

**A COMPARATIVE STUDY ON VARIANCE BETWEEN ESTIMATED AND FINAL
BILLING IN CARDIOLOGY AND GENERAL SURGERY DEPARTMENTS AT A
TERTIARY CARE HOSPITAL**

Dissertation Submitted to



The IIHMR University, Jaipur

for the partial fulfillment for the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

by

Gursimran Kaur

Under the Supervision and Guidance of

Dr. Mamta Chauhan

2025



MAX
Healthcare



CERTIFICATE

This is to certify that **Dr. Gursimran Kaur** in partial fulfillment of the requirements for the award of the degree of MBA Hospital and Health Management from the IIMMR University, Jaipur has successfully completed her internship at Max Super Speciality Hospital, Shalimar Bagh during Mar 10 - May 31, 2025.

Place: Delhi
Date: 2nd June'2025

25
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CERTIFICATE

This is to certify that dissertation titled “A Comparative Study on Variance between Estimated and Final billing in Cardiology and General Surgery departments at a Tertiary Care Hospital” is a record of the research work undertaken by Dr. Gursimran Kaur in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.

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A handwritten signature in blue ink, appearing to read 'S. Gupta', with a horizontal line underneath.

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DECLARATION BY STUDENT

I hereby declare that this dissertation “**A Comparative Study on Variance between Estimated and Final billing in Cardiology and General Surgery departments at a Tertiary Care Hospital**” is the Bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

(Signature)


Dr. Gursimran Kaur

Date: 19/06/2025

ABSTRACT:

In the rapidly evolving landscape of healthcare, the accuracy of financial estimates provided to patients before treatment plays a pivotal role in shaping their overall experience and trust in the hospital system. This dissertation examines the variance between estimated and final billed amounts in the Cardiology and General Surgery departments of Max Super Speciality Hospital, Shalimar Bagh - a NABH and NABL accredited tertiary care hospital. The study is driven by the need to understand the operational and clinical factors contributing to billing discrepancies and to provide actionable insights that can improve hospital billing practices.

The main goals of this study are to evaluate the extent of estimation accuracy, compare the estimation performance between departments, and analyze the root causes for discrepancies. Conducted as a retrospective, descriptive, and comparative study, it included a total of 567 patients discharged between January and March 2025. Patients with complete records of estimated and final billing were selected through purposive sampling. "Data was analyzed in Microsoft Excel using statistical methods and visual tools including bar charts and pie charts to find patterns, compare departmental accuracy, and illustrate variance distribution.

The findings revealed that significant differences existed between estimated and actual billed amounts in both departments, with Cardiology showing slightly higher variance. The five leading reasons for variance were identified as increased pharmacy bills, variations in length of stay (LOS), use of implants, unexpected procedural changes, and reductions in investigations or pharmacy needs. Among these, LOS and pharmacy costs emerged as dominant predictors.

The study concludes that while estimations are foundational to financial transparency, their accuracy is often limited by dynamic clinical events that unfold during patient care. The research recommends implementing integrated estimation systems tied to electronic medical records (EMRs), standardizing departmental estimation practices, training cross-functional teams, and conducting regular variance audits. These measures can significantly reduce estimation errors, thereby improving patient communication, institutional reputation, and financial sustainability.

Keywords: Estimation Accuracy, Hospital Billing, Cardiology, General Surgery, Billing Variance

AKNOWLEDGEMENT

I am deeply grateful to **Mr. Arvind Pahwa, Unit Head, Max Super Speciality Hospital, Shalimar Bagh**, for the opportunity to complete my Dissertation in the **Hospital operations and Quality Department**. And for the experience has been both enriching and inspiring,

First and foremost, I would like to express my profound gratitude. to **Dr. Girija Ruge Yadav, GM Hospital Operations, Max Super Speciality Hospital, Shalimar Bagh**, whose exceptional guidance and mentorship over the past three months have been invaluable.

I am deeply grateful **Mrs. Sudarshana Shrimal, Mr. Sarabjeet Singh Khanuja** and **Mr. Ranjit Kumar** at **Max Super Speciality Hospital, Shalimar Bagh** for their seamless coordination and assistance, which ensured a smooth and productive dissertation.

I am deeply grateful to **Mr. Akshay Arjune, Deputy Manager – Human Resources** at **Max Super Speciality Hospital, Shalimar Bagh**, for his invaluable support and coordination throughout the dissertation process. His guidance and assistance at every stage from onboarding to orientation ensured a seamless entry into the organization.

I would want to truly thank **Mr. Jaswinder Pal Singh, Mrs. Gurvinder Kaur, Mr Ashish Chawla, Ms. Kanwalpreet Arora, Ms. Tavneet Kaur, Ms. Manmeet Kaur, Dr. Bhumika Taneja, Ms. Ipsita Panigrahi, Dr. Nimeshika Sharma, Ms. Mannat Verma** for their unwavering support, encouragement throughout the course of this dissertation. Their emotional strength, understanding and constant motivation have been a pillar of strength.

I am also immensely thankful to **Dr. Mamta Chauhan, Professor at IIHMR Jaipur**, for her constant support, insights, and encouragement have been crucial in helping me navigate and make the most of this experience.

Dr. Gursimran Kaur

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CHAPTER 1: INTRODUCTION

1.1 Background and Context

Accurate financial estimation of medical expenses is a critical pillar in ensuring transparency, patient satisfaction, and financial predictability in healthcare service delivery. In modern hospital operations - particularly in tertiary care facilities - the ability to generate realistic pre-treatment estimates directly impacts patient trust, administrative efficiency, and the institution's credibility. With increasing healthcare costs and rising dependency on insurance and third-party administrators (TPAs), hospitals are expected to provide upfront financial clarity to patients and their families. ⁽¹⁾ However, due to the dynamic and often unpredictable nature of clinical care, substantial variance frequently arises between the initially estimated amount and the final bill generated at discharge.

Cardiology and general surgery departments are often high-volume, high-cost specialties where such discrepancies are more pronounced. ⁽²⁾⁽⁵⁾ These departments deal with acute and complex cases where intraoperative changes, the need for emergency interventions, the use of implants, pharmacy fluctuations, and variations in the length of hospital stay (LOS) can quickly lead to deviations from the originally estimated costs. Though some of these variances are clinically justified and inevitable, they can become problematic when consistent patterns of over- or underestimation arise due to operational inefficiencies or non-standardized billing processes. ⁽⁴⁾⁽⁶⁾

Max Super Specialty Hospital, Shalimar Bagh, a NABH and NABL accredited tertiary care hospital under the Max Healthcare group, provides advanced clinical care and robust administrative support systems. The hospital caters to a diverse patient population including cash, TPA, and international patients. It maintains structured systems for clinical documentation, digital billing, and cost estimation, making it an ideal setting for an in-depth analysis of billing variance.

1.2 Problem Statement

Despite the widespread use of estimation tools, hospitals often lack structured review mechanisms to assess estimation accuracy. Estimation protocols may not always reflect real-time clinical variables, leading to unanticipated financial burdens for patients or financial losses for the institution. The absence of periodic analysis and standardized estimation

workflows leads to discrepancies that could otherwise be anticipated or corrected. Moreover, the lack of alignment between clinical and billing teams further widens the gap between anticipated and actual healthcare expenditures.

In Cardiology and General Surgery departments, where patients often undergo elective or semi-elective interventions with pre-defined packages, the expectation of accurate billing is high. Variance in these settings not only affects institutional reputation but also hampers cost planning, TPA approvals, and post-operative financial reconciliation. The need to understand, quantify, and categorize such discrepancies is, therefore, imperative to improve overall hospital operations and patient communication.

1.3 Purpose of the Study

The fundamental goal of this study is to investigate the variance between estimated and final billing in the departments of Cardiology and General Surgery in a tertiary care setting. The research aims to determine the extent of estimation accuracy, understand department-specific causes of variance, and propose strategies to mitigate these discrepancies. By conducting a retrospective data-driven analysis, this study aims to provide practical findings that might result in more accurate billing processes, enhanced patient satisfaction, and stronger interdepartmental coordination.

1.4 Research Objectives

The study specifically intends:

- To assess the variance between estimated and final billed amounts in Cardiology and General Surgery departments.
- To identify the major reasons contributing to variance in billing.
- To compare estimation accuracy between the two departments.
- To categorize types and frequencies of variance.
- To evaluate the proportion of accurate estimates (variance within $\pm 10\%$).

1.5 Research Question

What are the major reasons for variance between estimated and final billed amounts in Cardiology and General Surgery departments, and how accurately are estimates being provided?

1.6 Hypotheses

- Null Hypothesis (H_0): There is no significant difference in estimation accuracy between the Cardiology and General Surgery departments.
- Alternative Hypothesis (H_1): There is a significant difference in estimation accuracy between the two departments.

1.7 Significance of Study

This study contributes to the growing need for financial transparency and efficiency in hospital management. By identifying department-specific trends in estimation variance, the findings can support hospital administrators in strengthening estimation protocols, training clinical and billing teams, and optimizing digital tools for more accurate forecasting. Ultimately, this research aims to reduce billing-related grievances, enhance institutional credibility, and improve the overall patient experience in tertiary care settings.

CHAPTER 2: REVIEW OF LITERATURE

This chapter summarizes previous research and publications relevant to the variance between estimated and final billing in hospitals, particularly focusing on cardiology and general surgery. The literature reviewed explores healthcare cost estimation challenges, patient satisfaction related to billing, cost drivers such as length of stay and pharmacy usage, and discrepancies across different healthcare settings.

The studies included span across national and international contexts and provide a foundation for understanding estimation dynamics and operational variances in hospitals. The table below summarizes the reviewed literature:

Author (Year)	Study Location	Sample Size	Sampling Technique	Salient Features
Lim SL et al. (2022)	Malaysia	329 patients	Based on retrospective patient record review	Found that extended stays in ICU and CCU were major contributors to higher hospital costs.
Ong SC et al. (2022)	Malaysia	Multi-center	Data gathered from multiple hospital sites retrospectively	Revealed that treatment expenses for heart failure vary considerably across institutions.
Tupe D et al. (2024)	India	652 drugs	Comparative analysis of drug costs	Highlighted major differences in the pricing of medications used for heart failure treatment.

Table 2.1: Summary of Reviewed Literature

Prinja S et al. (2013)	India	12 surgeries	Detailed cost estimation using micro-costing methods	Showed that hospitals often spend more on surgical care than the reimbursement they receive.
Lesyuk W et al. (2018)	Global	35 studies	Literature-based systematic review	Concluded that inpatient care is the most expensive element in managing heart failure.
Health-e Blog (2022)	India	Not stated	Observational review of available data	Provided a comparison of open-heart surgery costs in public versus private hospitals.
Haidar A et al. (2024)	USA	4.7 million cases	Nationwide hospital billing data analysis	Found that cardiovascular procedures were among the most financially demanding hospitalizations.
Patel K et al. (2013)	USA	850 patients	Cross-sectional survey-based study	Linked billing dissatisfaction to poor communication between hospitals and patients.

Table 2.1: Summary of Reviewed Literature (Continued)

The findings reinforce the importance of integrating cost analysis with clinical workflows to improve estimation accuracy.

The review also supports the rationale of this study, showing that factors such as length of stay, pharmacy and diagnostics utilization, and unplanned procedural changes significantly contribute to final billing discrepancies.

CHAPTER 3: METHODOLOGY

This chapter explains the research methodology used in the study, including the research design, population, sampling, data tools, statistical methods, and ethical considerations. It also incorporates the research questions and hypotheses as defined in the approved synopsis for clarity and alignment.

3.1 Research Questions

The study was guided by the following research questions:

What is the variance between estimated and final billed amounts in the departments of Cardiology and General Surgery?

What are the major factors contributing to this variance?

How does estimation accuracy differ between the two departments?

What percentage of patients have accurate estimates (variance within $\pm 10\%$)?

3.2 Research Design

The study is a retrospective, observational, descriptive, and comparative analysis of estimation accuracy and billing variance in Cardiology and General Surgery departments. It is a quantitative study based on secondary data analysis.

3.3 Study Setting

The study was conducted at Max Super Specialty Hospital, Shalimar Bagh, New Delhi, a NABH and NABL accredited tertiary care hospital offering high-end clinical and diagnostic services. The facility has a dedicated billing and finance department with standardized estimation and documentation processes.

3.4 Study Population

All patients admitted and discharged under the Cardiology and General Surgery departments from January 1 to March 31, 2025 formed the population of interest. The study was restricted to patients with available and complete data on both the estimated amount and final bill.

3.4.1 Inclusion Criteria

All cash, TPA and International discharged patients from Cardiology and General Surgery departments.

Patients with available and complete estimated and final billing records.

Patients discharged between January and March 2025.

3.4.2 Exclusion Criteria

Emergency-only, daycare, and diagnostic patients.

Patients from other departments.

Patients with incomplete billing records.

PSU and EWS category patients.

3.4.3 Sample Size and Sampling Technique

The study used purposive sampling to cover 567 discharged patients. Out of these, 291 patients belonged to the Cardiology department and 276 patients to the General Surgery department.

3.4.4 Study Tools and Instruments

A structured Microsoft Excel sheet was used to extract and record the following data points:

Patient department

Type of payer (TPA/Cash/International)

Estimated amount

Final billed amount

Length of stay (estimated and actual)

Category of accuracy/variance

Reason for variance (if any)

3.5 Operational Definitions

Accurate Estimate: Final bill amount within $\pm 10\%$ of the estimate.

Variance: Any billing discrepancy beyond $\pm 10\%$ of the estimate.

Reason for Variance: Categories such as pharmacy deviation, LOS change, procedure changes, implant use, etc.

3.6 Data Analysis Methods (Using Microsoft Excel)

Microsoft Excel was used for organizing, cleaning, and analyzing the data. The steps included:

- Data entry and consistency checks for accurate variables.
- Calculation of variance percentage for each patient.
- Classification of each case as “accurate,” “underestimated,” or “overestimated” using Excel formulas.
- Tabulation and frequency analysis through filters and functions.
- Creation of PivotTables to analyze data by department, payer type, and variance reason.
- Generation of visual aids such as bar graphs and pie charts to depict accuracy and variance trends.
- Average and range calculations to assess the distribution of estimation differences.

3.7 Ethical Considerations

Institutional Approval: Formal permission for secondary data access was obtained from the hospital administration.

Confidentiality: All data were anonymized and coded to ensure no personal patient information was disclosed.

Voluntary Participation: Data collection did not involve any direct interaction with patients.

Data Protection: Digital files were stored in encrypted folders on password-protected systems.

Ethical Review: This study protocol was authorized by IIHMR University's institutional ethical review committee.

CHAPTER 4: RESULTS

This chapter displays the outcomes of the study conducted on billing estimation accuracy in the Cardiology and General Surgery departments of Max Super Speciality Hospital, Shalimar Bagh. The results are analyzed and interpreted using tables and figures derived from patient records, grouped by variance categories, departments, and reasons for discrepancies. Each section highlights department-wise comparisons and patterns observed from the collected data.

4.1 Sample Overview:

The study covered 567 patients.:

- Cardiology: 291 patients
- General Surgery: 276 patients

Each patient record included the estimated amount, final billed amount, and the variance along with its documented reason (if any). Patients were categorized based on the percentage deviation from the estimated amount and assigned to appropriate variance categories.

4.2 Data Analysis Detail:

Data analysis was carried out using Microsoft Excel. The following steps were performed:

- Entry and validation of patient-level data
- Classification of estimation variance as accurate, under, or overestimated
- Grouping based on department and variance ranges
- Reason coding for each discrepancy
- Pivot table creation and generation of bar and pie charts

This allowed for comprehensive department-wise comparisons and the identification of trends and gaps in estimation practices.

4.3 Department-wise Accuracy and Error Analysis:

The estimation accuracy was assessed by comparing the final billed amount with the estimated amount. A case was classified as accurate if the final amount was within $\pm 10\%$ of the estimated amount.

Department	Accuracy	Error	Total
Cardiology	229	62	291
General surgery	193	83	276

Table 4.1: Accuracy and Error Count by Department

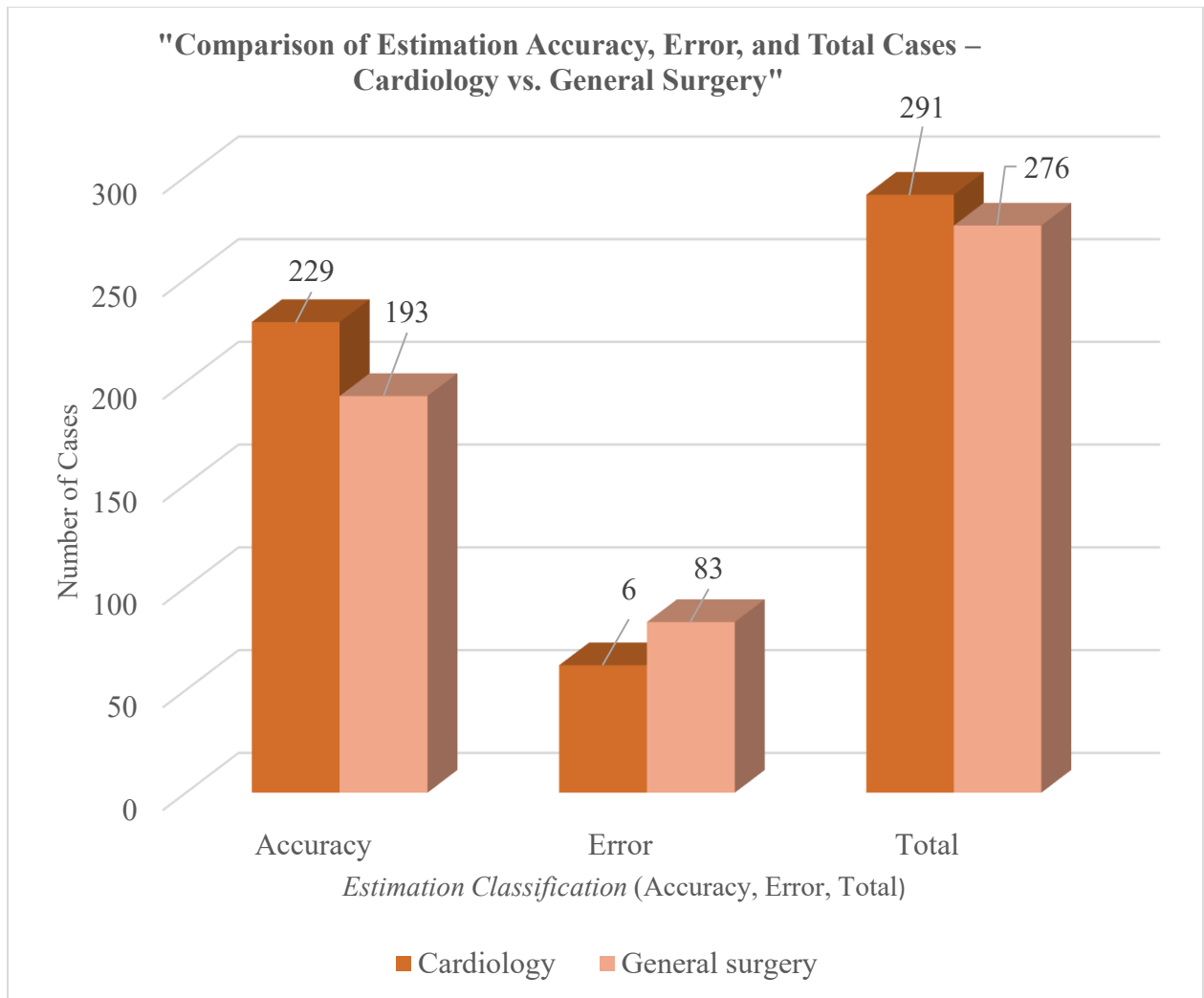


Figure 4.1: Comparative Accuracy and Error by Department

Cardiology department demonstrates stronger estimation performance, both in terms of higher accuracy and dramatically fewer errors, despite managing a comparable number of patients. On the other hand, General Surgery exhibits a much higher error rate, implying that it may benefit from targeted interventions such as estimate reviews, better planning for surgical variability, or process standardization.

4.4 Distribution of Variance Categories:

Cases were also grouped into three categories: Accurate ($\pm 10\%$), Overestimated ($>10\%$), and Underestimated ($< -10\%$).

Category	Total	Percentage
Accurate ($\hat{A} \pm 10\%$)	229	79
Over Estimate	31	11
Under Estimate	31	11

Table 4.2: Distribution of Variance Categories - Cardiology

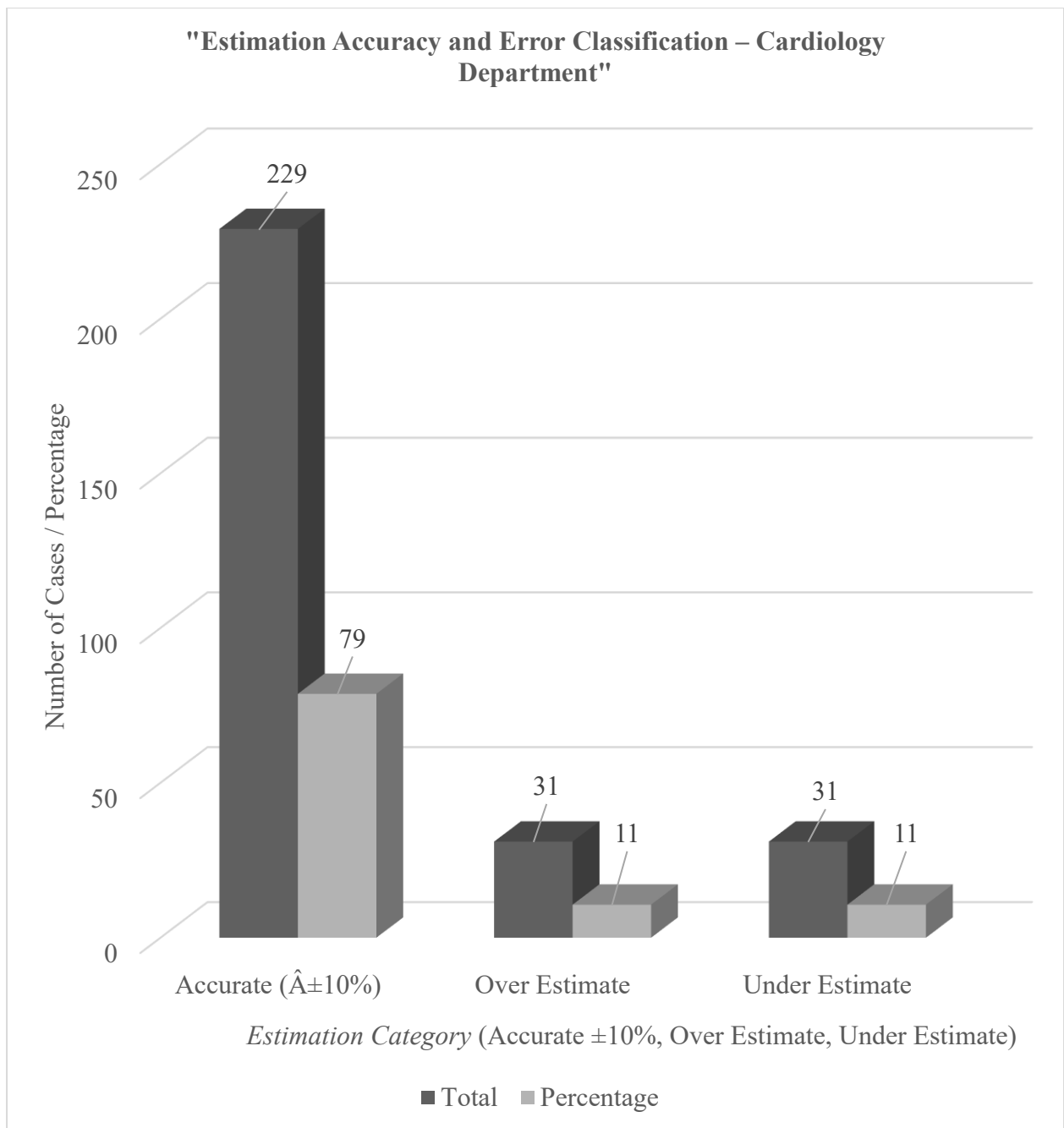


Figure 4.2: Cardiology – Variance Distribution Bar Chart

This chart illustrates that 79% of Cardiology cases fell within the accurate range, with 11% each being over- and under-estimated.

Category	Count	Percentage
Accurate ($\hat{A} \pm 10\%$)	193	70
Over Estimate	44	16
Under Estimate	39	14

Table 4.3: Variance Category Distribution – General Surgery

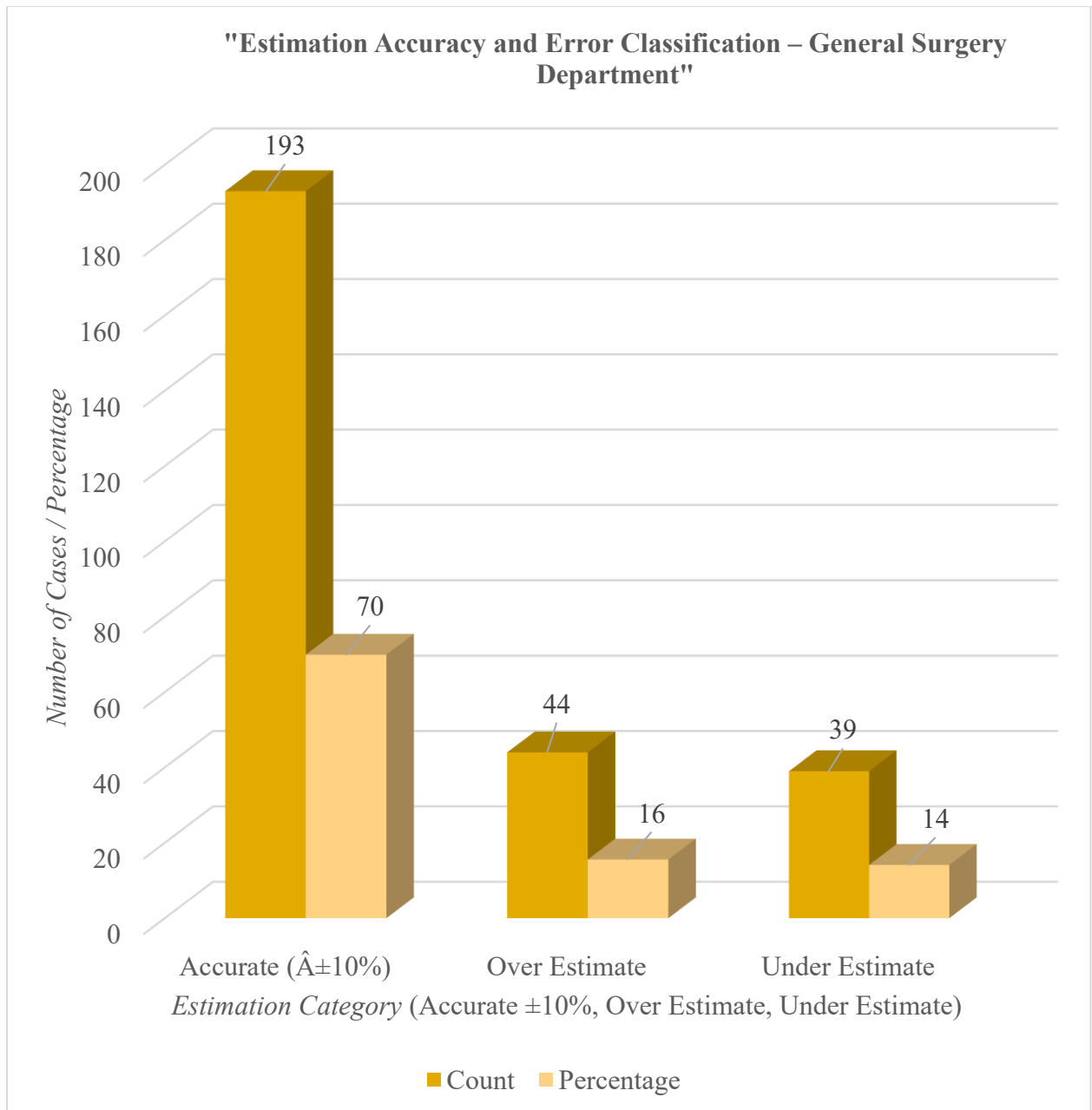


Figure 4.3: General Surgery – Variance Distribution Bar Chart

This chart illustrates that 70% of General Surgery cases were accurate, while 30% were either over- or under-estimated.

4.5 Variance Percentage Range Analysis:

Variance percentages were computed to classify patients into detailed categories like 0–10%, 11–20%, ..., >100%, and their negative counterparts (N 0–10%, N 11–20%, etc.).

Variance Categories	Total
0 - 10	140
11 - 20	28
21 - 30	16
31 - 40	5
41 - 50	6
51 - 60	4
61 - 70	1
71 - 80	1
91 - 100	2
>100	12
N 0 - 10	282
N 11 - 20	28
N 21 - 30	19
N 31 - 40	12
N 41 - 50	7
N 51 - 60	1
N 61 - 70	2
N 71 - 80	1

Table 4.4: Combined Patient Count by Variance Range

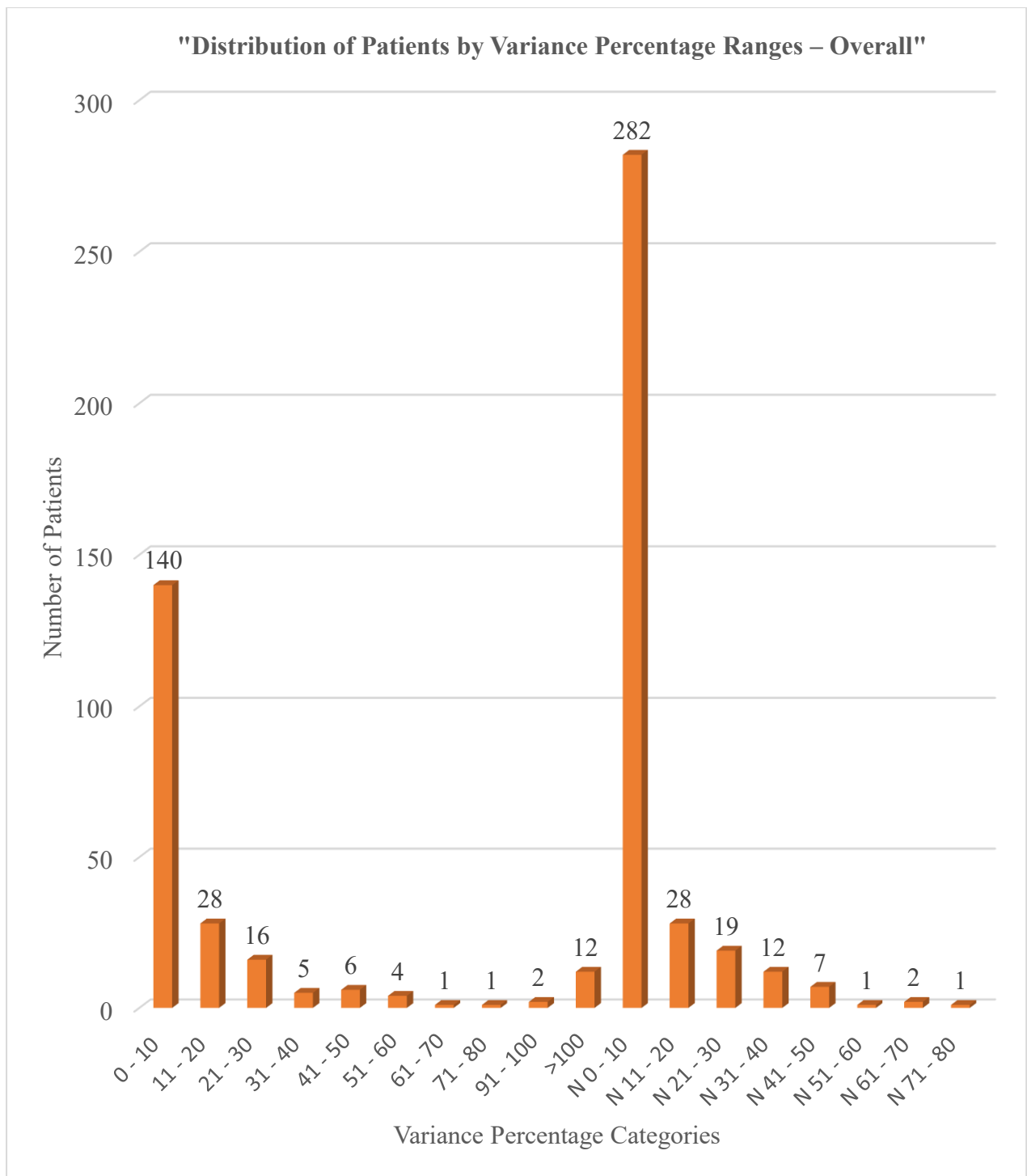


Figure 4.4: Overall Patient Distribution Across Variance Percentage Categories

This bar chart illustrates the number of patients distributed across variance percentage ranges. A significant majority fall in the 0–10% and N 0–10% bands, indicating high estimation accuracy and instances where final bills were slightly lower than expected.

Variance Categories	Cardiology	General Surgery
0 - 10	94	46
11 - 20	11	17
21 - 30	6	10
31 - 40	2	3
41 - 50	3	3
51 - 60	1	3
61 - 70	1	0
71 - 80	0	1
91 - 100	1	1
>100	6	6

Table 4.5: Positive Variance Distribution by Department

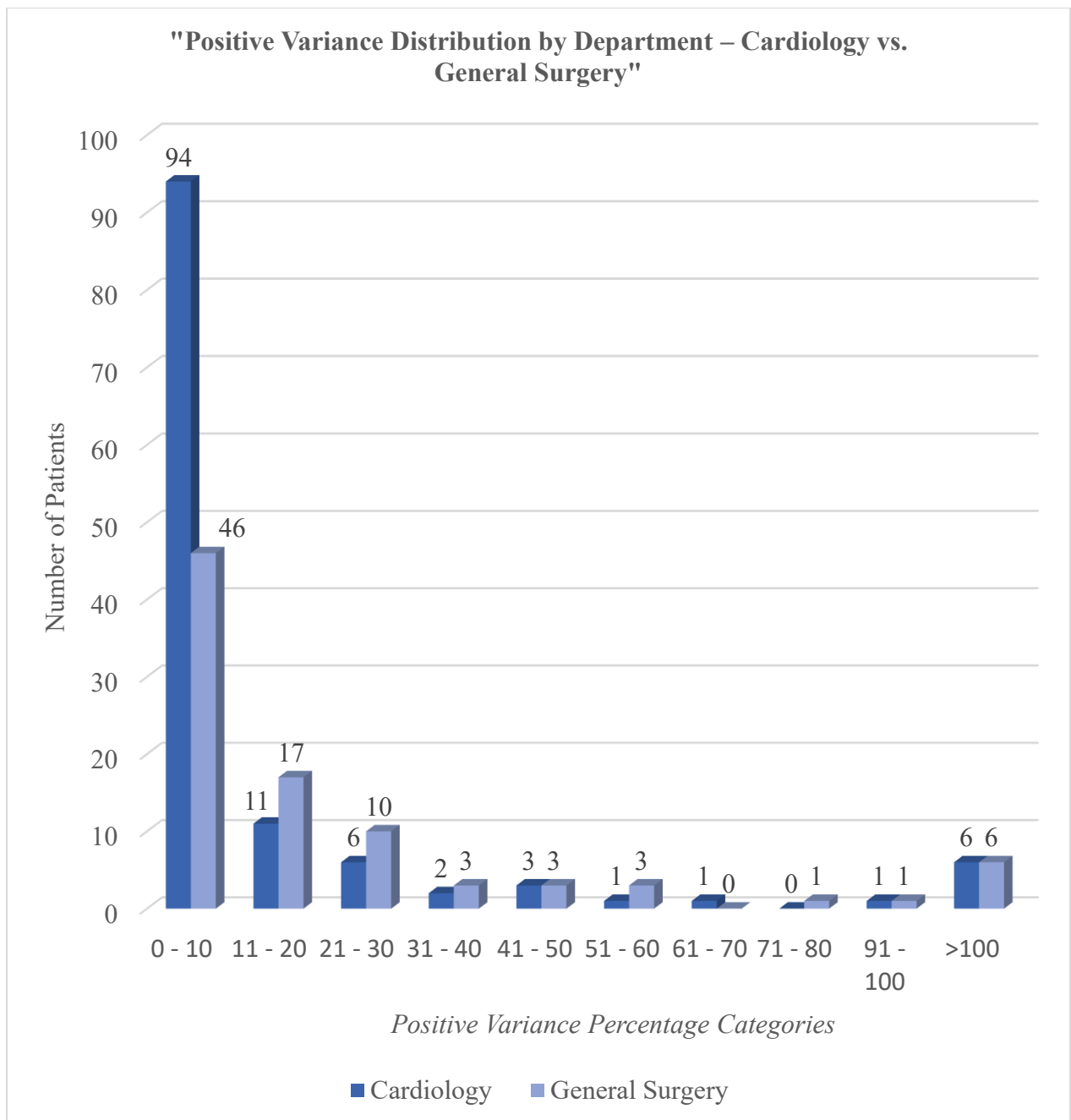


Figure 4.5: Positive Variance Category Distribution

Cardiology (94 cases) and General Surgery (46 cases) had a positive variance within 0–10%, indicating high estimation accuracy. However, General Surgery shows a more widespread distribution of higher variance categories

Variance Categories	Cardiology	General Surgery
N 0 - 10	135	147
N 11 - 20	10	18
N 21 - 30	8	11
N 31 - 40	6	6
N 41 - 50	5	2
N 51 - 60	0	1
N 61 - 70	2	0
N 71 - 80	0	1

Table 4.6: Negative Variance Distribution by Department

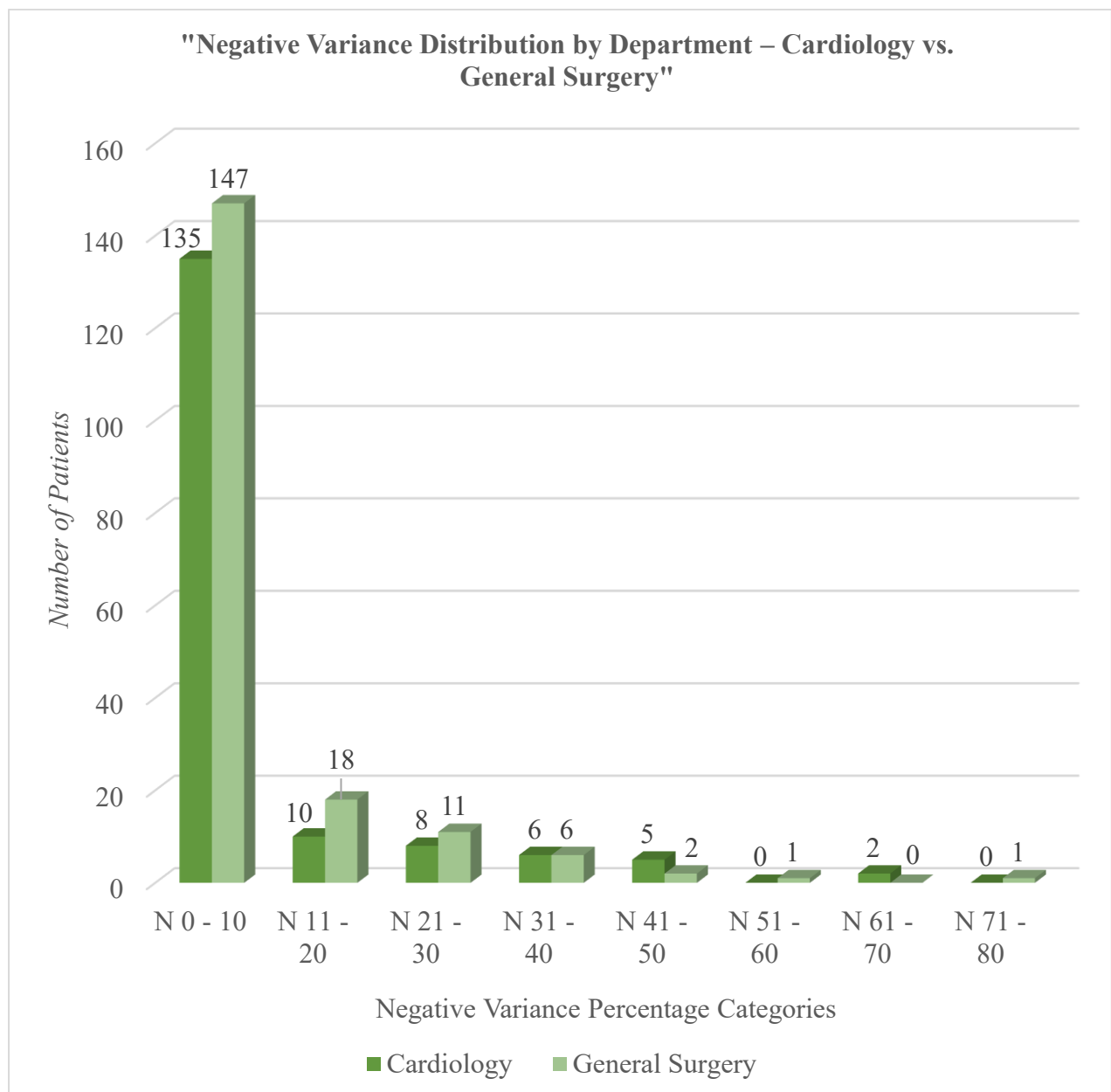


Figure 4.6: Negative Variance Category Distribution

Majority of negative variance cases in both Cardiology (135) and General Surgery (147) lie within the N 0–10% range, indicating minor underbilling. However, General Surgery exhibits slightly more dispersion across higher negative variance categories

4.6 Reason-wise Variance Analysis:

Each patient recorded one primary reason, grouped into categories such as increased pharmacy usage causes increase in bill, implant addition, changes in LOS, or reduced diagnostic needs which eventually leads to decreased bill.

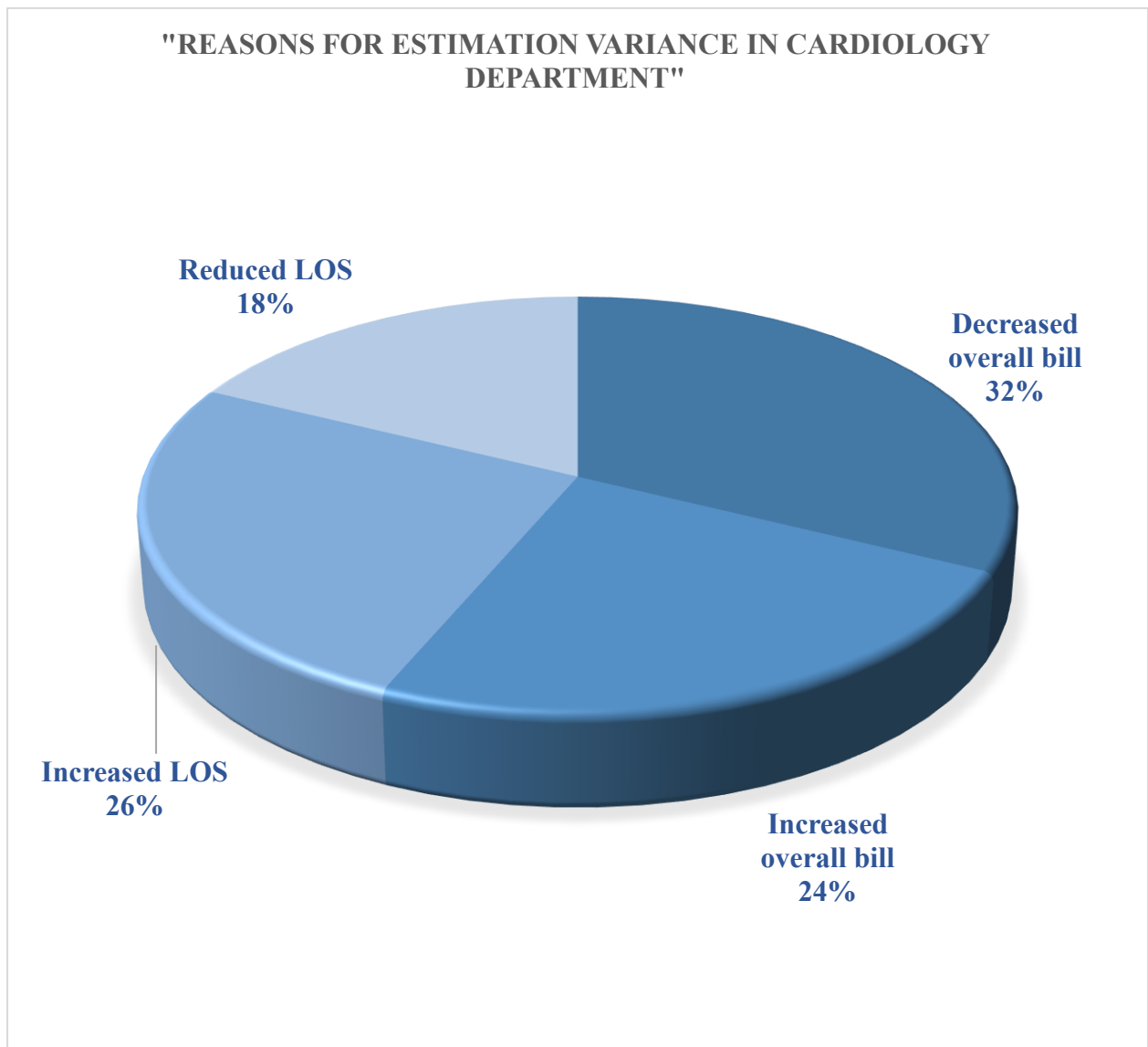


Figure 4.7: Pie Chart – Reasons for Variance in Cardiology

This chart highlights the most frequent reasons for variance in the Cardiology department. 'Decreased overall bill' accounts for the highest share at 32%, followed by 'Increased LOS' (26%), 'Increased overall bill' (24%), and 'Reduced LOS' (18%). These insights help identify clinical and administrative drivers of financial deviations.

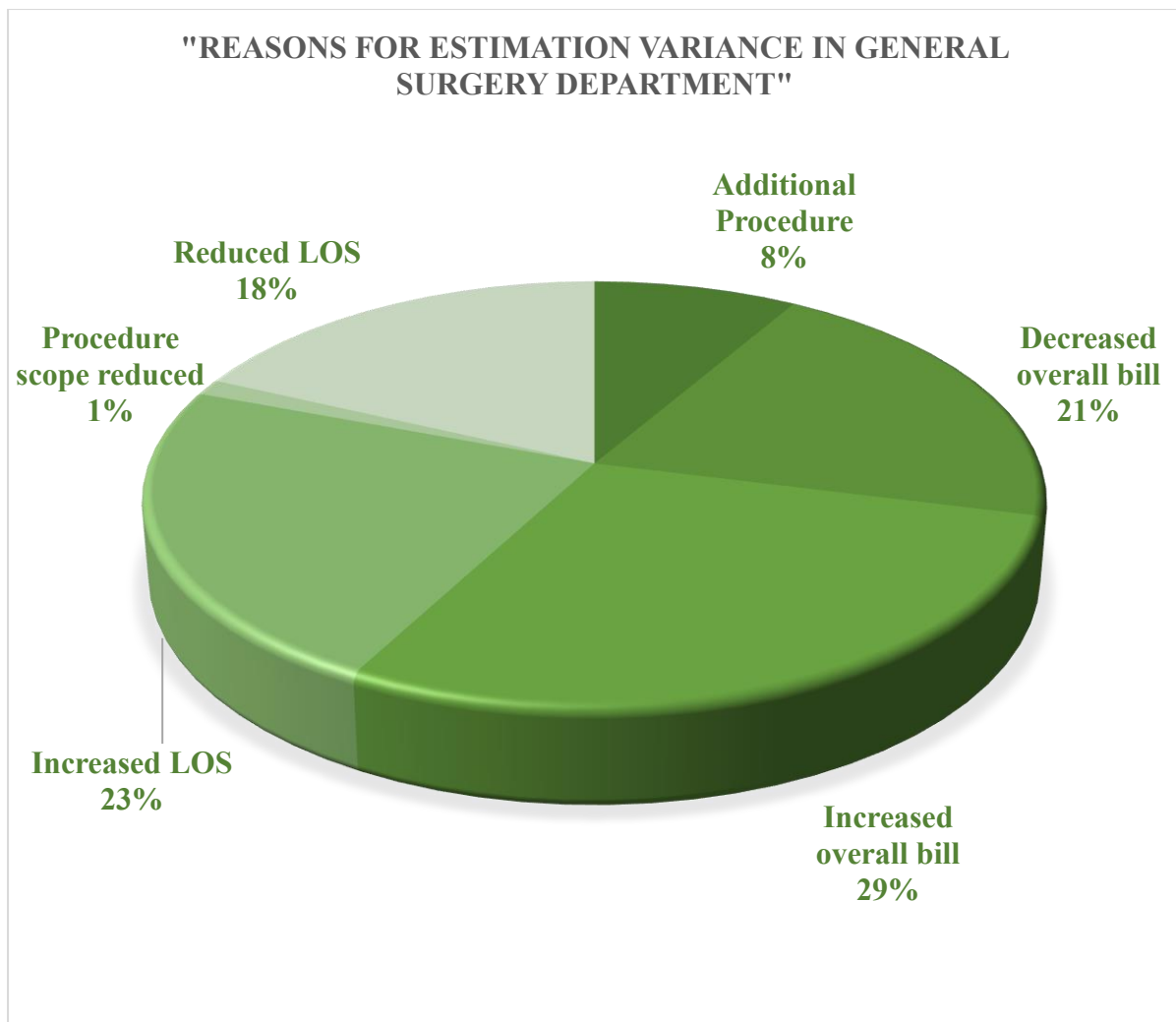


Figure 4.8: Pie Chart – Reasons for Variance in General Surgery

This chart presents the distribution of reasons for billing variance in the General Surgery department. The most common contributors are 'Increased overall bill' (29%), followed by 'Increased LOS' (23%) and 'Decreased overall bill' (21%). Notably, 'Additional Procedure' accounted for 8% and 'Procedure scope reduced' contributed only 1%, suggesting that unexpected interventions and prolonged stays are primary factors for estimation discrepancies.

4.7 Accuracy of Estimates:

	Overall	Cardiology	General Surgery
Accuracy	74.4	78.7	69.9

Table 4.7: Estimation Accuracy (3-Month Analysis)

This table shows how much each department's accuracy percentage contributes to the overall accuracy. Cardiology contributes the majority share with a higher accuracy percentage (78.69%), while General Surgery contributes slightly less (69.93%). These values, when averaged with their case volumes, form the overall accuracy rate of 74.43%.

In summary, Cardiology showed higher billing estimation accuracy than General Surgery. Most discrepancies fell within acceptable bounds ($\pm 10\%$).

CHAPTER 5: DISCUSSION

5.1 Interpretation of Results

The present study evaluated billing estimation accuracy across the Cardiology and General Surgery departments at Max Super Speciality Hospital, Shalimar Bagh. The findings revealed that Cardiology outperformed General Surgery in estimation accuracy, with 78.7% of cases in Cardiology classified as accurate (within $\pm 10\%$ variance), compared to 69.9% in General Surgery. The overall accuracy across both departments was 74.4%.

This accuracy trend suggests that Cardiology demonstrates better alignment between pre-procedure estimates and final billing. This could be attributed to the more predictable nature of cardiological procedures, adherence to standard clinical pathways, or greater experience in cost estimation by departmental coordinators. In contrast, General Surgery's lower accuracy may stem from greater variability in intraoperative findings, unplanned interventions, or procedural complexity that alters the financial trajectory post-admission.

Variance analysis revealed that the majority of patients in both departments fell within the 0–10% and N 0–10% variance ranges, highlighting a generally consistent estimation process. However, notable discrepancies were identified, especially in the General Surgery department, with significant over- and under-estimations attributed to additional procedures, increased length of stay (LOS), or changes in surgical plans.

5.2 Comparison with Previous Studies

“The findings of this study are in line with several national and international studies addressing cost estimation challenges and hospital billing variances.”⁽⁵⁾ For instance, **Lesyuk et al. (2018)** in a systematic review of heart failure cost-of-illness studies found that inpatient care constitutes the largest portion of hospital expenditures, which supports this study's identification of prolonged length of stay (LOS) as a major contributor to final billing variance.⁽⁵⁾

Similarly, **Lim et al. (2022)** and **Ong et al. (2022)** from Malaysia concluded that “Extended ICU/CCU stays and differences in institutional protocols led to inconsistent treatment costs”⁽¹⁾—reflecting how increased LOS and institutional practices can influence final billing outcomes, as seen in this study.⁽²⁾

The Indian context also echoes these observations. **Prinja et al. (2013)** showed that hospital reimbursements often fail to cover actual provider costs, especially in surgical procedures.⁽⁴⁾ This aligns with the findings from General Surgery in this dissertation, where cost underestimation was frequently linked to unanticipated procedures and clinical scope modifications.

Tupe et al. (2024) highlighted disparities in drug pricing, which may indirectly contribute to fluctuating pharmacy-related expenses—a variance category prominently observed in the Cardiology department here.⁽³⁾

Lastly, **Patel et al. (2013)** emphasized how dissatisfaction with billing arises from poor financial communication—reinforcing the importance of better estimate transparency recommended in this study.⁽⁶⁾

These studies collectively validate that the financial unpredictability observed in this dissertation is a recurring theme in healthcare systems globally and highlight the need for standardized estimation workflows, robust audit systems, and clinical-billing collaboration to minimize variance and improve patient trust.

5.3 Reason-wise Variance Reflection

The analysis of documented reasons for variance provides valuable insight into process weaknesses and operational blind spots. In Cardiology, the most common reason for variance was a decrease in overall bill (32%), which can occur due to patients not undergoing all pre-planned interventions, early discharge, or change in treatment direction⁽¹⁾⁽⁵⁾. Conversely, in General Surgery, increased overall bill (29%) and prolonged LOS (23%) emerged as key contributors to estimation error, which may relate to post-operative complications, emergency procedures, or delay in discharge planning⁽¹⁾⁽²⁾.

A small percentage of variance in both departments was linked to implant addition, scope reduction, or pharmacy/investigation changes, which though minor in count, significantly influenced the financial output in some cases⁽³⁾⁽⁴⁾⁽⁶⁾.

5.4 Strengths of the Study:

1. Focused Departmental Comparison:

The study offers a focused comparison between two major departments—Cardiology and General Surgery—allowing for deep insights into department-specific estimation practices, workflows, and variance drivers.

2. Robust Sample Size:

With a total of 567 patient records analyzed (291 from Cardiology and 276 from General Surgery), the study's conclusions are backed by statistically reliable data, providing credibility and validity to the results.

3. Standardized Variance Categorization:

The classification of variance into well-defined percentage ranges (e.g., 0–10%, 11–20%, etc.) enabled objective categorization and helped in identifying outlier trends with greater precision.

4. Visual Representation for Clear Communication:

The inclusion of bar charts, pie charts, and stacked bar graphs enhanced the interpretability of results for stakeholders at all levels, from clinical teams to administrative managers.

5. Practical Reason Documentation:

By capturing and analyzing real-world reasons for discrepancies (e.g., increased LOS, additional procedure, reduced scope), the study goes beyond numeric variance to provide actionable insights.

6. Use of Real Hospital Data:

The study is grounded in authentic hospital operations and data from Max Super Speciality Hospital, making its findings practical and relevant for immediate quality improvement.

5.5 Limitations of the Study:

1. Limited Departmental Scope:

The study focuses only on Cardiology and General Surgery. While these are critical departments, inclusion of others (e.g., Orthopaedics, Oncology, Internal Medicine) could have broadened generalizability.

2. Exclusion of External Financial Factors:

Key influencing variables such as room category upgrades, insurance co-payments, and discounts were not factored into the variance calculations, which could alter the accuracy reflection.

3. Lack of Advanced Statistical Modelling:

Due to use of Microsoft Excel for analysis, the study did not include regression or multivariate analysis which could have explored causal relationships between factors affecting variance.

4. Manual Reason Attribution:

Variance reasons were captured manually, relying on human input and interpretation, which introduces potential bias and inconsistency across entries.

5. Time-Bound Scope:

The study covers only a three-month period. Variance trends could differ seasonally, especially for departments with variable caseloads influenced by climatic or epidemiological factors.

6. Non-inclusion of Patient or Clinician Perspectives:

The study did not capture qualitative feedback from patients or doctors regarding perceptions of estimate communication, which could add another layer of interpretive value.

5.6 Implications for Hospital Practice

1. Departmental Audit Culture:

Institutionalizing monthly or quarterly audits for estimation variance across all departments can help in monitoring real-time performance and holding teams accountable for accurate cost projections.

2. Integrated HIS-based Estimation Tracking:

Hospitals should leverage Hospital Information Systems (HIS) to integrate estimation tracking modules, linking admission orders, billing estimates, and final bills for automatic flagging of deviations.

3. Training of Estimation Coordinators:

Finance and billing staff involved in pre-admission estimates must undergo continuous training regarding clinical procedures, packages, and real-world outcomes to improve forecast reliability.

4. Protocol for Estimate Revision:

A system of mid-treatment or intraoperative estimate revision (after surgical plan changes or complications) should be made mandatory with documentation and patient communication.

5. Feedback Loops with Clinical Teams:

Shared dashboards highlighting each department's monthly estimation accuracy can foster ownership and encourage collaboration between finance and medical teams to reduce preventable gaps.

6. Use of AI and Predictive Analytics:

Incorporating machine learning models to predict final bill ranges based on clinical diagnosis, case history, and treatment plans can assist estimation teams with higher accuracy forecasting.

7. Transparency with Patients and Attendants:

Clear communication of estimation terms, possible cost escalations, and variance scenarios (in layman terms) can increase trust and reduce disputes during discharge.

CHAPTER 6: CONCLUSION

6.1 Conclusion

The objective of this study was to analyze the accuracy of financial estimation in the Cardiology and General Surgery departments of Max Super Speciality Hospital, Shalimar Bagh, over a three-month period. Using patient-wise comparisons between estimated and final billed amounts, the study categorized each case based on percentage variance and explored contributing reasons for discrepancies.

A total of 567 cases were analyzed—291 from Cardiology and 276 from General Surgery. The overall estimation accuracy, defined as the percentage of cases where the variance was within $\pm 10\%$ of the estimated amount, stood at 74.43%. Department-wise analysis revealed that Cardiology achieved a higher accuracy of 78.69%, while General Surgery recorded a lower accuracy of 69.93%.

The variance patterns were further broken down into positive (actual bill higher than estimate) and negative (actual bill lower than estimate) ranges. The majority of cases across both departments fell into the 0–10% and N 0–10% categories, reflecting a generally robust estimation process. However, a closer inspection revealed department-specific trends and gaps. In General Surgery, there was a higher frequency of cases with significant over- or under-estimations. Cardiology, on the other hand, showed tighter alignment between estimated and final bills.

The analysis of reasons for variance highlighted some recurring themes:

- Increased Length of Stay (LOS) and Additional Procedures were key factors for over-estimation.
- Reduced LOS, Change in Clinical Plan, and Under-utilization of Pharmacy/Investigations led to under-estimation.
- Certain unique cases reflected the addition or removal of implants or changes in surgical approach during intra-operative decision-making.

These findings underscore the dynamic nature of hospital care and how financial forecasting must adapt to clinical realities. ⁽⁵⁾ While estimation cannot always be perfectly accurate, the

presence of recurring patterns and department-specific behaviors suggests that targeted interventions can significantly reduce variance and improve estimation reliability. ⁽⁴⁾

This study provides empirical evidence supporting the need for standardization, better documentation, and improved interdisciplinary communication for accurate financial estimation.

6.2 Recommendations

Based on the study's findings, the following recommendations are made to improve estimating accuracy and increase hospital operating efficiency:

6.2.1 Departmental Strategies

- 1. Monthly Department-wise Variance Audits**

Each department should maintain a variance dashboard to track monthly trends, outlier cases, and recurring error categories. This will encourage accountability and allow benchmarking.

- 2. Clinical-Billing Collaboration**

A joint review mechanism between clinical and billing teams can help in pre-approval of complex cases where cost escalation risk is high.

- 3. Mid-Treatment Estimate Updates**

For patients undergoing procedures with uncertain outcomes or extended LOS, there should be a mandatory re-estimation checkpoint within 48 hours of admission or after any major intervention.

6.2.2 Process Improvements

- 1. Reason Documentation Standardization**

Implement structured dropdown-based fields in the HIS for capturing reasons for variance, rather than relying on free text or manual entry.

2. Estimate Protocol Integration in Admission SOPs

Admissions must not be processed without validated estimate documentation, countersigned by both finance and clinical units. This improves patient understanding and reduces disputes.

3. Mandatory Clinical Review Before Discharge

For all high-variance cases (>20%), a discharge summary review should include a variance explanation and documentation, signed by the treating consultant.

6.2.3 Training and Technology Integration

1. Staff Training on Estimation Dynamics

Conduct monthly workshops for billing coordinators, resident doctors, and finance executives on estimation tools, ICD coding, and variance impact.

2. AI-Based Estimation Tools

Introduce predictive algorithms using AI and machine learning to generate more precise estimates based on historical trends, diagnosis, procedures, and patient profiles.

3. Real-Time Alerts in HIS

Automated alerts should notify the finance team of cases where the ongoing cost exceeds the original estimate by >10%, allowing for proactive intervention.

6.2.4 Patient Communication and Transparency

1. Printed and Digital Estimate Summaries

Share detailed estimates with patients and families in both printed and digital formats, including service inclusions and exclusions.

2. Feedback Mechanism for High-Variance Cases

Introduce a feedback form for patients where variance exceeded 20%, to understand their perspective and improve communication strategies.

6.3 Final Reflection

This study bridges the clinical and financial operations of hospital management and emphasizes the need for real-time estimation governance. As hospitals transition towards data-driven operations, such audits play a critical role in maintaining financial credibility, operational efficiency, and patient trust.

Improving estimation accuracy is not just a financial imperative - it reflects institutional transparency, ethical care delivery, and administrative competence. With the implementation of the above recommendations, Max Super Speciality Hospital and other similar institutions can significantly reduce estimation errors, improve planning, and strengthen patient experience.

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