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Original Article

# Ileus is a predictor of local infection in patients with acute necrotizing pancreatitis

Robert A. Moran [a, b], Niloofar Y. Jalaly [b], Ayesha Kamal [b], Sandesh Rao [c], Robert Klapheke [c], Theodore W. James [c], Swetha Kambhampati Thiruvengadam [c], Martin A. Makary [d], Kenzo Hirose [d], Vivek Kumbhari [b], Ellen M. Stein [a, b], Mouen A. Khashab [b], Anne Marie Lennon [b], Anthony N. Kalloo [a, b], Atif Zaheer [a, e], Ruben Hernaez [b], Vikesh K. Singh [a, b, *]

[a] Pancreatitis Center, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[b] Division of Gastroenterology, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[c] Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[d] Division of Surgical Oncology, Department of Surgery, Johns Hopkins University School of Medical, Baltimore, MD, USA
[e] Division of Abdominal Imaging, Department of Radiology, Johns Hopkins University School of Medical, Baltimore, MD, USA

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ABSTRACT

*Background & objectives:* Infected pancreatic necrosis (IPN) is associated with increased morbidity and mortality. Gut barrier dysfunction has been shown to increase the risk of bacterial translocation from the gut into the pancreatic bed. The primary aim of the study is to evaluate if ileus, a clinical marker of gut barrier dysfunction, can predict the development of IPN.

*Methods:* A retrospective cohort study of patients with necrotizing pancreatitis (NP) was conducted from 2000 to 2014. Ileus was defined as ≥2 of the following criteria: nausea/vomiting; inability to tolerate a diet, absence of flatus, abdominal distension and features of ileus on imaging. Extensive necrosis was defined as >30% nonenhancing pancreatic parenchyma on contrast-enhanced CT. Multivariable cox proportional hazard analysis was used to evaluate known and potential predictors of IPN.

*Results:* 142 patients were identified with NP, 61 with IPN and 81 with sterile necrosis. In comparison to a diagnosis of ileus documented in the medical chart, the ileus criteria had a sensitivity, specificity and positive and negative predictive value of 100%, 93%, 78% and 100%, respectively. On multivariate cox proportional hazard analysis, ileus [HR:2.6; 95%CI:1.4–4.9] and extensive necrosis [HR:2.8; 95%CI:1.3–5.8] were independently associated with the development of IPN while there was no association with bacteremia [HR:1.09; 95%CI:0.6–2.1].

*Conclusion:* Ileus in NP can be accurately defined using surgical criteria. Ileus is independently associated with the future development of IPN. Further studies will be needed to determine if ileus can serve as a clinical marker to direct therapeutic interventions aimed at reducing the incidence of IPN.


## 1. Introduction

Acute necrotizing pancreatitis (ANP) comprises 5–10% of all episodes of acute pancreatitis (AP) and is associated with increased morbidity and mortality [1]. Superinfection of necrotic pancreatic tissue, referred to as infected pancreatic necrosis (IPN), is one of the most feared complications of AP and is associated with a mortality rate in the range of 15–20%, according to recently published studies [2,3].

Gut barrier dysfunction can lead to bacterial seeding of necrotic pancreatic tissue via a number of potential routes including: transperitoneal, lymphatic and/or hematogenous spread. Significant gut barrier dysfunction can be seen in up to 60% of patients with severe acute pancreatitis (SAP) and is characterized by increased mucosal permeability and endotoxemia [4–6].

*Abbreviations:* AP, Acute pancreatitis; ANP, Acute necrotizing pancreatitis; CECT, Contrast-enhanced CT; CCI, Charlson cormorbidity index; HR, Hazards ratio; IPN, Infected pancreatic necrosis; IQR, Interquartile range; NP, Necrotizing pancreatitis NP; NPV, Negative predictive value; PPV, Positive predictive value; SAP, severe acute pancreatitis; SD, Standard deviation.

* Corresponding author. Division of Gastroenterology, Johns Hopkins Hospital, 1830 E. Monument Street, Room 428, Baltimore, MD 21205, USA.
*E-mail address:* vsingh1@jhmi.edu (V.K. Singh).

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Preserving the gut barrier using enteral as compared to parenteral nutrition has been shown to improve outcomes in randomized controlled trials of SAP [7,8]. Bacteremia, occurring prior to the diagnosis of IPN, has been associated with the subsequent development of IPN [9,10]. Several studies have evaluated if the presence of extensive necrosis seen on contrast-enhanced CT (CECT) is associated with the development of IPN. While the results have been mixed, the majority of these studies do support an association between extensive necrosis and the subsequent development of IPN [9,11–15]. Ileus, a clinical marker of gut dysfunction is a well-described complication of SAP; however, its prognostic value in AP is poorly understood, likely due to the lack of a working definition for ileus in non-surgical patients.

The aims of the present study were as follows: Firstly, to develop a working definition for ileus in patients with AP. Second, to explore if antecedent ileus, defined as ileus occurring before the diagnosis of IPN, was independently associated with an increased risk of developing IPN.

## 2. Methods

### 2.1. Study design, population and data collection

All AP patients who were transferred or directly admitted to Johns Hopkins Hospital from January 2000 to December 2014 were retrospectively identified from an administrative billing database using the International Classification of Disease, *Ninth Revision* (ICD-9) code 577.0. Data was collected according to a predefined data collection form for all adult patients (≥18 years of age) admitted with a diagnosis of AP. ANP was initially identified on CT reports with confirmation obtained through an independent review of the CECT images. All available transfer documents were reviewed to extract clinical details prior to admission to our institution. January 2000 was chosen as the start date for this study as this was the time period in which the picture archive and communication system (PACS) at Johns Hopkins Hospital was introduced and allowed for an independent review of the digital CECT images.

The study was approved by the Johns Hopkins Institutional Review Board for Human Research and complied with Health insurance Portability and Accountability Act (HIPPA) regulations.

### 2.2. Inclusion criteria

Patients were required to meet all three of the following inclusion criteria: 1) age ≥18 years, 2) AP, defined as the presence of 2 or more of the following: characteristic abdominal pain, serum amylase and/or lipase ≥3 times the upper limit of normal, and CECT of the abdomen demonstrating changes consistent with AP [1] and 3) ANP, defined as either lack of enhancement on pancreatic parenchyma on CECT or contrast enhanced MRI abdomen performed greater than 72 h after presentation.

### 2.3. Definition and diagnostic performance of ileus criteria

The criteria for prolonged or recurrent postoperative ileus from a recent systemic review and global physician survey was used to define ileus in the present study [16]. The presence of ileus was established through a review of the daily medical and nursing progress notes. Ileus was present if a patient simultaneously had ≥2 of the following 5 criteria: 1) Nausea/vomiting; 2) Inability to tolerate a diet for >24 h; 3) Absence of flatus for >24 h; 4) Abdominal distension on physical exam; and 5) Documentation of ileus or suspected ileus from radiology reports (abdominal radiographs, CT and MRI scans). These criteria were then compared to a chart-diagnosis of ileus, defined as a recorded diagnosis of ileus in the medical chart, to establish its performance characteristics, including: sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). A chart-diagnosis of ileus was used as the gold standard for defining ileus, as this represents the overall assessment of the treating clinician(s), and is, at present, the only way a diagnosis of ileus is established. Antecedent ileus was defined as the presence of ileus (based on the previously stated ileus criteria) that occurred greater than or equal to 1 day prior to the date of diagnosis of IPN.

### 2.4. Definitions of outcome variables

The criteria for defining definitive and probable IPN are listed in Table 1 [17,18].

A senior radiologist (A.Z.) reviewed all CECT and contrast enhanced MRI scans blinded to the clinical data. Extensive necrosis was defined as > 30% necrosis on contrast-enhanced CT or MRI.

Bacteremia was defined as a positive blood culture. Antecedent bacteremia was defined as an episode of bacteremia in a patient with IPN that occurred greater than or equal to 1 day prior to the date of diagnosis of IPN.

Comorbidity was calculated using the Charlson cormorbidity index (CCI) [19].

Organ failure was defined according to the revised Atlanta classification [1]. Transient organ failure was defined as organ failure lasting for <48 h and persistent organ failure was defined as organ failure lasting for ≥48 h.

Inpatient mortality was defined as death occurring during hospitalization for AP.

## 3. Statistical analysis

Continuous and categorical data were compared between groups using standard parametric testing. Medians were compared using the Wilcoxon signed-rank test. Time to event analysis was conducted using the Kaplan-Meier method with log rank testing. Multivariable regression analyses were performed to evaluate the factors associated with the development of IPN using Cox proportional hazard regression. Cox proportional assumption were checked using Schoenfeld residuals. Multivariable regression models were adjusted for age and comorbidity. Advanced age has been associated with less gut barrier dysfunction [6]. As the model was adjusted for the presence of extensive necrosis, which is a robust independent predictor of adverse outcomes in AP, it was not adjusted for other collinear predictors of SAP, such as serum C-reactive protein or the Acute Physiology and Chronic Health Evaluation II score. The results are presented as estimated hazards ratio (HR) with respective 95% confidence intervals (95% CI) and *p* values. A two-sided p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS version X (City, State).

## 4. Results

### 4.1. Description of study population

From 2000 to 2014, 142 patients met inclusion criteria and their demographic characteristics are detailed in Table 2. Transferred patients represented 63% of the total cohort. A total of 56 patients were classified as having definite IPN and an additional 5 patients were classified as having probable IPN (Table 1). IPN patients were more likely to be white (85% vs 65%, $p < 0.01$), older (55.2 vs 49.9 years, $p = 0.03$) and have been transferred from another hospital (75% vs 54%, $p = 0.01$). Patients with sterile necrosis were more

**Table 1**
Criteria for diagnosis of infected pancreatic necrosis.

| | Number of patients N = 61 |
|---|---|
| **Definitive IPN** | 56 |
| • Positive pancreatic tissue culture (surgical or percutaneous) | |
| **Probable IPN** | 5 |
| • Negative pancreatic tissue cultures *with* CT findings of infection (air on CT) *and* positive blood cultures. | (2) |
| • Negative pancreatic tissue cultures *with* CT findings of infection (air on CT) *and* negative blood cultures. | (1) |
| • Negative pancreatic tissue cultures *without* CT findings of infection *and* positive blood cultures *with* no other clear source of infection. | (2) |

likely to have alcohol as the etiology of AP (44% vs. 16%, p = 0.002). There was no difference in the proportion of males and mean Charlson comorbidity index scores between the two groups. The median time from admission to diagnosis of IPN was 4 weeks (interquartile range [IQR]:2.1–7.7 weeks).

### 4.2. Diagnostic performance of ileus criteria

Thirty two patients were diagnosed with ileus in this study based on the aforementioned criteria, with a mean number of criteria of 3.21 (SD ± 0.97) (Table 3). Of these 32 patients, 25 (78%) and 7(22%) did and did not have a chart-diagnosis of ileus, respectively. There were no patients with a chart-diagnosis of ileus who did not fulfill the criteria for ileus. When comparing ≥2 of the proposed diagnostic criteria for ileus to documentation of ileus in the medical chart, the sensitivity, specificity, PPV and NPV for the ileus criteria was 100%, 93%, 78% and 100%, respectively, when compared to a chart-diagnosis of ileus.

Imaging findings consistent with ileus were found in 23 of the 25 patients with a chart-diagnosis of ileus and only 1 of the 7 patients who met ileus criteria only. Patients with a chart-diagnosis of ileus had a greater mean number of ileus criteria compared to patients who meet criteria only without a chart-diagnosis of ileus (3.44 ± 0.96 vs 2.57 ± 0.79, p = 0.04). However, the mean number of

**Table 2**
Comparison of demographics, clinical characteristics, nutritional interventions and outcomes of patients with infected versus sterile pancreatic necrosis.

| | All patients, n = 142 | Infected pancreatic necrosis, n = 61 | Sterile pancreatic necrosis, n = 81 | *P* |
|---|---|---|---|---|
| ***Demographics*** | | | | |
| Male, n (%) | 142 | 46 (75) | 63 (78) | 0.74 |
| Mean age, years (mean ± SD) | 52.20 (14.15) | 55.23 (13.49) | 49.92 (14.29) | 0.03 |
| Race, n (%) | | | | 0.26 |
| - White | 105 (74) | 52 (85) | 53 (65) | |
| - Black | 31 (22) | 7 (11) | 24 (30) | |
| - Asian | 6 (4) | 2 (4) | 4 (5) | |
| Transferred from outside hospital | 90 (63) | 46 (75) | 44 (54) | 0.01 |
| ***Clinical characteristics*** | | | | |
| Etiology, n (%) | | | | |
| - Gallstones | 54 (38) | 29 (48) | 25 (31) | 0.16 |
| - Alcohol | 46 (32) | 10 (16) | 36 (44) | 0.002 |
| - Other | 42 (30) | 22 (36) | 20 (25) | 0.57 |
| CCI (mean ± SD) | 2.16 (2.13) | 2.49 (2.3) | 1.91 (1.98) | 0.11 |
| Extensive necrosis, n (%) | 89 (63) | 47 (76) | 40 (49) | <0.001 |
| ***Nutritional interventions*** | | | | |
| TPN use during admission, n (%) | 92 (65) | 52 (85) | 40 (49) | <0.001 |
| Enteral feeding (NG/NJ) during admission, n (%) | 55 (39) | 35 (57) | 20 (25) | <0.001 |
| ***Outcomes*** | | | | |
| Organ failure, n (%) | 91 (43) | 54 (89) | 37 (46) | <0.001 |
| - Transient | 16 (11) | 7 (11) | 9 (11) | 0.95 |
| - Persistent | 73 (51) | 45 (74) | 28 (35) | <0.001 |
| Inpatient mortality, n (%) | 13 (9) | 12 (20) | 1 (1) | <0.001 |

CCI: Charlson comorbidity index, IPN: infected pancreatic necrosis, NG: nasogastric, NJ: nasojejunal, SN: sterile necrosis.
All values expressed as number (%).

**Table 3**
Patients with positive ileus criteria with and without a chart diagnosis of ileus.

| | All | Ileus criteria without a chart-diagnosis of ileus | Ileus criteria with a chart-diagnosis of ileus | *p* |
|---|---|---|---|---|
| | (n = 32) | (n = 7) | (n = 25) | |
| Mean number of ileus criteria, (SD) | 3.21 (±0.97) | 2.57 (±0.79) | 3.44 (±0.96) | 0.04 |
| Mean number of clinical ileus criteria. (excluding imaging findings), (SD) | 2.5 (±0.84) | 2.42 (±0.53) | 2.52 (±0.92) | 0.80 |
| ***Ileus Criteria*** | | | | |
| - Positive imaging findings, (%) | 24 (75) | 1 (14) | 23 (92) | 0.001 |
| - Nausea/Vomiting, (%) | 19 (60) | 5 (71) | 14 (56) | 0.46 |
| - Tolerate oral feeding, (%) | 23 (72) | 5 (71) | 18 (72) | 0.98 |
| - No flatus, (%) | 13 (41) | 2 (29) | 11 (44) | 0.24 |
| - Abdominal distension, (%) | 25 (78) | 5 (71) | 20 (80) | 0.62 |

clinical ileus criteria (excluding imaging) was the same in patients with a chart-diagnosis of ileus and patients who met criteria only ($2.52 \pm 0.92$ vs $2.42 \pm 0.53$, $p = 0.80$). Patient with a chart-diagnosis of ileus were significantly more likely to have imaging findings of ileus compared to patients who met ileus criteria only (92% vs 14%, $p = 0.001$). The median number of days between patient meeting criteria for ileus and initial chart-diagnosis of ileus was 0 (IQR: 0 to 1). The median number of days from patients meeting criteria for ileus and the diagnosis of IPN was 21 (IQR: 9–38).

### 4.3. Factors associated with the development of IPN

After establishing a definition for ileus, we examined the factors associated with the development of IPN. Of the 61 patient with IPN, a total of 16 were excluded from the secondary analysis evaluating the factors associated with the development of IPN for the following reasons: 1) Transferred after or within 24 h of the diagnosis of IPN ($n = 11$), thus a preceding history of bacteremia or ileus could not be determined. 2) Probable IPN were excluded to ensure a uniform method of defining the date of diagnosis for IPN ($n = 5$). After removing these 16 patients, there was no significant change in the demographic, clinical characteristics or outcomes of the cohort (data not shown).

Extensive necrosis (76% vs. 51%), antecedent bacteremia (36% vs. 11%) and antecedent ileus (47% vs. 14%) were significantly more common in IPN than sterile necrosis (Table 4). On univariable and multivariable analysis, respectively, extensive necrosis [HR (95% CI): 2.25 (1.13–4.50) and 2.80 (1.34–5.81)] and antecedent ileus [HR (95%CI): 2.05 (2.34–13.21) and 2.60 (1.39–4.89)] were associated with the development of IPN (Table 5). Antecedent bacteremia and was not associated with the development on IPN on either univariable [HR(95%CI): 1.17 (0.63–2.18)] or multivariable analysis [HR(95%CI): 1.09 (0.58–2.05)]. Kaplan-Meier estimates for the development of IPN are presented in Fig. 1a, b and c. The model met the proportional hazards assumption as tested by the Schoenfeld residuals.

The median number of days between antecedent bacteremia and the diagnosis of IPN based on the previously stated criteria was 7 (IQR: 3–12.5 days).

**Table 5**
Univariate and multivarate cox proportional hazard analysis for the development of infected pancreatic necrosis.

| Clinical predictor | Univariable | | Multivariable[a] | |
|---|---|---|---|---|
| | HR (95%CI) | *p* | HR (95%CI) | *p* |
| Antecedent bacteremia | 1.17 (0.63–2.18) | 0.614 | 1.09 (0.58–2.05) | 0.785 |
| Antecedent Ileus | 2.05 (2.34–13.21) | 0.019 | 2.60 (1.39–4.89) | 0.003 |
| Extensive necrosis | 2.25 (1.13–4.50) | 0.022 | 2.80 (1.34–5.81) | 0.006 |

HR – Hazard Ratio, IPN – Infected pancreatic necrosis, CI: confidence interval.
[a] Adjusted for clinical predictors in addition to age and Charlson comorbidity index.

## 5. Discussion

The present study has a number of findings. Firstly, a working criteria for ileus has been developed for patients with AP. Second, in a time to event model, both antecedent ileus and extensive necrosis were found to be significantly associated with an incident diagnosis of IPN. Finally, although antecedent bacteremia was more common in IPN patients, it was not associated with an incident diagnosis of IPN in the time to event model.

Given that there were no established criteria for the diagnosis of ileus in non-postoperative patients, we adapted criteria from a recent systematic review and global physician survey on postoperative ileus [16,20]. In comparison to a chart-diagnosis of ileus, the criteria espoused in the present study demonstrated excellent performance characteristics. Documentation of ileus in the medical chart was heavily influenced by the presence of imaging studies demonstrating ileus. After the imaging features of ileus were excluded from patients who had meet the ileus criteria, there was no difference in the mean number of ileus criteria for patients with and without a chart diagnosis of ileus. This suggests that clinicians are more likely to diagnose ileus when there is supporting radiographic evidence despite a similar clinical picture. However, patients with AP may lack the typical imaging features (air fluid levels) associated with a classical postoperative ileus due to delayed gastric emptying from the adjacent pancreatic inflammation [21]. This is a possible explanation for why a minority of patients in the present study who met criteria for ileus did not have a diagnosis of ileus in their medical record.

Gut barrier dysfunction is a key pathological process in severe AP [4,5]. Animal models of ANP have demonstrated that ileus is associated with significant damage to intestinal neuronal plexuses, supporting ileus as a clinical sign of gut dysfunction in AP [22]. The clinical evidence showing that gut barrier dysfunction leads to seeding of necrotic pancreatic tissue is limited. Hematogenous spread is supported by the findings of a number of clinical studies that have shown an association between antecedent bacteremia and the development of IPN [9,15]. Transperitoneal seeding is supported by the findings of Busquets et al., where 22 of the 39 patients with sterile NP who underwent laparotomy had infected ascitic fluid, suggesting bacterial translocation across the intestinal wall [23]. Only limited experimental models support lymphatic spread as a mechanism of seeding in infected pancreatic necrosis [24]. While one prior study ileus was shown to be associated with IPN, this study had several important limitations including the lack of criteria for defining ileus and clarity regarding whether ileus occurred before or after the diagnosis of IPN [25]. The later point is particularly important as many of these patients underwent surgery and may have developed postoperative ileus. In the present study, antecedent ileus was independently associated with the development of IPN. In addition, the time between the diagnosis of antecedent ileus and IPN was long (median of 21 days), suggesting that ileus results in IPN rather than the converse, that is, IPN results in ileus.

**Table 4**
Clinical predictors of infected pancreatic necrosis in the subgroup analysis cohort.

| | All patients, n = 126 | Infected pancreatic necrosis, n = 45 | Sterile pancreatic necrosis, n = 81 | *p* |
|---|---|---|---|---|
| Extensive necrosis | 74 (59) | 34 (76) | 41 (51) | 0.006 |
| Antecedent bacteremia in IPN or bacteremia in SN | 25 (20) | 16 (36) | 9 (11) | 0.001 |
| Antecedent ileus in IPN or ileus in SN | | | | |
| - Meet Ileus criteria | 32 (25) | 21 (47) | 11 (14) | <0.001 |
| - Chart diagnosis of ileus | 25 (20) | 16 (36) | 9 (11) | <0.001 |

CCI: Charlson comorbidity index, IPN: infected pancreatic necrosis, SN: sterile necrosis.
All values expressed as number(%).

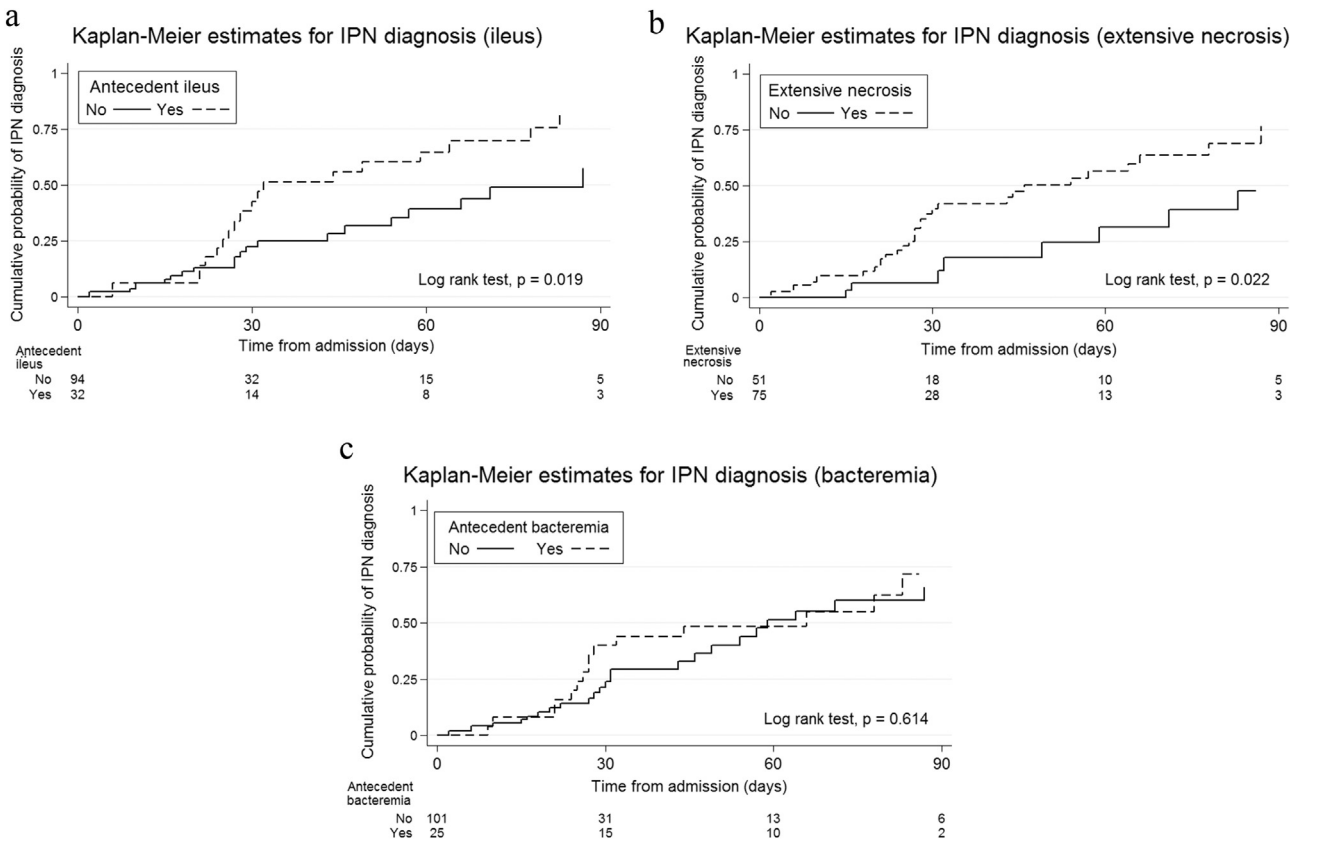


**Fig. 1.** a: Kaplan Meier estimates of infected pancreatic necrosis adjusted for antecedent ileus. b: Kaplan Meier estimates of infected pancreatic necrosis adjusted for extensive necrosis. c: Kaplan Meier estimates of infected pancreatic necrosis adjusted for antecedent bacteremia.

Multiple laboratory markers have been associated with an incident diagnosis of IPN (procalcitonin, CRP, white blood cell count, interleukin-6, and interleukin-8) with conflicting results [26–31]. The presence and extent of pancreatic necrosis are strongly associated with outcomes in AP, it is unclear if these laboratory markers would offer additional prognostic value in predicting IPN or other adverse outcomes in a refined cohort of only patients with NP [12–14,32]. In addition, the criteria for ileus are easily and more commonly assessed in clinical practice and given that they were present at a median of 21 days prior to the diagnosis of IPN, may be a superior and more practical predictor of IPN than any single or combination of laboratory markers.

Antecedent bacteremia was statistically more common in the IPN group compared to the SN group (36% vs 11%, $p = 0.001$); however, it was not associated with the development of IPN in the time to event model. The lack of a time to event analysis is the primary limitation of prior studies that evaluated the association between bacteremia and the development of IPN [9,15]. The short median time interval (7 day) between antecedent bacteremia and a diagnosis of IPN in the present study, potentially suggests that a large proportion of bacteremia occurred as a result of IPN. Bacterial seeding of necrotic pancreatic parenchyma is likely to be present for a significant period prior to the clinical suspicion and subsequent intervention resulting in a positive tissue culture confirming IPN. Other sources of bacteremia, including indwelling percutaneous and central venous catheters may also be responsible for antecedent bacteremia in some of these patients. It is also possible that direct peritoneal and/or lymphatic dissemination of bacteria is the basis for IPN and not hematogenous spread. Regardless of the role that bacteremia plays in IPN, there is no question that it should be aggressively treated when diagnosed, given its association with increased mortality in AP [9].

The present study has several important clinical implications. At present, antimicrobial prophylaxis is not recommended for the prevention of IPN and the use of prophylaxis has been shown to increase the risk of intra-abdominal fungal infections, which have been associated with high mortality [33,34]. Published studies that evaluated antimicrobial prophylaxis utilized patients with extensive necrosis to define the high risk group that may benefit from prophylaxis. The present study reports that both ileus and extensive necrosis are more powerful predictors for the development of IPN than bacteremia. The presence of either ileus or a combination of ileus and extensive necrosis may better define an at risk group for the development of IPN and represent an improved selection criteria for future studies evaluating antimicrobial prophylaxis in ANP. In addition, while there is hesitancy amongst clinicians to offer enteral nutrition to ANP patients with ileus, this is the group who may derive the most benefit from enteral nutrition, and thus, consideration should potentially be given to the administration of small quantities of enteral feeding in these patients, with gradual escalation as their ileus resolves. Finally, given the establishment of a working definition for ileus in acute pancreatitis patients, a platform has been developed to explore the prognostic value of this simple and easily recognized clinical entity for all patients with AP.

The main strength of the present study is the use of a validated definition for ileus. While this definition is not specific for ileus in AP, the 4 clinical features employed in the criteria are

common features of overall gut barrier dysfunction and decreased motility that are intuitive features of ileus in patients with AP [35–37]. In addition, the use of a time to event model for the multivariable analysis, controlled for time to diagnosis after admission, which is different between patients with SN and IPN.

While the large number of transferred patients in this study is a potential limitation, it should be noted that several studies have shown that the majority of ANP patients at tertiary centers are transferred from outside hospitals. In spite of this, we only had to exclude 11 patients as the timing of a positive blood culture was not clear. Enteral nutrition and TPN use were not incorporated into the present time to event model as many patients in this study received both enteral nutrition and TPN at variable times during hospitalization. In addition, there is likely substantial provider and patient bias towards the use of each nutrition modality, namely the use of TPN in patients with SAP and ileus as well as the challenges of nasogastric and nasojejunal tube insertion and maintenance. The method to define the date of diagnosis of IPN in the present study ensured uniformity in the occurrence of the outcome but likely resulted in an important limitation - the time from antecedent ileus and bacteremia to clinically apparent infection is undoubtedly shorter in prior studies compared to the present study, as the date of IPN diagnosis was based on the date positive pancreatic cultures were obtained and not when IPN was suspected clinically. However, it should be noted that the timing of infected necrosis in the present study is broadly consistent with previous studies [9,38].

In conclusion, antecedent ileus and extensive necrosis are independently associated with the development of IPN among patients with NP. Future studies will be needed to determine if ileus can serve as a clinical marker for interventions aimed at reducing the development of IPN.

## Disclosures

Mouen Khashab: Consultant for Boston Scientific, Xlumena and Olympus.

Anthony Kalloo: Equity holder for Apollo Endosurgery.

Anne Marie Lennon: Consultant for Novo Nortis & Olympus.

Vikesh Singh: Consultant for Abbvie, D-Pharm, Calcimedica, Novo Nordisk, and Boston Scientific. Advisory board participant for Salix, Enteromedics, and Celltrion.

All the other authors have no disclosures.

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