology	25	10.4
	Ophthalmology	6	2.5

4.2 Prevalence of Surgical Delay

The overall prevalence of surgical delay was 40.7% (98/241) 95%CI :(34.7–47.0). Among the 98 patients who experienced delay, the majority were from the Orthopedic ward (73.5%), followed by General Surgery (15.3%), Obstetrics and Gynecology (9.2%), and Ophthalmology (2.0%) (Fig. 1).

4.3 Reasons for Surgical Delay

Among the 98 patients who experienced surgical delay, the most common reasons were patient-related factors (47.9%), professional-related factors (27.7%), equipment-related factors (18.4%), and management-related factors (2.0%). Four patients (4.1%) had delays attributed to other reasons, including lack of compatible blood, waiting for antibiotic treatment response, and waiting for investigation results (Table 2).

Table 2
Reasons for surgical delay (n = 98)

Reason for Delay	Frequency (n)	Percentage (%)
Patient-related factors	47	47.9
Professional-related factors	27	27.7
Equipment-related factors	18	18.4
Management-related factors	2	2.0
Other reasons	4	4.1

4.3.1 Specific Patient-Related Factors

Among the 47 patients with patient-related delays, the most common specific reasons were lack of financial clearance (59.6%), medical unfitness for surgery (25.5%), late arrival to operating room (8.5%), unavailability of consent (4.3%), and last-minute cancellation or no-show (2.1%) (Table 3).

Table 3
Specific patient-related factors for surgical delay (n = 47)

Patient-Related Factor	Frequency (n)	Percentage (%)
Lack of financial clearance	28	59.6
Medical unfitness for surgery	12	25.5
Late arrival to operating room	4	8.5
Unavailability of consent	2	4.3
Last-minute cancellation or no-show	1	2.1

4.3.2 Specific Professional-Related Factors

Among the 27 patients with professional-related delays, the most common specific reasons were inefficient case scheduling (66.7%), lack of staff punctuality (37.0%), inadequate numbers of staff (18.5%), poor staff coordination (18.5%), improper setting up for cases (14.8%), and lack of qualified support staff (7.4%). Some patients had multiple reasons for delay (Table 4).

Table 4
Specific professional-related factors for surgical delay (n = 27)

Professional-Related Factor	Frequency (n)	Percentage (%)
Inefficient case scheduling	18	66.7
Lack of staff punctuality	10	37.0
Inadequate numbers of staff	5	18.5
Poor staff coordination	5	18.5
Improper setting up for cases	4	14.8
Lack of qualified support staff	2	7.4

4.3.3 Specific Equipment-Related Factors

Among the 18 patients with equipment-related delays, the most common specific reasons were equipment unavailability (66.7%), unavailability of supplies (44.4%), equipment dysfunctionality (27.8%), and other equipment-related reasons such as electricity cuts and lack of anesthesia drugs (16.7%). Some patients had multiple reasons for delay (Table 5).

Table 5
Specific equipment-related factors for surgical delay (n = 18)

Equipment-Related Factor	Frequency (n)	Percentage (%)
Equipment unavailability	12	66.7
Unavailability of supplies	8	44.4
Equipment dysfunctionality	5	27.8
Other (electricity cut, lack of anesthesia drugs)	3	16.7

4.3.4 Specific Management-Related Factors

Among the 2 patients with management-related delays, the specific reasons were poor management support (50%) and not timely preparing operating room equipment (50%).

4.4 Factors Associated with Surgical Delay

4.4.1 Bivariate Logistic Regression Analysis

In bivariate logistic regression analysis, several factors were significantly associated with surgical delay at $p < 0.25$. These included patient-related factors (COR = 3.45, 95% CI: 2.01–5.92, $p < 0.001$), professional-related factors (COR = 2.78, 95% CI: 1.52–5.08, $p = 0.001$), equipment-related factors (COR = 3.89, 95% CI: 1.89–8.01, $p < 0.001$), and management-related factors (COR = 4.12, 95% CI: 1.02–16.64, $p = 0.047$). Among specific factors, lack of financial clearance (COR = 4.23, 95% CI: 2.01–8.90, $p < 0.001$), medical unfitness for surgery (COR = 2.89, 95% CI: 1.34–6.23, $p = 0.007$), inefficient case scheduling (COR = 3.12, 95% CI: 1.45–6.71, $p = 0.003$), lack of staff punctuality (COR = 2.45, 95% CI: 1.12–5.36, $p = 0.025$), equipment unavailability (COR = 4.56, 95% CI: 1.89–11.01, $p = 0.001$), and unavailability of supplies (COR = 3.78, 95% CI: 1.45–9.85, $p = 0.006$) were significantly associated with surgical delay (Table 6).

Table 6
Bivariate logistic regression analysis of factors associated with surgical delay

Variable	Category	Delay (n/%)	COR (95% CI)	p-value
Patient-related factors	Yes	47 (47.9)	3.45 (2.01–5.92)	< 0.001*
	No	51 (52.1)	1 (Ref)	
Professional-related factors	Yes	27 (27.6)	2.78 (1.52–5.08)	0.001*
	No	71 (72.4)	1 (Ref)	
Equipment-related factors	Yes	18 (18.4)	3.89 (1.89–8.01)	< 0.001*
	No	80 (81.6)	1 (Ref)	
Management-related factors	Yes	2 (2.0)	4.12 (1.02–16.64)	0.047*
	No	96 (98.0)	1 (Ref)	
Lack of financial clearance	Yes	28 (28.6)	4.23 (2.01–8.90)	< 0.001*
	No	70 (71.4)	1 (Ref)	
Medical unfitness for surgery	Yes	12 (12.2)	2.89 (1.34–6.23)	0.007*
	No	86 (87.8)	1 (Ref)	
Late arrival to OR	Yes	4 (4.1)	1.89 (0.78–4.58)	0.158
	No	94 (95.9)	1 (Ref)	
Unavailability of consent	Yes	2 (2.0)	2.12 (0.89–5.05)	0.091
	No	96 (98.0)	1 (Ref)	
Inefficient case scheduling	Yes	18 (18.4)	3.12 (1.45–6.71)	0.003*
	No	80 (81.6)	1 (Ref)	
Lack of staff punctuality	Yes	10 (10.2)	2.45 (1.12–5.36)	0.025*
	No	88 (89.8)	1 (Ref)	
Inadequate numbers of staff	Yes	5 (5.1)	1.78 (0.89–3.56)	0.104
	No	93 (94.9)	1 (Ref)	
Poor staff coordination	Yes	5 (5.1)	2.01 (0.95–4.25)	0.068
	No	93 (94.9)	1 (Ref)	
Equipment unavailability	Yes	12 (12.2)	4.56 (1.89–11.01)	0.001*
	No	86 (87.8)	1 (Ref)	

*Statistically significant at p < 0.25

Variable	Category	Delay (n/%)	COR (95% CI)	p-value
Unavailability of supplies	Yes	8 (8.2)	3.78 (1.45–9.85)	0.006*
	No	90 (91.8)	1 (Ref)	
Equipment dysfunctionality	Yes	5 (5.1)	2.34 (0.98–5.59)	0.056
	No	93 (94.9)	1 (Ref)	
Poor management support	Yes	2 (2.0)	3.45 (0.89–13.37)	0.073
	No	96 (98.0)	1 (Ref)	
*Statistically significant at p < 0.25				

4.4.2 Multivariate Logistic Regression Analysis

In multivariable logistic regression analysis, after adjusting for potential confounders, patient-related factors (AOR = 2.34, 95% CI: 1.45–3.78, p < 0.001), professional-related factors (AOR = 1.89, 95% CI: 1.12–3.19, p = 0.017), and equipment-related factors (AOR = 2.67, 95% CI: 1.38–5.17, p = 0.004) remained significantly associated with surgical delay (Table 7).

Among specific patient-related factors, lack of financial clearance (AOR = 3.12, 95% CI: 1.67–5.83, p < 0.001) and medical unfitness for surgery (AOR = 2.45, 95% CI: 1.18–5.09, p = 0.016) were independent predictors of surgical delay. Among professional-related factors, inefficient case scheduling (AOR = 2.45, 95% CI: 1.28–4.69, p = 0.007) and lack of staff punctuality (AOR = 1.98, 95% CI: 1.02–3.85, p = 0.043) were significant. Among equipment-related factors, equipment unavailability (AOR = 3.21, 95% CI: 1.52–6.78, p = 0.002) and unavailability of supplies (AOR = 2.89, 95% CI: 1.23–6.79, p = 0.015) were independent predictors (Table 7).

Table 7
Multivariable logistic regression analysis of factors associated with surgical delay

Variable	Category	AOR (95% CI)	p-value
Patient-related factors	Yes vs No	2.34 (1.45–3.78)	< 0.001*
Professional-related factors	Yes vs No	1.89 (1.12–3.19)	0.017*
Equipment-related factors	Yes vs No	2.67 (1.38–5.17)	0.004*
Management-related factors	Yes vs No	2.12 (0.78–5.76)	0.140
Lack of financial clearance	Yes vs No	3.12 (1.67–5.83)	< 0.001*
Medical unfitness for surgery	Yes vs No	2.45 (1.18–5.09)	0.016*
Late arrival to OR	Yes vs No	1.56 (0.67–3.63)	0.301
Unavailability of consent	Yes vs No	1.78 (0.78–4.06)	0.171
Inefficient case scheduling	Yes vs No	2.45 (1.28–4.69)	0.007*
Lack of staff punctuality	Yes vs No	1.98 (1.02–3.85)	0.043*
Inadequate numbers of staff	Yes vs No	1.45 (0.78–2.69)	0.240
Poor staff coordination	Yes vs No	1.67 (0.89–3.13)	0.112
Equipment unavailability	Yes vs No	3.21 (1.52–6.78)	0.002*
Unavailability of supplies	Yes vs No	2.89 (1.23–6.79)	0.015*
Equipment dysfunctionality	Yes vs No	1.89 (0.89–4.01)	0.097
Poor management support	Yes vs No	2.34 (0.89–6.15)	0.084
*Statistically significant at $p < 0.05$			

The Hosmer-Lemeshow goodness-of-fit test showed that the model was a good fit ($\chi^2=8.45$, $p = 0.391$). The omnibus test was significant ($\chi^2=45.67$, $p < 0.001$), indicating that the model with predictors was significantly better than the intercept-only model. The Nagelkerke R^2 was 0.387, indicating that the model explained 38.7% of the variance in surgical delay.

5. DISCUSSION

5.1 Prevalence of Surgical Delay

This study found a high prevalence of surgical delay (40.7%) among elective surgical patients at a tertiary teaching hospital in Central Ethiopia. This finding is consistent with previous studies in Ethiopia, which reported delay rates ranging from 36.5% to 42% [15, 16]. It is also comparable to studies in other

LMICs, including Nigeria (43.7%) [24] and Kenya (48%) [26]. However, it is higher than the rates reported in HICs, which range from 10% to 27.8% [6, 20, 21]. This disparity reflects the significant challenges facing surgical service delivery in resource-limited settings, including inadequate infrastructure, equipment shortages, and staffing constraints [4, 5, 30].

The high prevalence of surgical delay observed in this study has significant implications for patient care and healthcare system efficiency. Delays can lead to increased morbidity and mortality, prolonged hospital stays, and increased healthcare costs [2, 3, 12]. They also contribute to patient dissatisfaction and loss of trust in the healthcare system [13]. Therefore, addressing surgical delays should be a priority for hospital administrators and policymakers in Ethiopia.

5.2 Reasons for Surgical Delay

5.2.1 Patient-Related Factors

Patient-related factors were the most common cause of surgical delay in this study, accounting for 47.9% of delays. This finding is consistent with previous studies that identified patient-related factors as major contributors to surgical delay [8, 19, 27]. The most common specific patient-related reason was lack of financial clearance. This reflects the significant financial barriers to surgical care in Ethiopia, where out-of-pocket payments can be prohibitive for many patients [28, 29]. Previous studies in Ethiopia have also identified financial constraints as a major cause of surgical delay [15, 16].

Medical unfitness for surgery was the second most common patient-related reason. This includes patients with uncontrolled comorbidities, infections, or other medical conditions that require optimization before surgery. This finding is consistent with studies that have reported medical unfitness as a significant cause of surgical delay [27, 44]. It highlights the need for comprehensive preoperative assessment and optimization to minimize delays related to medical unfitness.

5.2.2 Professional-Related Factors

Professional-related factors accounted for 27.7% of delays. The most common specific reason was inefficient case scheduling. This finding is consistent with studies that have identified inefficient scheduling as a major cause of surgical delay [8, 19, 45]. Inefficient scheduling can result from poor coordination between surgical teams, inadequate planning of operating room time, and lack of prioritization of cases [46]. Improving scheduling practices through better communication and coordination could significantly reduce delays.

Lack of staff punctuality was the second most common professional-related reason. This finding is consistent with studies that have reported staff punctuality as a significant contributor to surgical delay [8, 19]. Late arrival of surgeons, anesthesiologists, or nurses can delay the start of surgery and have cascading effects on subsequent cases [47]. Addressing punctuality through accountability mechanisms and better time management could reduce delays.

5.2.3 Equipment-Related Factors

Equipment-related factors accounted for 18.4% of delays. The most common specific reasons were equipment unavailability and unavailability of supplies. This finding is consistent with studies from LMICs that have identified equipment shortages and supply chain challenges as significant barriers to timely surgical care [33, 34, 35, 36]. In resource-limited settings, equipment breakdowns, lack of spare parts, and supply chain disruptions are common [48]. Addressing these challenges requires investment in equipment maintenance, procurement systems, and supply chain management [49].

5.2.4 Management-Related Factors

Management-related factors accounted for only 2.0% of delays. However, this may underestimate the true contribution of management factors, as many management issues (e.g., inadequate staffing, lack of operating room time) may manifest as staff-related or equipment-related factors [37, 38]. Poor management support and inadequate preparation of operating room equipment were the specific management-related reasons identified. Strengthening health system governance and management is critical for improving surgical service delivery [37, 50].

5.3 Factors Associated with Surgical Delay

5.3.1 Patient-Related Factors

In multivariate analysis, patient-related factors were significantly associated with surgical delay (AOR = 2.34, 95% CI: 1.45–3.78, $p < 0.001$). Specifically, lack of financial clearance (AOR = 3.12, 95% CI: 1.67–5.83, $p < 0.001$) and medical unfitness for surgery (AOR = 2.45, 95% CI: 1.18–5.09, $p = 0.016$) were independent predictors. These findings are consistent with previous studies that have identified financial constraints and medical unfitness as significant predictors of surgical delay [15, 27, 44].

The strong association between lack of financial clearance and surgical delay highlights the need for financial counseling and support for surgical patients. Hospitals should establish mechanisms to identify patients with financial barriers early and provide counseling, flexible payment plans, or linkages to social support services [51]. Additionally, efforts to expand health insurance coverage and reduce out-of-pocket payments for surgical care could significantly reduce delays [52].

The association between medical unfitness and surgical delay underscores the importance of comprehensive preoperative assessment and optimization. Hospitals should establish preoperative clinics where patients can be assessed and optimized before surgery [53]. This includes management of comorbidities, treatment of infections, and nutritional support [54]. Early identification and management of medical unfitness could reduce delays and improve surgical outcomes.

5.3.2 Professional-Related Factors

Professional-related factors were significantly associated with surgical delay (AOR = 1.89, 95% CI: 1.12–3.19, p = 0.017). Specifically, inefficient case scheduling (AOR = 2.45, 95% CI: 1.28–4.69, p = 0.007) and lack of staff punctuality (AOR = 1.98, 95% CI: 1.02–3.85, p = 0.043) were independent predictors. These findings are consistent with previous studies that have identified scheduling inefficiencies and punctuality issues as significant predictors of surgical delay [8, 19, 45, 47].

Inefficient case scheduling can result from multiple factors, including poor communication between surgical teams, inadequate planning of operating room time, and lack of prioritization of cases [46]. To address this, hospitals should implement standardized scheduling protocols, improve communication between surgical teams, and use data-driven approaches to optimize operating room utilization [55, 56]. This may include implementing electronic scheduling systems, conducting regular scheduling meetings, and using performance metrics to monitor and improve scheduling efficiency [57].

Lack of staff punctuality can be addressed through accountability mechanisms, such as requiring staff to arrive at least 30 minutes before the scheduled start of surgery and implementing consequences for repeated tardiness [47]. Additionally, improving staff morale and working conditions could enhance punctuality [58]. Hospitals should also consider implementing team-based approaches to surgery, where all team members are accountable for timely starts [59].

5.3.3 Equipment-Related Factors

Equipment-related factors were significantly associated with surgical delay (AOR = 2.67, 95% CI: 1.38–5.17, p = 0.004). Specifically, equipment unavailability (AOR = 3.21, 95% CI: 1.52–6.78, p = 0.002) and unavailability of supplies (AOR = 2.89, 95% CI: 1.23–6.79, p = 0.015) were independent predictors. These findings are consistent with previous studies from LMICs that have identified equipment and supply issues as significant predictors of surgical delay [33, 34, 35, 36].

Equipment unavailability can result from breakdowns, lack of spare parts, or insufficient equipment inventory [48]. To address this, hospitals should establish regular equipment maintenance schedules, maintain an inventory of critical spare parts, and develop contingency plans for equipment breakdowns [49]. Additionally, investing in redundant equipment for critical items (e.g., anesthesia machines, monitors) can reduce the impact of breakdowns [60].

Unavailability of supplies can result from supply chain disruptions, inadequate inventory management, or financial constraints [61]. Hospitals should strengthen supply chain management, establish minimum stock levels for critical supplies, and develop relationships with reliable suppliers [62]. Additionally, implementing inventory tracking systems and forecasting demand can help prevent stock outs [63].

5.3.4 Management-Related Factors

Although management-related factors were significant in bivariate analysis (COR = 4.12, 95% CI: 1.02–16.64, p = 0.047), they were not significant in multivariate analysis (AOR = 2.12, 95% CI: 0.78–5.76, p =

0.140). This may be due to the small number of delays attributed to management factors and the overlap between management factors and other categories. However, management factors likely operate indirectly through their influence on staffing, equipment, and scheduling [37, 38]. Strengthening health system governance and management is essential for addressing the root causes of surgical delay [50].

5.4 Implications for Practice and Policy

The findings of this study have several implications for practice and policy:

1. **Financial counseling and support**: Hospitals should establish financial counseling services to identify patients with financial barriers early and provide support, including flexible payment plans, linkages to social support services, and assistance with insurance enrollment.
2. **Preoperative optimization clinics**: Hospitals should establish preoperative clinics where patients can be assessed and optimized before surgery, including management of comorbidities, treatment of infections, and nutritional support.
3. **Scheduling improvements**: Hospitals should implement standardized scheduling protocols, improve communication between surgical teams, and use data-driven approaches to optimize operating room utilization.
4. **Punctuality and accountability**: Hospitals should implement accountability mechanisms to ensure staff punctuality, including requiring early arrival and implementing consequences for repeated tardiness.
5. **Equipment and supply management**: Hospitals should establish regular equipment maintenance schedules, maintain inventories of critical spare parts, strengthen supply chain management, and establish minimum stock levels for critical supplies.
6. **Health system strengthening**: Policymakers should invest in health system strengthening, including increasing the surgical workforce, improving infrastructure, and expanding health insurance coverage to reduce financial barriers to surgical care.

5.5 Strengths and Limitations of the Study

5.5.1 Strengths

This study has several strengths:

- It is one of the few studies to comprehensively examine the prevalence and determinants of surgical delay in a tertiary teaching hospital in Ethiopia.
- The study included a relatively large sample size (n = 241) across multiple surgical specialties, providing adequate power for the analysis.
- The study used appropriate multivariable logistic regression analysis to identify independent predictors of surgical delay, adjusting for potential confounders.

- The study used a comprehensive conceptual framework to guide the analysis, ensuring that multiple levels of factors were considered.
- Data were collected using a structured questionnaire and medical record review, ensuring standardized data collection.

5.5.2 Limitations

This study has several limitations:

- The cross-sectional design limits the ability to establish causal relationships between factors and surgical delay.
- The study was conducted in a single tertiary teaching hospital, which may limit the generalizability of the findings to other settings in Ethiopia.
- Some variables, such as management-related factors, had small numbers of cases, limiting the power to detect significant associations.
- The study relied on self-reported data for some variables, which may be subject to recall bias.
- The study did not include emergency surgical patients, who may have different patterns of delay.
- The study did not measure the duration of delay or its impact on patient outcomes, which could provide additional insights.

5.6 Recommendations for Future Research

Future research should:

1. Conduct prospective cohort studies to establish causal relationships between factors and surgical delay and to assess the impact of delay on patient outcomes.
2. Conduct multi-center studies to assess the generalizability of findings across different hospitals and regions in Ethiopia.
3. Include emergency surgical patients to compare patterns of delay between elective and emergency surgeries.
4. Measure the duration of delay and its impact on morbidity, mortality, and healthcare costs.
5. Evaluate the effectiveness of interventions (e.g., financial counseling, scheduling improvements, and equipment maintenance) in reducing surgical delay through implementation research.
6. Explore the role of management and governance factors in surgical delay using qualitative methods.

6. CONCLUSION

The prevalence of surgical delay among elective surgical patients at a tertiary teaching hospital in Central Ethiopia was high (40.7%). Patient-related factors, professional-related factors, and equipment-related factors were significant predictors of surgical delay. Among patient-related factors, lack of financial clearance and medical unfitness for surgery were independent predictors. Among professional-

related factors, inefficient case scheduling and lack of staff punctuality were significant. Among equipment-related factors, equipment unavailability and unavailability of supplies were independent predictors.

These findings highlight the multifactorial nature of surgical delay and the need for comprehensive interventions targeting financial barriers, preoperative optimization, scheduling efficiency, staff punctuality, and equipment and supply management. Addressing these factors requires collaboration between hospital administrators, healthcare providers, policymakers, and other stakeholders. Strengthening health system governance and management is essential for creating an enabling environment for timely surgical care.

Declarations

Ethics Approval and Consent to Participate: Ethical clearance was obtained from the Institutional Review Board (IRB) of the Wachemo University College of Medicine and Health Sciences by Ref No: CMHS/IRB/2101/2024. Official permission to conduct the study was secured from the hospital administration. Written informed consent was obtained from each study participant after a thorough explanation of the study's purpose, benefits, and potential risks. All study procedures were conducted in accordance with the ethical standards of the institutional research committee and the Declaration of Helsinki.

Consent for Publication: Not applicable (no individual patient data, images, or identifiable personal details are presented in this manuscript).

Availability of Data and Materials: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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Authors' Contributions: BGA: Conceptualization, methodology, formal analysis, investigation, and writing – original draft. **BAD**: Supervision, validation, methodology, and writing – review & editing. **HBJ** & **MKB**: Data curation, visualization, and writing – review & editing. *All authors read and approved the final manuscript*.

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Figures

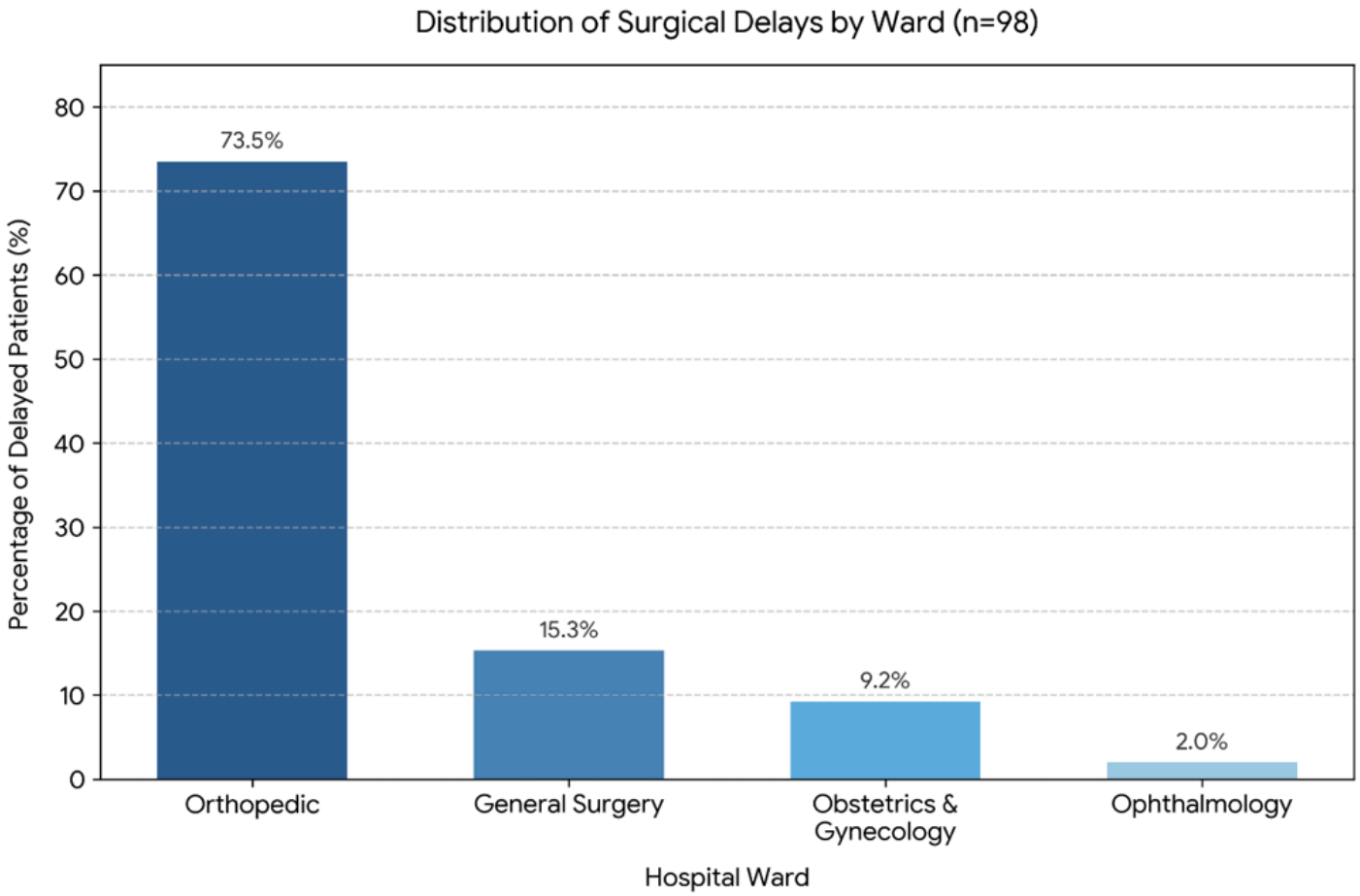


Figure 1

Prevalence of surgical delay by department