Readmission in acute pancreatitis: Etiology, risk factors, and opportunities for improvement

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Acute pancreatitis (AP) is associated with a readmission rate ranging from 7 to 34%. Readmission rates are highest among biliary (4–37%) and alcohol-induced (2–60%) acute pancreatitis. Severe acute pancreatitis and necrotizing pancreatitis have readmission rates ranging from 20 to 75%. The most common causes of readmission include recurrent acute pancreatitis (17–45% of readmissions) and smoldering symptoms/local complications (17–38%). A number of risk scores reliably estimate risk of readmission in acute pancreatitis. Decreased rates of readmission were reported in patients that underwent same-admission cholecystectomy in biliary pancreatitis and alcohol cessation interventions in alcohol-induced pancreatitis. This review article discusses readmission in acute pancreatitis, including etiology, risk factors, and opportunities for improved patient care.

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Introduction

Acute pancreatitis (AP) is a leading cause for gastrointestinal based hospital admissions in the United States with over 300,000 annual admissions and increasing prevalence in recent decades [1,2]. Acute pancreatitis represents a heterogeneous disease ranging from a mild, self-limited illness to severe disease with organ failure, prolonged disease course, need for invasive interventions, and high mortality. Treatment principles in AP include supportive care, prevention of physical debilitation and malnutrition, and mitigation of recurrent acute pancreatitis (RAP) [3,4]. Increasing prevalence and improved patient outcomes have resulted in more patients discharged after inpatient treatment for AP than ever before [2]. Readmission rates after hospital admission for AP vary considerably depending on patient and disease-specific factors.

Hospital readmission rate is an increasingly utilized metric of patient care quality and reflects a significant burden to both the individual patient and the health care system [5]. In the US, vast resources are dedicated to decreasing readmission rates after hospital admission and up to 70% of all unplanned hospital readmission may be preventable [6,7]. A degree of readmission is inherent to patients with AP; however, room for improvement exists as one in five patients discharged with AP will be readmitted to the hospital [8,9]. Readmission rates in AP are influenced by etiology, patient medical comorbidities, and the severity of AP. Improving readmission rates in AP requires a detailed understanding of the risk factors, mechanisms and etiologies of readmission, and principles of care that have previously improved patient outcomes.

The aim of this narrative literature review was to identify risk factors, mechanisms, and etiology of readmission after hospital discharge for treatment of AP and to review treatment principles and mitigation strategies to decrease unplanned hospital readmission rates in patients with AP.

Methods

In December 2021, two authors (BB, TM) conducted a narrative literature review on MEDLINE, PubMed, EMBASE, and Cochrane Library. A combination of search terms included “acute pancreatitis,” “necrotizing pancreatitis,” “severe acute pancreatitis,” and “readmission” using the Boolean operators AND or OR. Pertinent manuscripts were reviewed and summarized by the two authors with a focus on English full-text and modern publications in the last two decades. Historical manuscripts were included, where applicable, for context. The subsequent narrative literature review was interpreted and discussed in the context of invited expert opinion in the management of acute pancreatitis.

Definitions. Diagnostic criteria for AP and its complications were defined according to the 2012 revision of the Atlanta classification [3]. Acute pancreatitis was defined as the presence of at least two of the following three criteria: abdominal pain characteristic of AP, serum
amylase or lipase concentration at least three times greater than the upper limit of normal, or characteristic findings of AP on contrast-enhanced cross-sectional imaging. Disease onset was defined as the date of symptom onset. Necrotizing pancreatitis (NP) was defined as a lack of enhancement of the pancreatic parenchyma on contrast-enhanced cross-sectional imaging or the presence of an acute necrotic collection (ANC, <4 weeks) or walled-off necrosis (WON, >4 weeks).

In the absence of NP, local complications were defined as acute peripancreatic fluid collection (APFC, <4 weeks) or pseudocyst (>4 weeks). Infected pancreatic necrosis was diagnosed in the setting of extraluminal gas in the pancreatic and/or peripancreatic tissues on cross-sectional imaging and confirmed with positive bacteria and/or fungi on Gram stain and culture of aseptically obtained pancreatic necrosis specimens. Organ failure was defined according to the modified Marshall scoring system for organ dysfunction as a score of two or greater.

Results

Readmission rates and risk factors in acute pancreatitis. Readmission rates in studies that included all patients treated for AP ranged from 7 to 34% and varied depending on etiology, disease severity, and medical comorbidities [8–30]. Fig. 1. The median length of stay in four studies reporting readmission duration was 4–9 days [9,10,13,15].

Readmission rates were highest in patients with AP from biliary (4–37% [8,9,11–13,15,17,18,20,21,29–31]) or alcohol (2–60% [8–13,15,20,31]) etiologies. Only one study in alcohol-induced AP reported a readmission rate of less than 10% [15]. Readmission rates in medication, post-ERCP, and hypertriglyceridemia etiologies of AP were 0–5% [8,11,12,15]. Among patients with mild AP readmission rates were 7–27% [11,15,24,27,29,31]. Readmission rates were higher in patients with severe AP or necrotizing pancreatitis (20–75%) [8,9,11,16,20,23,29,30,32]. A number of comorbidities were identified as risk factors for readmission and themes included alcohol dependence, atrial fibrillation, cirrhosis, chronic kidney disease, coronary artery disease, diabetes mellitus, hypertension, obesity, opioid dependence, and concomitant psychiatric illness [8–11,13,17,19,20,29]. In three studies an Elixhauser comorbidity measure of ≥3 was associated with increased hospital readmission rates (11.3–16.8% vs 5.1–11.1%) [13,17,29]. In each report, readmission rates in patients with an Elixhauser score of ≥3 were approximately one and a half to two-fold higher. One study reported that in alcohol-induced AP a Charlson Comorbidity Index (CCI) of ≥2 was associated with increased hospital readmission rate (17.8% vs. 11.6%) [10]. Several studies evaluating patients with AP of any etiology and severity reported no differences in readmission rates according to CCI [9,15,20].

Predicting hospital readmission in acute pancreatitis. A summary of studies that developed risk scores to predict readmission in AP is shown in Table 1. As previously discussed, an Elixhauser score of ≥3 was a strong predictor of hospital readmission in AP [13,17,29]. Several studies developed prediction scores to determine risk of hospital readmission after inpatient treatment for AP (Fig. 2). Ding et al. developed a nomogram for predicting 30-day readmission risk using AP etiology, infected NP, total serum bilirubin concentration, serum glucose concentration, and serum albumin concentration [15]. This model was associated with a sensitivity and specificity of 66.7% and 75.4% for predicting readmission, respectively [15]. Wu et al. initially described the Pancreatitis Activity Scoring System (PASS) highlighting five parameters to define disease activity, including: organ failure, systemic inflammatory response syndrome (SIRS), abdominal pain, morphine equivalent dose, and tolerance of solid diet [33]. Buxbaum et al. externally validated PASS as a predictor of early hospital readmission in AP [20]. On multivariable analysis, a PASS of >60 at discharge was associated with a 5-fold increased risk for hospital readmission in AP and was 68% sensitive and 71% specific in predicting hospital readmission [20]. Whitlock et al. reported five variables at discharge independently associated with hospital readmission, including: gastrointestinal symptoms, intolerance of solid diet, the presence of pancreatic necrosis, treatment with antibiotics, and ongoing pain [22]. Using these five variables, a score was developed to stratify patients into risk categories for hospital readmission – low risk (≤1 point, 4–5% readmission rate), moderate risk (2–3 points, 15–18%), and high risk (≥4 points, 68–87%) [22].

Etiology of readmission in acute pancreatitis. Among all AP patients, RAP was one of the most common causes for hospital readmission representing between 17 and 45% of readmissions [8,11,13,15,19,22,28,29]. Among patients with biliary and alcohol etiology of AP, RAP was responsible for 17–28% [28,29] and 22–45% [10] of readmissions,

Readmission Rates in Acute Pancreatitis

Fig. 1. Readmission rates in acute pancreatitis

Abbreviations: AP, acute pancreatitis; EtOH, alcohol; SAP, severe acute pancreatitis; NP, necrotizing pancreatitis.
respectively. Other frequent causes of hospital readmission among all AP patients included: smoldering symptoms or local complications of AP (17–38% of readmissions) [8,11,15,17,22] and hepatobiliary complications (4–17% of readmissions) [11,13,19]. One study reported that the rate of readmission from postoperative complications after cholecystectomy for biliary AP was 21% [29]. Two studies reported etiologies of readmission after SAP/NP. Among this patient population, symptomatic necrosis and infected necrosis accounted for 21–54% and 24–30% of readmissions, respectively [16,23]. A common cause of readmission among SAP/NP patients was failure to thrive (5–19% of readmissions) [16,23]. In NP patients, extrapancreatic infections accounted for 7% of readmissions [23].

**Decreasing readmission in acute pancreatitis.** In biliary AP, definitive treatment by cholecystectomy or endoscopic biliary intervention during the same admission or within two weeks of AP diagnosis was associated with a significant decrease in readmission, Table 2 [13,17,21,28–30]. In all biliary AP patients, same admission cholecystectomy was associated with a 56–71% relative risk reduction in hospital readmission [13,17,21,29,30]. Only one study aimed at decreasing readmission rates in alcohol-associated AP was identified. Sorrento et al. reported a reduction in 30-day readmission rates from 31.2% to 19.3% in patients receiving inpatient alcohol cessation counseling during their index admission with alcohol-induced AP [34]. On multivariable analysis, alcohol cessation counseling was associated with a 50% reduction in readmission [34]. Among patients with SAP/NP, one study evaluated the impact of a dedicated pancreatitis nurse coordinator on readmission outcomes utilizing frequent and early outpatient reassessment via telecommunication [16]. In this study, the readmission rate decreased from 64% to 78.5% and the mean number of inpatient days after initial hospitalization decreased from 15.4 days to 7.8 days. Significant decreases in readmission for symptomatic necrosis requiring supportive care, failure to thrive, infected necrosis requiring intervention, non-necrosis infection, and drain dysfunction were attributed to decreased readmission rates.

![Fig. 2. Prediction scores for readmission risk in acute pancreatitis. 2A. Nomogram developed by Ding et al. 2B. The Pancreatitis Activity Scoring System and readmission risk validated by Buxbaum et al.](image-url)
Impact of readmission in acute pancreatitis. Among all AP patients, no study correlated readmission with an increased mortality rate in the acute phase. However, one study identified unplanned 30-day hospital readmission as the strongest predictor of one-year mortality in AP patients. After controlling for comorbidities and disease severity, 30-day readmission was associated with a 4.5-fold increased risk of death at one-year follow-up [14]. Few studies reported the financial burden of hospital readmission. In alcohol induced AP, the mean hospital charge per patient readmitted was $38,927 [10]. Another study evaluating hospital readmission in all AP patients reported a median hospital charge of $24,380 per patient [13]. One study estimated the cost of readmission in NP patients and reported a mean of $18,720–36,960 per patient [16]. Utilizing a pancreatitis nurse coordinator to frequently re-assess patients discharged with NP this study estimated a savings of $1.2 million in aggregate health care costs at a single institution over a one-year period by reducing unplanned readmission rate from 64% to 45% [16].

Discussion

Readmission affects 7–34% of patients diagnosed with AP with a median length of readmission ranging from 4 to 9 days. Etiologies associated with the highest rates of readmission include biliary (4–37%) and alcohol induced (2–60%) AP. In patients with biliary AP, same admission cholecystectomy is associated with a relative risk reduction in readmission of 56–71%. In alcohol induced AP, interventions to promote alcohol cessation reduced readmission rates by half. Severity of AP impacts readmission rates: readmission in mild AP ranges from 7 to 27% while readmission in SAP/NP ranges from 20 to 75%. In SAP/NP, early outpatient reassessment and improved outpatient communication decreased readmission rates by nearly 20%. Risk factors for readmission in AP included increasing comorbidities and more severe disease. Several reliable scoring systems have been developed to estimate readmission risk as a useful tool for clinicians. The pancreatitis activity scoring system (PASS) is the only scoring system currently with external validation, but all three models are practical. The readmission nomogram developed by Ding et al., the SNNP score, and the PASS score all performed well in predicting readmission in AP. Any of these metrics may be utilized; however, a practical approach by a health care system would be to utilize one risk score consistently. The most common causes of readmission in patients with AP include RAP (17–45% of readmissions), smoldering symptoms and/or local complications (17–38%), and hepatobiliary complications (4–17%). Estimated health care costs of readmission in patients with AP range from $18,000–39,000. Acute pancreatitis patients readmitted within 30-days of hospital discharge were observed to have a 4.5-fold increased risk of death at one-year follow-up.

Readmission rates were highest among patients with biliary and alcohol induced AP – these etiologies account for >80% of the more than 300,000 annual admissions for AP in the United States, highlighting an opportunity for improvement in patient care. In patients with biliary etiology of AP cholecystectomy is the standard of care to treat the underlying etiology of AP and prevent recurrent acute pancreatitis. In this review, same admission cholecystectomy significantly reduced the rate of readmission in biliary AP, further supporting cholecystectomy as the standard of care in patients who are suitable operative candidates [13,17,21,29,30]. If same admission cholecystectomy is not feasible due to constraints with operative scheduling or individual patient characteristics, every effort should be made to perform cholecystectomy as soon as possible after discharge, ideally within two weeks [28]. In patients with contraindications to cholecystectomy, endoscopic biliary intervention (stone removal/sphincterotomy/stenting) appears to be an effective alternative in reducing readmission rates, albeit to a lesser extent than cholecystectomy [30]. In patients with alcohol induced AP, cessation of alcohol use is critically important to short-term and long-term outcomes. Most patients with alcohol etiology of AP do not receive alcohol cessation counseling during their index hospital admission; however, this intervention decreases 30-day hospital readmission rates by about 40% [34]. Additionally, alcohol cessation decreases the risk of recurrent acute pancreatitis and progression to chronic pancreatitis [35]. In AP, same admission cholecystectomy (or endoscopic biliary intervention) and alcohol cessation aim to decrease rates of RAP and may impact smoldering symptoms/local complications of AP, the commonest causes of hospital readmission in AP identified in this review. Beyond these interventions, attempts at reducing readmission in AP should focus on the subacute phase after hospital discharge.

Clinicians treating conditions associated with high rates of readmission have observed success in reducing readmission by increased outpatient communication with patients and early reassessment of clinical status via televisits or in-person clinic visits. This intervention has been established in medical populations such as congestive heart failure and chronic obstructive pulmonary disorder and is gaining traction among surgical populations [36–38]. More recently, at our institution the application of a dedicated pancreatitis nurse coordinator to allow for frequent outpatient reassessment of NP patients has demonstrated a significant reduction in rates of unplanned hospital readmission. This study reduced readmission rates by 20% resulting in a reduction in the mean number of unplanned inpatient hospital days by 7.6 days per patient [16]. Despite the budget required to support a dedicated pancreatitis nurse coordinator, the impact of this reduction in readmission appeared to be a cost-effective strategy. In the current review, the financial impact of hospital readmission in AP was identified to range from $18,000–39,000 per patient, demonstrating a clear cost incentive for reducing readmission in AP [10,13,16]. Interestingly, 30-day readmission in patients with AP was associated with an increased risk of one-year mortality, highlighting the impact of AP on a patient’s overall health [14]. The impact of a pancreatitis nurse coordinator on patient experience is difficult to measure. Beyond decreased readmission rates
and fewer inpatient hospital days, a dedicated pancreatitis nurse coordinator allows for improved patient education, increased communication among the multi-disciplinary team, and optimal discharge planning. A dedicated pancreatitis nurse coordinator will have the biggest impact on patients at highest risk for hospital readmission, thus, a thorough understanding of risk factors for hospital readmission and predictors of hospital readmission is extremely important to all clinicians treating patients with AP.

Models to estimate individual patient readmission risk allow clinicians to identify highest risk patients for possible intervention aimed at improving outcomes. In this review, three models for predicting readmission risk were identified [15,22,33]. Among these models, two general themes were identified: systemic inflammation and nutrition. These models identified the presence of systemic inflammatory response syndrome (SIRS) [33], infection [15,33], and organ failure [33] as risk factors for readmission. Infection results in systemic inflammation and organ failure in AP is largely driven by systemic inflammatory mediators [39,40]. Additionally, glucose homeostasis is impacted by systemic inflammation and in one model elevated serum glucose was associated with increased readmission rates [15]. Systemic inflammation is characteristic of AP and plays an important role in disease severity and progression of mild AP to SAP with or without necrosis [39,40]. Systemic inflammation impacts the catabolic/anabolic balance and can negatively affect nutritional status, another important theme identified in these models to predict risk of readmission in AP. Decreased serum albumin concentration [15] and intolerance to oral diet [22,33] were associated with higher readmission rates. Nutritional status at the time of hospital discharge, as well as a thoughtful nutritional plan, are intimately linked to hospital readmission in any disease process [41–43] and must be considered in AP patients. Profound systemic inflammation and malnutrition are nearly ubiquitous in all necrotizing pancreatitis patients, which was identified as the highest risk patient population for readmission in AP. Finally, increasing patient comorbidities increased readmission risk and appeared to be best measured by an Elixhauser comorbidity index of ≥3 [13,17,29]. In AP, at the time of discharge, clinicians should understand the impact of systemic inflammation, nutritional status, severity of AP, and patient comorbidities on readmission risk and develop a thoughtful discharge plan for patients. The models identified in this review serve as a guide to identify highest risk patients for hospital readmission to aide in discharge planning and should be combined with clinical judgment assessing severity of disease and medical comorbidities.

Limitations. This study was performed as an invited narrative review and therefore a formal systematic review and meta-analysis was not performed. Acute pancreatitis is an extremely heterogeneous disease process and the variability in patient and disease specific parameters among studies was not evaluated. Given the clinical spectrum of AP, recurrent AP, and chronic pancreatitis, it was not always possible to discriminate between initial cases of AP, recurrent AP, and acute on chronic pancreatitis. The data included were reviewed and discussed in the context of invited opinion based on clinical experience in AP.

Conclusions
Acute pancreatitis is an extremely common cause of hospital admission and is associated with high readmission rates with opportunities for improved clinical outcomes. Same admission cholecystectomy in biliary AP and alcohol cessation in alcohol-associated AP significantly reduced rates of readmission in several studies. A dedicated pancreatitis nurse coordinator improved readmission rates, patient experience, and multidisciplinary communication in NP and may be applicable to all AP patients. Future efforts to improve readmission rates in AP may focus on the highest risk patients which can be estimated with several available risk stratification models. When developing a discrete discharge plan, clinicians should consider the degree of systemic inflammation, nutritional status, disease severity, and medical comorbidities to develop individualized outpatient care strategies that may improve patient outcomes.

Ethical approval
This study was granted exempt status by the Indiana University School of Medicine Institutional Review Board.

Funding sources
No funding was obtained for this study.

CRediT authorship contribution statement
BDB was involved in the acquisition and analysis/interpretation of data and drafting/revising the article. SPM was involved in the interpretation of data and drafting/revising the article. TKM was involved in the conception and design of this study, the acquisition and analysis/interpretation of data, and drafting and revising the article. All authors give final approval of the submitted version of this manuscript.

Declaration of competing interest
This manuscript has been reviewed and approved by all co-authors. None of the co-authors have any conflicts of interest to report. This manuscript has not been submitted to any other journal.

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