GFM Gastroenterology and Functional Medicine

ORIGINAL ARTICLE

Radiologic imaging utilization in the diagnosis of acute pancreatitis

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ABSTRACT

Background and objectives: Acute pancreatitis is a major cause of hospitalizations in the United States. Imaging is often unwarranted in early, uncomplicated pancreatitis however can prove to be useful in specific clinical scenarios. This study aimed to investigate whether our institution overutilizes abdominal imaging in the diagnosis of pancreatitis. **Methods**: Patients with acute pancreatitis admitted to our institution between 2015 and 2020 were identified using the International Classification of Diseases diagnosis codes. A total of 669 patients met the criteria for acute pancreatitis according to the revised Atlanta Classification. The data was presented using frequencies and percentages and patients with abdominal imaging were compared to those without. Mann Whitney *U* test and chi-square test were used to compare continuous and categorical variables respectively. Univariable and multivariable regression analysis was used to analyze factors associated with the performance of abdominal imaging. **Results**: Our results found that 495 patients (74%) had an abdominal computerized tomography (CT) scan, while 363 patients (52%) had an abdominal ultrasound. More than half of the patients who already met 2 out of 3 clinical and laboratory criteria of the revised Atlanta classification still underwent abdominal imaging, even though it was not necessary. However, we found no significant difference in outcomes between patients who underwent imaging and those who did not, including the need for mechanical ventilation, intensive care unit admission, and inpatient death. **Conclusion**: A significant number of patients admitted for acute pancreatitis undergo abdominal imaging even after fulfilling clinical and laboratory diagnostic criteria.

Key words: pancreatitis, imaging, acute pancreatitis, diagnosis

INTRODUCTION

Acute pancreatitis is characterized by sudden onset inflammation of the pancreas. It is a common gastrointestinal disorder in the United States, with an increasing incidence over the past few decades. According to the National Health and Nutrition Examination Survey (NHANES) data from 2013 to 2016, the estimated annual incidence of acute pancreatitis was 23.6 cases per 100,000 persons, affecting approximately 73,000 individuals each year.[1] Pancreatitis is more common in males than in females, and the incidence increases with age. Highest incidence rates are observed in individuals aged 45 to 64 years.[2] Gallstones and alcohol abuse are the most common causes of acute pancreatitis, accounting for approximately 70% of all

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Received: 21 November 2023; Revised: 5 December 2023; Accepted: 11 December 2023
https://doi.org/10.54844/gfm.2023.480

cases.[3] Other causes include hypertriglyceridemia, medication induced pancreatitis, pancreatic duct obstruction, infections, and autoimmune disorders. Common signs and symptoms of acute pancreatitis include upper abdominal pain, nausea, vomiting, and fever. In severe cases patients may develop systemic inflammatory response and organ failure.

Acute pancreatitis is diagnosed when at least two of three following findings are met: abdominal pain that is suggestive of pancreatitis, elevation in serum amylase or lipase of at least three times the upper limit of normal, and characteristic findings on imaging. In 2012, the revised Atlanta classification of acute pancreatitis was released which standardized the terminology to provide further classification of the severity of each case based on the presence or absence of (peri)pancreatic necrosis and organ failure. The classification system helped divide acute pancreatitis to either interstitial edematous pancreatitis or necrotizing pancreatitis based on imaging findings.[4] The assessment of the clinical and morphologic severity is important, as the mortality rates for interstitial pancreatitis is less than 1%, but increases to 10%–23% in cases of necrotizing pancreatitis.[5]

The International Association of Pancreatology and American Pancreatic Association guidelines for management of acute pancreatitis recommend computerized tomography (CT) imaging in three specific situations: when there is diagnostic uncertainty, when there is suspicion for severe acute pancreatitis based on clinical predictors, or when there is failure to respond to conservative treatment or in the setting of clinical deterioration.[6] Advanced imaging can help differentiate interstitial edematous pancreatitis and necrotizing pancreatitis and can help identify local complications that may require intervention. However, many of these changes will not be seen on initial imaging. Therefore, the recommended timing for imaging is at least 72–96 hours after the onset of symptoms.[4] Unnecessary use of imaging in the diagnosis of acute pancreatitis can increase healthcare costs and radiation exposure for patients. Existing literature has shown that CT scans are often overutilized in the diagnosis of acute uncomplicated pancreatitis.

In this study, we aim to assess current imaging practices in the diagnosis of acute pancreatitis on admission at our community hospital. Understanding this trend at our institution can help us modify our practices to better utilize our resources and improve patient outcomes while minimizing healthcare expenditure.

METHODS

Identification of study population and data collection

Patients admitted for acute pancreatitis between January 2015 and December 2020 with appropriate International Classification of Diseases (ICD)-10 diagnosis codes were identified using electronic medical records. ICD-10 codes: K85.1, K85.9, K85.2 and K85.8 were utilized. Institutional review board approval was obtained prior to obtaining a list of patients. All data was stored in a secure folder with strict protocols for accessing and using the data to maintain privacy and confidentiality. A total of 1015 patients were admitted for acute pancreatitis during the study period, and 669 met the diagnostic criteria.

Diagnosis of acute pancreatitis was confirmed by chart review, using the revised Atlanta classification. As previously mentioned, presence of two of the following: typical abdominal pain, elevated lipase, or amylase more than 3 times upper normal limit or imaging findings concerning for pancreatitis. Patient charts were reviewed for abdominal imaging. This includes ultrasound of the abdomen and cross-sectional imaging such as CT or magnetic resonance imaging (MRI). Both non-contrast computed tomography (NCCT) and contrast enhanced computerized tomography (CECT) are utilized at our institution. Our institution is equipped with a multi-slice CT scanner and allows for faster and more detailed imaging. Imaging performed at time of patient admission and within 24 hours of admission was considered in our study. Imaging was reviewed by a board-certified radiologist. Choice of imaging for each patient was performed in the context of clinical scenario and at discretion of ordering provider.

Inclusion and exclusion criteria

All adult patients above 18 years of age admitted to the hospital with primary or secondary diagnosis of acute pancreatitis between January 2015 and December 2020 were included in our study. These patients met the revised Atlanta criteria for diagnosis of acute pancreatitis. Patients with chronic pancreatitis, history of pancreatic cancer, those who had abdominal surgery or trauma within the past 6 months, those with incomplete medical records or those transferred from or to another hospital were excluded from study population. Patients who had imaging performed more than 24 hours after admission were excluded from the analysis. Patients who had imaging performed for reasons other than acute pancreatitis were also excluded from the analysis. These criteria were established to ensure that the study population consisted of patients who underwent abdominal imaging within 24 hours of admission for the purpose of diagnosing or evaluating pancreatitis. The exclusion criteria in our study were designed to eliminate confounding factors that could affect the interpretation of the results.

Statistical analysis

The frequencies and percentages of the study population were calculated and presented as descriptive statistics. Mann Whitney *U* test was used to compare continuous variables, such as age and laboratory values, between the group of patients who underwent abdominal imaging and those who did not. Chi-square test was used to compare categorical variables between the two groups such as sex, comorbidities and clinical outcomes. In addition, univariable and multivariable logistic regression analysis were performed to identify factors associated with performance of abdominal imaging. Odds ratio (OR) and 95% confidence interval (CI) were calculated for each variable in the model. Results were analyzed using Stata software (Version 17; StataCorp, College Station, TX).

RESULTS

The study included a total of 669 patients, with majority of them undergoing abdominal imaging on admission. Of the total population, 53% were male, and the mean age was 52 ± 15 years (Table 1). The study population comprised of 70% African American, 9% Caucasian, and 12% Hispanic patients. Alcohol use was the primary contributing factor for acute pancreatitis in 55% of cases, while gallstones were present in 21% of cases. Interestingly, only 43% of patients with gallstones received cholecystectomy during their index admission for acute pancreatitis.

Abdominal imaging was performed in 92% of patients, with 74% undergoing abdominal CT scan, 52% undergoing abdominal ultrasound, and 34% receiving both studies. Of the patients who met the Atlanta criteria definition for acute pancreatitis, 71% of patients met 2 out of 3 clinical and laboratory criteria. Among these patients, 65% still received abdominal CT imaging, and 47% also had a concomitant abdominal ultrasound (Figure 1). Only 8% of the total patient population did not receive any abdominal imaging.

Univariate analysis revealed that history of gallstones was associated with higher odds of abdominal imaging (OR 2.76, 95% CI [1.07–7.05], $P = 0.028$), while a history of alcohol use was associated with lower odds (OR 0.54, 95% CI [0.30–0.97], $P = 0.037$). However, these associations were not significant after multivariable analysis. Patients who underwent abdominal imaging tended to have higher values of aspartate aminotransferase (AST) (39 *vs.* 30), alanine aminotransferase (ALT) (32 *vs.* 20), and alkaline phosphatase (ALP) (107 *vs.* 97), but this difference was only significant for AST ($P = 0.032$) after adjusting for confounding factors in multivariable analysis. These findings demonstrate there is no strong association between elevated liver enzyme values, history

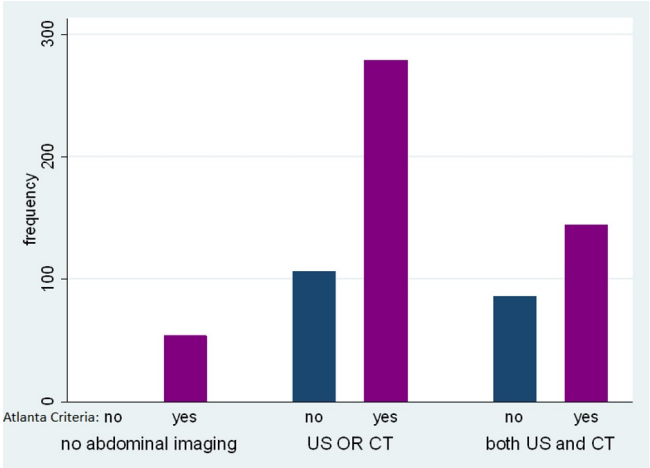

Figure 1. Correlation between imaging for pancreatitis and Atlanta criteria compliance demonstrating majority of the patients in the study had either ultrasound (US) or computerized tomography (CT) scan despite fulfilling Atlanta criteria.

of gallstone or alcohol use with patients undergoing abdominal imaging and therefore cannot be interpreted as causation or the reason behind imaging. Other laboratory parameters on admission such as serum creatinine, blood urea nitrogen, total bilirubin, lipase, and triglycerides did not differ significantly between both groups. There were no significant differences in the number of poor outcomes (need for mechanical ventilation, ICU admission, and inpatient death) regardless of whether patients received abdominal imaging or not ($P = 0.272$).

Furthermore, subgroup analysis of patients with gallstones showed that 76% of them underwent abdominal imaging. Among those who received imaging, 80% underwent abdominal CT scan, 57% underwent abdominal ultrasound, and 37% received both studies. The subgroup analysis did not reveal any significant difference in poor outcomes between those with and without abdominal imaging. Detailed results are presented in Table 2.

DISCUSSION

Overutilization of imaging in acute pancreatitis has been an area of debate in recent years. While imaging is necessary in diagnosis and management in certain cases, unnecessary imaging can lead to increased health care costs, radiation exposure and potential complications. The objective of our study was to examine the pattern of early imaging utilization among patients who present with acute pancreatitis to our emergency department (ED).

Our results show that majority of patients with acute pancreatitis received abdominal imaging, with only 8%

Table 1: Demographics and laboratory findings of patients fulfilling Atlanta criteria, according to use of imaging

n (%)	No imaging (*n* = 54)	Abdominal imaging (*n* = 615)	*P* value
Age (yr)	49 ± 13	52 ± 16	0.138
Female	21 (39)	296 (48)	0.192
Ethnicity			0.850
African American	425 (69)	40 (74)	
Caucasian	57 (9)	3 (6)	
Hispanic	7 (13)	72 (12)	
Others	4 (7)	61 (10)	
Diabetes	21 (39)	227 (37)	0.773
CAD	4 (7)	85 (14)	0.183
HTN	29 (54)	396 (64)	0.118
Asthma	9 (17)	69 (11)	0.232
COPD	2 (4)	47 (8)	0.287
Gallstones	5 (9)	135 (22)	0.028
Alcohol use	37 (69)	331 (54)	0.037
Lab parameters: median (IQR)			
Serum creatinine (mg/dL)	0.8 (0.6–1.2)	0.9 (0.7–1.2)	0.412
BUN (mg/dL)	13.5 (9–20)	13 (9–21)	0.863
AST (U/L)	30 (19–47)	39 (21–110)	0.032
ALT (U/L)	20 (14–38)	32 (17–74)	0.004
Total bilirubin (mg/dL)	0.9 (0.6–1.6)	0.8 (0.5–1.4)	0.429
Alkaline phosphatase (U/L)	97 (77–115)	107 (79–157)	0.042
Lipase (U/L)	544 (346–898)	566 (253–1610)	0.792
Triglycerides (mg/dL)	95 (65–156)	109 (75–167)	0.412
Poor outcomes (ICU admission, mechanical ventilation, inpatient mortality)	2 (4)	48 (8)	0.272

Note: CAD: coronary artery disease; HTN: hypertension; COPD: chronic obstructive pulmonary disease; BUN: blood urea nitrogen; AST: aspartate aminotransferase; ALT: alanine aminotransferase

Table 2: Table showing results of the multivariate analyses for factors associated with use of abdominal imaging

Variables	Odds ratio	95% CI	*P* value
Male	0.80	0.44–1.45	0.46
Female	Reference		
African American	Reference		
Caucasian	1.53	0.45–5.20	0.50
Hispanic	0.90	0.38–2.13	0.82
Asian	1.10	0.25–4.97	0.90
Others	1.48	0.34–6.47	0.60
History of gallstones	2.27	0.86–5.99	0.10
History of significant alcohol use	0.69	0.37–1.29	0.24

of patients not receiving imaging. Abdominal CT was the most used imaging modality, with 74% of patients undergoing this study. Significant proportion of patients who underwent CT in our study met the Atlanta criteria for acute pancreatitis and had classical abdominal pain and elevated lipase levels, indicating potential overuse of this diagnostic tool. Table 3 provides an overview of recent studies that have evaluated use of abdominal imaging in patients with acute pancreatitis. These studies have shown varying rates of imaging utilization, with most suggesting potential overuse of imaging in certain patient populations.

Few relevant studies highlighting crucial findings were performed by Kothari *et al.*, Jin *et al.* and Trieu *et al.*[7–9] Kothari and colleagues performed a single center, retrospective study which aimed to assess utilization and associated cost of CT imaging among patients with uncomplicated acute pancreatitis. The authors of this study concluded that although over half of the study population underwent CT imaging, a rather small percentage of patients had evidence of complicated disease or local complications. Average cost of CT scan was over 4,500 dollars with total cost close to 1 million dollars during study period. Similar findings were also

Table 3: Recent studies describing trends in utilization of abdominal imaging in acute pancreatitis

Author (year) [Reference]	Type of study, total population	Key findings
Kothari (2019)[7]	Retrospective	Among 405 patients who met criteria for acute pancreatitis, 210 patients underwent imaging. Two patients had findings of necrosis or pancreatic cysts. The remaining 208 patients had either normal CT imaging or findings of acute pancreatitis
Jin *et al.* 2017[8]	Prospective, 96	This study compared two groups of patients with acute pancreatitis and found that there was no significant decrease in early CT/MR usage in the second group despite decreased rates of systemic inflammatory response syndrome (SIRS) during the first 24 hours of hospitalization. Age > 60 and SIRS or organ failure on day 1 were independent predictors of early imaging.
Trieu *et al.* (2020)[9]	Retrospective, 993	Early imaging was performed in majority of the patients meeting non imaging criteria for acute pancreatitis. Over 97% of imaging was normal or uncomplicated acute pancreatitis. Early imaging did not affect clinical management.
Reynolds (2018)[10]	Retrospective	About 166 patients met criteria for acute pancreatitis. 105 patients had cross sectional imaging at time of admission. Of these only 2 patients had findings that required change in clinical management.
Shinagare *et al.* (2014)[11]	Retrospective, 101	This study retrospectively identified patients with acute pancreatitis in the ED of a teaching hospital and found that only 1.6% of patients showed pancreatic necrosis, and 87.1% of patients could have been clinically diagnosed without imaging. Of the patients who met diagnostic criteria without imaging, 56.8% underwent imaging, with various results.
Spanier *et al.* (2010)[12]	Multicenter observational study, 166	This study analyzed the first hospital admissions of 166 patients with acute pancreatitis. Majority (89.2%) had mild disease course, and early CT scans were performed in 47% (78/166). Early CT scans did not show necrosis or lead to significant change in clinical management.

published by Trieu *et al.* who evaluated 993 patients with acute pancreatitis over 11-year period. Over 97% of patients had normal imaging and no effect was noted on clinical management.[9] On the other hand, Jin *et al.* sought to describe trends in utilization of CT/MRI during the time period of 2007 to 2015. Authors of this study concluded that there was no significant decrease in use of abdominal CT/MR during this time.[8] These findings are in part due to poor adherence to existing recommendations. Based on current guidelines imaging should be reserved for acute pancreatitis patients in whom diagnosis is unclear or if there is failure in response to therapy after 2–3 days.[13] Additionally, it is important to consider use of severity score calculators and criteria, such as the APACHE, Ranson, and BISAP, that rely predominantly on clinical and laboratory values to predict severity and guide management strategies.[14]

Currently there is no existing literature linking early imaging with improvement in clinical outcomes in acute pancreatitis. A recent analysis of trends over time in the US showed an increase in the use of CT and MRI imaging for patients with acute pancreatitis. Ultimately, in our study no significant differences in outcomes was found between patients who received abdominal imaging and those who did not. Similar findings were also reported by Shinagare *et al.* where despite 2.5-fold increase in utilization of CT imaging over the years, no measurable improvement in outcomes was observed.[10]

Although there is adequate data suggesting overutilization of early imaging in uncomplicated acute pancreatitis, it is also important to consider individual patient factors, such as presenting symptoms, comorbidities along with overall clinical picture. Certain patient populations, such as those suspected to have gallstone pancreatitis or those with severe presentation, may benefit from early imaging. As acute pancreatitis remains a prevalent cause for hospitalization, it is anticipated that imaging of the abdomen, particularly CT/MRI will continue to be frequently utilized. Use of clinical decision support tools is a useful strategy to decrease use and optimize yield of early CT/MR in acute pancreatitis. One specific example is using clinical tools to identify those acute pancreatitis patients presenting without systemic inflammatory response syndrome (SIRS) as these patients are less likely to benefit from use of early imaging. In a prospective study conducted by Singh *et al.*, clinical course of 252 acute pancreatitis patients was explored. All patients who required ICU stay, developed local complications or organ failure demonstrated evidence of SIRS on day one of hospitalization.

Direction of future research in acute pancreatitis should focus on optimizing use of imaging, including identifying patients who are most likely to benefit from early imaging. Other areas of focus include development of decision support tools and provider education tools to improve ordering practices. Additionally, studies should be conducted to evaluated long term outcomes of patients with acute pancreatitis and determine optimal follow up imaging and management strategies. Finally, studies should also be conducted to assess the generalizability of findings from a single center study and to explore potential racial and ethnic disparities in the utilization and outcomes of imaging in patients with acute pancreatitis.

Our study has several limitations. Firstly, the study did not assess severity of pancreatitis or CT findings (edematous vs necrotizing) on initial presentation. Our efforts were directed at identifying the effect of initial imaging on clinical outcomes, which was noted to be insignificant. Secondly, the timing of imaging in relation

to symptoms onset was not evaluated, which could have influenced accuracy of CT findings. Additionally, we did not evaluate if patients had repeat imaging after index admission. This could have provided additional information on progression of disease as well as aid in delineating underlying etiology and subsequent treatment. At our institution, lipase was the standard laboratory enzyme for pancreatitis, so we did not evaluate amylase levels for study population. It is important to note that several other acute abdominal conditions, such as visceral perforation and strangulated intestinal obstruction can also manifest with abdominal pain and elevated serum amylase and lipase levels which could confound the diagnosis if imaging is not considered. Additionally, this was a single-center study with a patient population consisting of a high proportion of African American patients which may limit generalizability of the results. Finally, our study was unable to demonstrate a casual

In summary, we demonstrate a trend of over-utilization of abdominal imaging in initial diagnosis of acute pancreatitis despite a large majority of cases meeting clinical and laboratory criteria. We hope to use our data to develop quality improvement initiatives at our institution to increase adherence to existing guidelines and improve patient care. These findings may also serve as the framework to conduct a randomized clinical trial to further assess whether the use of routine imaging may prove beneficial in the long-term outcomes and management of these patients thereby leading to overall cost reduction due to less missed or delayed diagnoses as well as assisting in determining the etiology of pancreatitis.

In conclusion, a significant number of patients who met criteria for acute pancreatitis based on clinical symptoms and laboratory findings still undergo unnecessary abdominal imaging. The percentage at our institution is higher than that reported in other studies, and this may reflect the general rise in utilization of advanced diagnostic modalities such as CT scanners. Further research is needed to evaluate impact of decision support tools and provider education on the appropriate use of imaging and long-term outcomes of patients.

DECLARATIONS

Acknowledgment
None.

Conflicts of interest
There is no conflict of interest among the authors.

Data sharing statement
No additional data is available.

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