

# Quality Analysis of Unplanned Readmissions Using Fishbone Diagram and Pareto Chart in a Chinese Tertiary Hospital

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**Purpose:** Existing research on unplanned readmissions has primarily focused on department- or disease-specific analyses, yet it lacks a systematic hospital management perspective. This study employs quality improvement tools to analyze causes of unplanned readmissions, identify key drivers, and lay the groundwork for interventions that reduce readmission rates, alleviate patient burdens, and optimize healthcare resource utilization.

**Patients and Methods:** This retrospective study included 341 patients who were readmitted within 31 days due to the same or related diseases. These patients were identified at a public tertiary Grade A general hospital in Chengdu between January 1, 2023, and December 31, 2024. Fishbone diagram was used to analyze the root causes of unplanned readmissions, while Pareto chart was employed to determine the distribution of the primary causes. Data were sourced from the hospital's information management system.

**Results:** The overall unplanned readmission rate was 0.38%. In surgical patients, unplanned readmissions were predominantly attributed to surgical complications (75.79%), which primarily included surgical site infections, respiratory infections, postoperative hemorrhage or hematoma, thromboembolic events, and impaired wound healing. Preventing the above-mentioned surgical complications is a key measure to reduce readmissions among surgical patients. For non-surgical patients, disease exacerbation constituted the primary cause of unplanned readmissions (72.19%), with pancreatitis, chronic obstructive pulmonary disease, cardiac arrhythmia, and fungal pneumonia identified as high-risk diseases leading to readmissions. Strengthening the management of these high-risk diseases is crucial for preventing readmissions among non-surgical patients.

**Conclusion:** Employing integrated fishbone diagram and Pareto chart analyses, this study systematically deciphered the root causes and dominant contributors to unplanned readmissions. These findings enabled the formulation of targeted evidence-based management strategies. This study provides novel insights and methodologies for hospital management practices, serving as a valuable reference for other healthcare institutions seeking to reduce unplanned readmission rates and enhance operational efficiency.

**Keywords:** hospital readmission, quality improvement tools, health policy, management strategies

## Introduction

Unplanned readmissions, as a critical indicator of healthcare quality and safety, not only significantly increase the financial burdens on patients but also lead to the waste of societal healthcare resources.<sup>1</sup> Internationally, unplanned readmission rates have been incorporated into healthcare quality evaluation systems and are regarded as an important adverse indicator. Quality improvement tools are increasingly being applied to enhance healthcare quality, helping hospitals identify and address service issues, thereby optimizing management and improving patient satisfaction and healthcare quality.<sup>2,3</sup> Within China's healthcare context, intensified market competition among hospitals has further exacerbated the risk of unplanned readmissions for patients.<sup>4</sup> Existing research on unplanned readmissions has primarily focused on department- or disease-specific analyses, yet it lacks a systematic hospital management perspective. This study aims to use fishbone diagram and Pareto chart

analyze the root causes and primary influencing factors of unplanned readmissions and to develop targeted management strategies, providing a theoretical basis for reducing unplanned readmission rates.

## Materials and Methods

### Study Design and Setting

This retrospective study was conducted at a public tertiary general hospital in Chengdu, Sichuan Province, China, covering the period from January 1, 2023, to December 31, 2024. The study protocol was approved by the hospital's ethics committee.

### Participants

Inclusion criteria required patients to meet all three conditions: 1) the interval between two hospitalizations was within 31 days; 2) the readmission was unplanned; 3) the readmission was due to the same disease or surgical complications. Patients of all ages were eligible. Each qualifying 31-day unplanned readmission event due to the same disease or surgical complications was analyzed as an independent observation, including recurrent events per patient. Exclusion criteria included patients who left against medical advice and those admitted for chemotherapy, radiotherapy, or other medical care for malignant tumors.

### Definition of Unplanned Readmission Rate

The definition of “unplanned readmission rate” was based on the National Tertiary Public Hospital Performance Assessment Manual (2024 Edition) in China. It is defined as the proportion of patients readmitted within 31 days after discharge due to the same or related diseases, excluding planned readmissions.<sup>5</sup> Numerator: Number of readmissions within 31 days due to the same or related diseases. Specifically, “same disease” refers to readmission with the same primary diagnosis ICD code category and subcategory; “related diseases” refers to readmissions due to surgical complications. Denominator: Total number of discharges during the same period, excluding patients who died, left against medical advice, or were admitted for chemotherapy, radiotherapy, or other medical care for malignant tumors.

### Data Collection and Analysis

Medical records for admissions from January 1, 2023, to December 31, 2024, were extracted from the hospital information management system on January 16, 2025, using structured SQL queries and compiled into a database using Microsoft Excel 2010. Two medical quality managers independently reviewed the medical records to analyze the reasons for unplanned readmissions. Inter-rater reliability was assessed using Cohen's kappa coefficient ( $\kappa = 0.87$ , 95% CI: 0.827–0.919,  $p < 0.001$ ), indicating substantial agreement. For cases with inconsistent classifications ( $n = 27$ , 7.9% of total cases), a secondary review was conducted to resolve discrepancies. Persistent disagreements ( $n = 11$ , 3.2% of total cases) were resolved through consensus discussions with attending physicians to clarify specific readmission etiologies. All data were entered into the database and preliminarily organized to ensure completeness and consistency. A fishbone diagram was used to conduct a root cause analysis of the reasons for unplanned readmission.<sup>6</sup> Descriptive statistical analysis was used to calculate the proportion and cumulative proportion of unplanned readmissions to quantify the distribution of different causes in readmission events. Subsequently, Pareto chart was constructed based on the above data to analyze the composition of readmission causes. The causes of unplanned readmissions were categorized into three classes: primary factors, with a cumulative proportion of 0% to 80%; secondary factors, with a cumulative proportion of 80% to 90%; and general factors, with a cumulative proportion of 90% to 100%.<sup>6</sup> The patient selection flowchart and fishbone diagram were generated in Adobe Illustrator CS5, and Pareto chart in Microsoft Excel 2010.

## Results

### Unplanned Readmission Status

Within 31 days post-discharge, 197 cases were readmitted for the same condition disease, and 144 cases for the related disease. Among 88,701 discharged patients, the cumulative unplanned readmission rate was 0.38% (Figure 1).

## Root-Cause Analysis via Fishbone Diagram

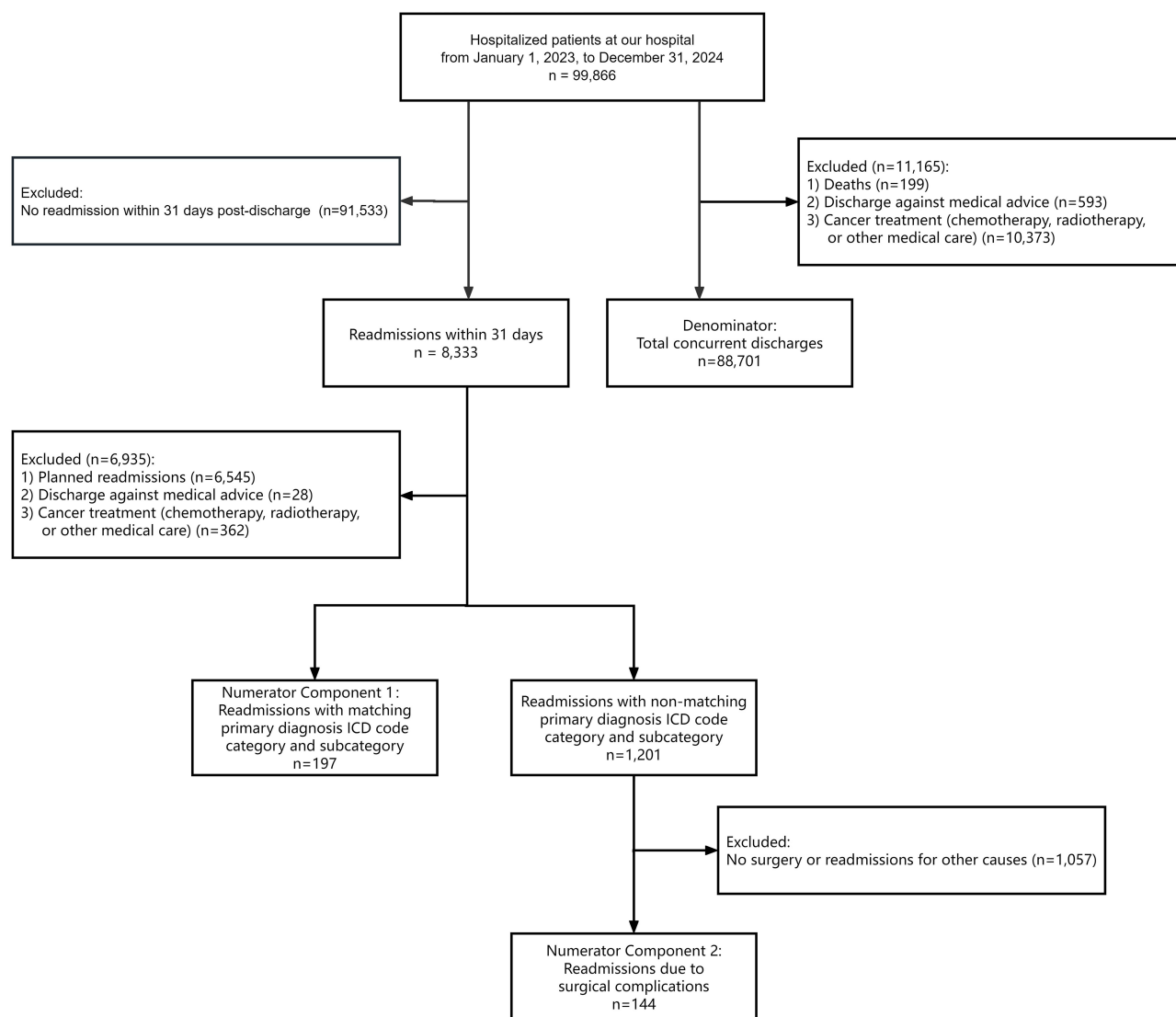
A fishbone diagram was employed to conduct root-cause analysis and identify factors contributing to unplanned readmissions (Figure 2). The causes were categorized into three main groups: surgical complications (144 cases, 42.23%), disease exacerbation (138 cases, 40.47%), and pathological findings necessitating reoperation (59 cases, 17.30%).

## Analysis of Readmission Causes in Surgical vs Non-Surgical Patients

Among 57,779 surgical patients, 190 (0.33%) experienced unplanned readmission, with surgical complications being the predominant cause (75.79%). In contrast, of 26,922 non-surgical patients, 151 (0.56%) required unplanned readmission, primarily due to disease exacerbation (72.19%) (Table 1).

## Pareto Chart Analysis of Surgical Complications

The main types of surgical complications leading to unplanned readmissions were primarily included surgical site infections, respiratory infections, postoperative hemorrhage/hematoma, thromboembolic events, and impaired wound



**Figure 1** Flowchart of Patient Enrollment and Screening Process. The numerator is the sum of Component 1 and Component 2.

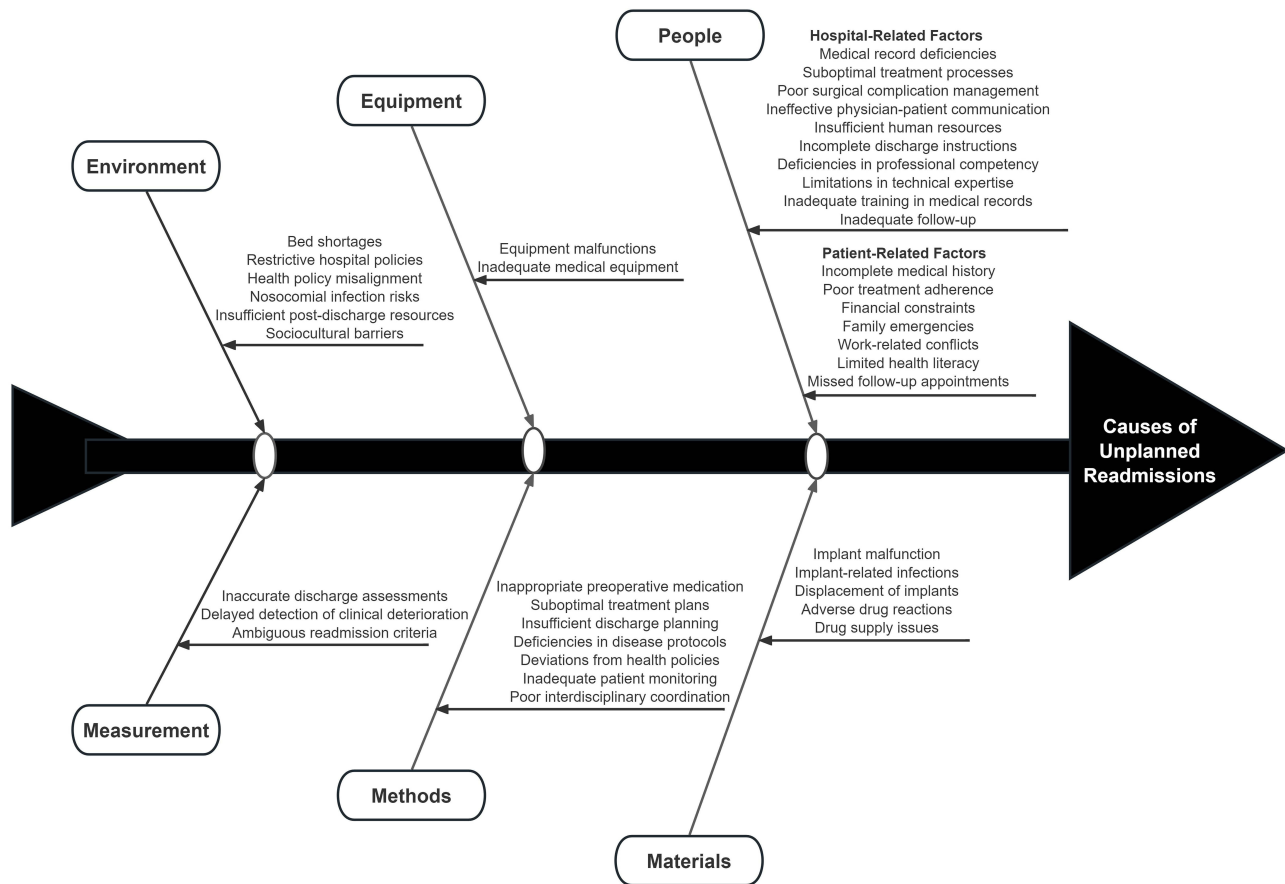


Figure 2 Root Cause Analysis of Unplanned Readmissions Using a Fishbone Diagram.

healing, with a cumulative proportion of 81.25%. The secondary types included iatrogenic pneumothorax and post-operative effusion, with a cumulative proportion of 9.03%. The general types accounted for only 9.72% (Figure 3).

### High-Risk Diseases for Unplanned Readmissions

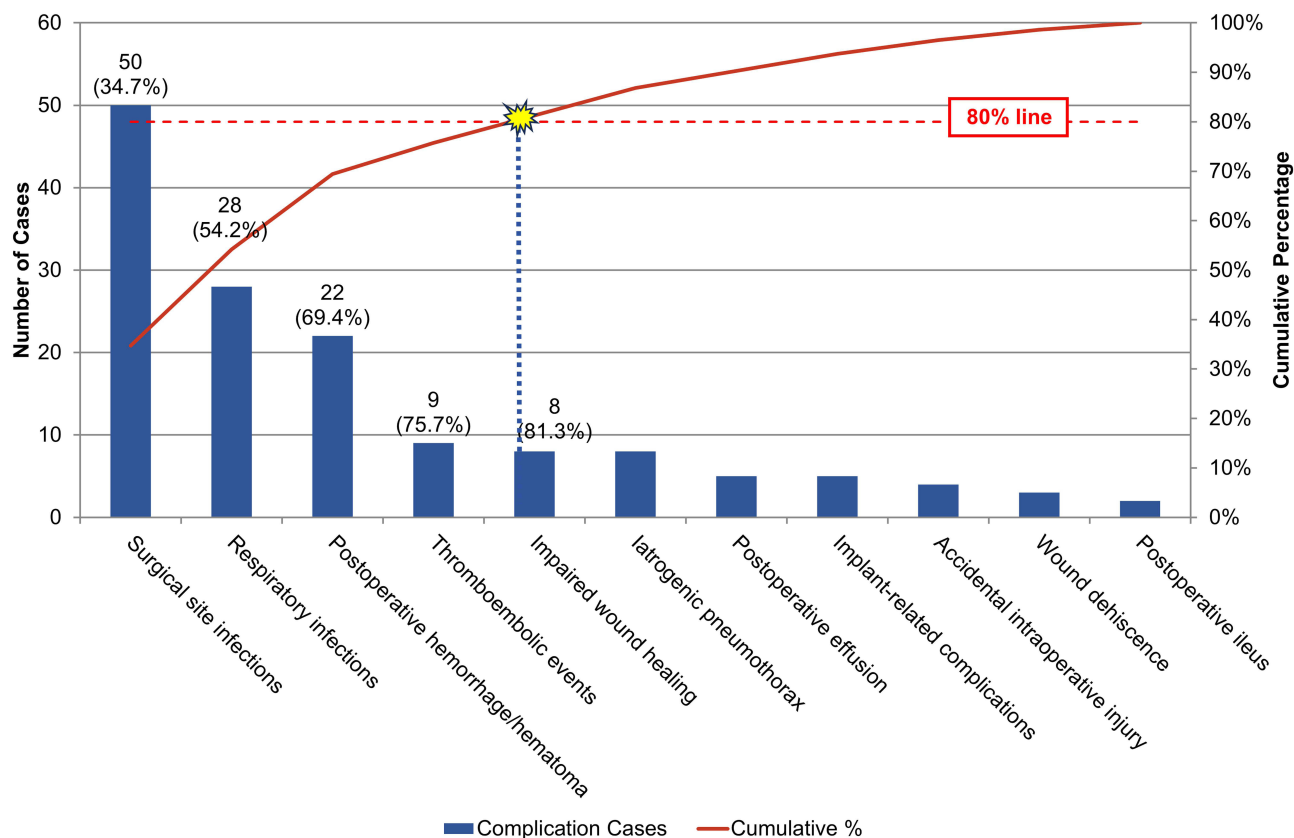
Among the 138 cases of unplanned readmissions due to disease exacerbation, pancreatitis, chronic obstructive pulmonary disease, cardiac arrhythmias, and fungal pneumonia were identified as high-risk diseases (Table 2).

### Discussion

Unplanned readmissions refer to instances where patients are readmitted to the hospital due to relapse of illness, inadequate treatment outcomes, or the emergence of new health issues after discharge. These readmissions are typically associated with the initial disease but are not prearranged. They may reflect issues related to medical quality, patient compliance, or disease complexity and are an important indicator of the quality and efficiency of medical services. Frequent readmissions can impose significant emotional and physical burdens on patients and their families, erode trust

Table 1 Analysis of Readmission Causes in Surgical vs Non-Surgical Patients

Patient Type	Total Concurrent Discharges (n)	Causes of Unplanned Readmission		
		Surgical Complications (n/%)	Disease Exacerbation (n/%)	Pathological Findings Necessitating Reoperation (n/%)
Surgical Patients	57,779	144(75.79)	29(15.26)	17(8.95)
Non-Surgical Patients	26,922	0(0.00)	109(72.19)	42(27.81)



**Figure 3** Pareto Chart Analysis of Major Surgical Complications Contributing to Unplanned Readmissions. The yellow starburst indicates the 80% cumulative percentage point (Pareto principle). The blue dashed line follows the cumulative curve, identifying the “vital few” complications (left of the threshold) responsible for most readmissions.

in the healthcare system, and increase out-of-pocket expenses for patients as well as resource consumption for healthcare institutions. Reducing hospital readmission rates is crucial for patients, healthcare institutions, and the entire healthcare system.<sup>2,7</sup> Although some readmissions are unavoidable, approximately 27% of readmissions are considered

**Table 2** Analysis of Associated Diseases Due to Exacerbation Leading to Unplanned Readmissions

Disease	Number of Cases (n)	Proportion (%)
Pancreatitis	14	10.14
Chronic Obstructive Pulmonary Disease	11	7.97
Atrial Fibrillation	9	6.52
Fungal Pneumonia	9	6.52
Hepatic Encephalopathy	6	4.35
Lumbar Disc Herniation	6	4.35
Intestinal Obstruction	5	3.62
Epilepsy	5	3.62
Coronary Artery Disease	5	3.62
Malignant Tumor	4	2.90
Immune-Related Pneumonitis	4	2.90
Inflammatory Bowel Disease	4	2.90
Cholecystitis	3	2.17
Others	53	38.41
Total	138	100

preventable.<sup>8</sup> Conducting a root cause analysis of unplanned readmissions is essential for developing effective strategies to reduce readmission rates.

A large-scale study incorporating data from 22 hospitals reported a 30-day post-discharge readmission rate of 12.17%.<sup>9</sup> In contrast, our hospital demonstrated a substantially lower unplanned readmission rate of 0.38%, which may be associated with differences in inclusion/exclusion criteria, hospital capacity, patient case mix, and varying degrees of emphasis on healthcare quality.<sup>10</sup> In our hospital, a root cause analysis of unplanned readmissions was conducted using the six dimensions of a fishbone diagram (people, materials, equipment, methods, environment, and measurement) to systematically identify key factors. These factors included medical record management defects and inadequate treatment and communication skills in hospital personnel; malfunction of implants and drug-related issues in materials; operational failures of medical equipment and resource limitations in equipment; preoperative management, treatment plan selection, and disease management process defects in methods; hospital management regulations, bed shortages, and health policy orientation in environment; and insufficient discharge condition assessment and lagging monitoring in measurement. This comprehensive analysis revealed the complex causes of unplanned readmissions and laid the foundation for hospital management and improvement initiatives.<sup>7</sup>

In our study, surgical complications were identified as the leading cause of unplanned readmissions among surgical patients, accounting for 75.79% of cases. According to the literature, the probability of surgical patients developing infections at or near the surgical incision site is as high as 3%.<sup>11</sup> A large retrospective cohort study involving 22,143 patients found that 12% of patients undergoing major surgery experienced unplanned readmission within 90 days post-discharge. Among these cases, wound complications were the most frequent reason for unplanned readmission. Specifically, bowel obstruction or small intestine obstruction was the primary cause after abdominal surgery, pneumonia following thoracic surgery, mechanical complications after orthopedic procedures, and wound complications after cardiac surgery.<sup>12</sup> Another study on colorectal cancer reported a 30-day unplanned readmission rate of 15.1%, with wound infections being the most common diagnosis (27%).<sup>13</sup> Surgical complications not only result in health and economic losses for patients but also pose potential losses to healthcare institutions. These complications can lead to a reduction in total revenue, as they encroach on the share of higher daily income generated by shorter hospital stays.<sup>14</sup> A thorough analysis of surgical complications can aid in developing targeted intervention measures to reduce readmission rates caused by surgical complications. Our findings indicate that surgical site infections, respiratory infections, postoperative hemorrhage/hematoma, thromboembolic events, and impaired wound healing are the major contributors to readmissions due to surgical complications. Therefore, prevention and management strategies should prioritize these complications, particularly in high-risk populations such as elderly patients and those with significant comorbidities.<sup>15</sup> From the hospital's perspective, enhancing surgical proficiency among physicians, rigorously implementing preoperative evaluations, surgical safety checklists, and intraoperative care protocols are key measures for ensuring perioperative safety and effectively mitigating surgical complications.<sup>16–18</sup>

Among non-surgical patients, disease exacerbation was the predominant cause of unplanned readmissions, constituting 72.19% of cases. Our study identified pancreatitis, chronic obstructive pulmonary disease (COPD), arrhythmias, and fungal pneumonia as high-risk diseases associated with unplanned readmissions. Acute pancreatitis is a costly and life-threatening condition, with readmission rates ranging from 7% to 34%. The rates vary by etiology: 4–37% for biliary acute pancreatitis, 2–60% for alcohol-induced pancreatitis, and 20–75% for severe or necrotizing pancreatitis. The most common reason for readmission is recurrent acute pancreatitis. Early outpatient follow-up and improved patient-provider communication can reduce readmissions by approximately 20%. Additionally, alcohol cessation, dietary modifications, cholecystectomy, and lipid-lowering therapies are effective strategies to decrease readmission rates.<sup>19,20</sup> COPD affects over 544 million individuals globally and is associated with one of the highest 30-day readmission rates, varying between 2.6% and 82.2% across regions and populations.<sup>21</sup> Chronic respiratory diseases were the third leading cause of death in 2017, responsible for 7.0% of global mortality. By 2030, COPD and its comorbidities are projected to account for over 4.5 million annual deaths, representing approximately 8.6% of global mortality.<sup>22</sup> The readmissions and mortality associated with COPD exacerbations impose substantial economic and emotional burdens on patients and families, significantly impacting public healthcare systems worldwide. Strategies to reduce COPD readmissions should include tobacco control policies, enhanced patient education, and post-discharge follow-up, particularly for high-risk patients

with factors such as male sex, prior hospitalization, prolonged hospital stays, and comorbidities including heart failure, cancer, diabetes, and malnutrition.<sup>22,23</sup> For non-surgical patients, reducing unplanned readmissions requires an analysis of institutional case-mix patterns and high-risk conditions. Optimizing in-hospital care and providing tailored discharge guidance are essential to minimizing avoidable readmissions. This study has several limitations. As a single-center retrospective analysis, the findings may lack generalizability due to potential regional variations. Additionally, the relatively short time span of the data collection may limit the assessment of long-term outcomes.

## Conclusion

Using fishbone diagram and Pareto chart analyses, this study demonstrates the multidimensional complexity of unplanned readmissions. Enhancing surgical complications prevention and improving the management of high-risk medical conditions are effective strategies to reduce unplanned readmission rates. Our findings provide novel insights for hospital administration, emphasizing the importance of process optimization and quality improvement at the institutional level. Future research should further validate the generalizability of these strategies in multicenter settings to advance continuous healthcare improvement and high-quality development.

## Ethical Issues

Ethical approval for this study was obtained from the Ethics Committee of West China Tianfu Hospital, Sichuan University, prior to the commencement of the research (Approval No.: 2024-024). As a retrospective analysis of de-identified patient records, a waiver of informed consent was granted since all protected health information was anonymized prior to data processing. All procedures complied with the ethical standards of the institutional and/or national research committees and adhered to the principles of the Declaration of Helsinki (2013 revision).

## Disclosure

The authors report no conflicts of interest in this work.

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