Management of adult pancreatic injuries: A practice management guideline from the Eastern Association for the Surgery of Trauma

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BACKGROUND: Traumatic injury to the pancreas is rare but is associated with significant morbidity and mortality, including fistula, sepsis, and death. There are currently no practice management guidelines for the medical and surgical management of traumatic pancreatic injuries. The overall objective of this article is to provide evidence-based recommendations for the physician who is presented with traumatic injury to the pancreas.

METHODS: The MEDLINE database using PubMed was searched to identify English language articles published from January 1965 to December 2014 regarding adult patients with pancreatic injuries. A systematic review of the literature was performed, and the Grading of Recommendations Assessment, Development and Evaluation framework was used to formulate evidence-based recommendations.

RESULTS: Three hundred nineteen articles were identified. Of these, 52 articles underwent full text review, and 37 were selected for guideline construction.

CONCLUSION: Patients with grade I/II injuries tend to have fewer complications; for these, we conditionally recommend nonoperative or nonresectional management. For grade III/IV injuries identified on computed tomography or at operation, we conditionally recommend pancreatic resection. We conditionally recommend against the routine use of octreotide for postoperative pancreatic fistula prophylaxis. No recommendations could be made regarding the following two topics: optimal surgical management of grade V injuries, and the need for routine splenectomy with distal pancreatectomy. (*J Trauma Acute Care Surg.* 2017;82: 185–199. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Systematic review, level III.

KEY WORDS: Pancreas; pancreatic injury; pancreatic trauma; practice management guideline.

Traumatic injuries to the pancreas are infrequent but can be associated with major morbidity and mortality, including acute hemorrhage, pancreatic leaks, abscesses, fistulae, and pancreatitis.[1] Estimates for the incidence of pancreatic injury range from 0.2% to 12% of abdominal traumas.[2–6] Many factors, such as patient stability, the acuity of concomitant life-threatening injuries, and the need for damage control procedures, must therefore be balanced when considering the proper approach to pancreatic injury management.

Historically, injuries to the pancreas were described by injury location as involving the head, body, and/or tail of the pancreas.[7–9] Early taxonomy for pancreatic injury did not require determination of involvement of the pancreatic duct, even though surgeons have long believed that ductal injury is the principal cause of pancreatic-specific morbidity and mortality.[10,11] The American Association for the Surgery of Trauma grading system, published in 1990, is a practical and prognostic way to describe pancreatic injury. With this system, typically, higher-grade injuries correlate with higher mortality and complications.[2,12] Grades I and II include minor pancreatic contusions and lacerations that spare the pancreatic duct. Grade III injuries include pancreatic duct injuries at the body and tail, and grade IV injuries include ductal injuries at the pancreatic head. Grade V injuries include massive disruption of the pancreatic head.

Computed tomography (CT) scan is the diagnostic modality of choice in hemodynamically stable blunt abdominal trauma patients to diagnose pancreatic injury. The sensitivities for detecting pancreatic injury are highly variable ranging from 47% to 79%, with newer-generation scanners being more sensitive.[13,14] Identification of pancreatic duct injury using CT imaging also varied, with sensitivities ranging from 52% to 54% with specificities between 90% and 95%.[13] Others have reported sensitivities from 91% to 95% with specificities of 91% to 100% pancreatic duct injury using multidetector CT scans.[15,16] Use of magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP) for diagnostic tools for pancreatic injury are limited to case reports. However, the use of magnetic resonance imaging is believed to increase the diagnostic confidence of pancreatic injury according to Panda et al.[16] A review of the case series also showed that MRCP can be a useful tool for diagnostic purposes, whereas ERCP may provide diagnostic as well as therapeutic intervention but is limited due to the logistics of performing ERCP in general and the technical challenges of performing it in a multiple trauma patient with the risk of exacerbating the issue with pancreatitis.[17]

Therapeutic operative interventions for pancreatic injury are typically treated by drainage or suture repair for minor injuries, whereas more extensive injuries generally require pancreatic resection.[4] Surgeons have advocated various reconstruction options after resection, including gastrojejunostomy, Roux-en-Y reconstructions, and pancreaticoduodenectomy.[18] Commonly reported complications have included fistulae, pseudocysts, intraabdominal

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TABLE 1. Outcome Importance for Each PICO

Outcome of Interest	PICO 1 Treatment of Low-Grade Injury Diagnosed by CT	PICO 2 Treatment of High-Grade Injury Diagnosed by CT	PICO 3 Operative Treatment of Low-Grade Injury	PICO 4 Operative Treatment of High-Grade Injury	PICO 5 Treatment of Grade V Injury	PICO 6 Routine Postoperative Fistula Prophylaxis With Octreotide	PICO 7 Routine Splenectomy With Distal Pancreatectomy
Mortality	8	9	8	9	9		8
Chronic pancreatitis	5	7					
Pancreatic fistula and/or leak	8	8	8	8	8	8	
Sepsis	7	8	7	8	8		5
Hospital length of stay	6	6	5	6	5		
Intensive care unit length of stay	5	6	5	6	5		
Intraabdominal abscess			7	7	7		
Time to closure of pancreatic leak						7	
Operative time							7
Blood loss							7

abscesses, and pancreatitis.[9] Pancreaticoduodenectomy was recommended by Foley and Fry[18] in 1969 as an aggressive approach for destructive pancreatic head injuries to curtail bleeding and ensure removal of all devitalized tissue. More recent advancements in surgical trauma care have introduced additional strategies, such as increased use of nonoperative management, endoscopic stenting for ductal injuries, and damage control surgery.[19–21] It is currently unknown which management strategies lead to the most favorable outcomes.

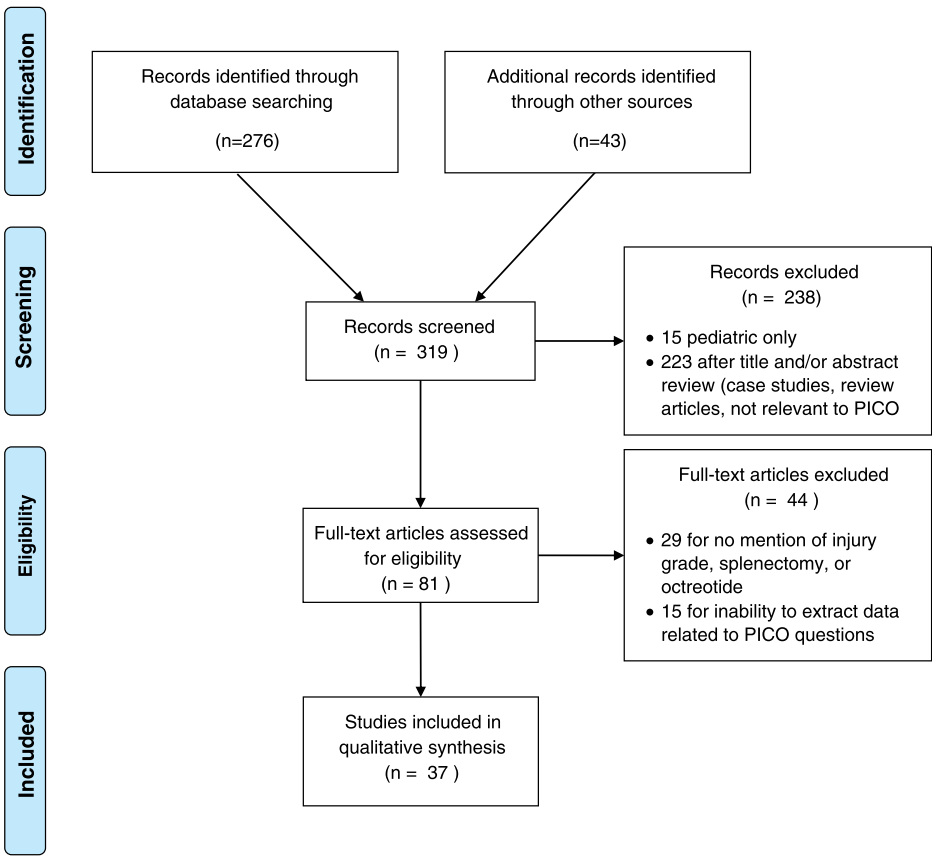

Figure 1. Included studies and PICO questions addressed.

Our group investigated treatment strategies by severity (American Association for the Surgery of Trauma grade) of pancreatic injury. Additionally, we investigated two other common management decisions: first, whether octreotide should routinely be used after pancreatic surgery to prevent the development of pancreatic fistulae; and second, whether splenectomy should routinely be performed concomitant with distal pancreatectomy. To address these concerns in an objective and transparent manner, the Guidelines Section of the Eastern Association for the Surgery of Trauma used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology for this work.[22,23] The overall objective of this article was to provide evidence-based recommendations for the physician who is presented with traumatic injury to the pancreas.

OBJECTIVES

The objective of this guideline was to determine optimal treatment for patients with pancreatic injuries. We created a set of Population, Intervention, Control, Outcome (PICO) questions, as follows:

PICO 1

For adults with grade I/II injury to the pancreas identified by CT scan (P), should operative intervention (I) or nonoperative management (C) be performed?

PICO 2

For adults with grade III/IV injury to the pancreas identified by CT scan (P), should operative intervention (I) or nonoperative management (C) be performed?

PICO 3

For adults undergoing an operation who are intraoperatively found to have a grade I/II pancreas injury (P), should resectional (I) or nonresectional management (C) be performed?

PICO 4

For adults undergoing an operation who are intraoperatively found to have a grade III/IV pancreas injury (P), should resectional (I) or nonresectional management (C) be performed?

PICO 5

For adults with total destruction of the head of the pancreas (grade V) (P), should pancreaticoduodenectomy (I) or surgical treatment other than pancreaticoduodenectomy (C) be performed?

PICO 6

For adults who have undergone an operation for pancreatic trauma (P), should routine octreotide prophylaxis (I) or no octreotide (C) be used?

PICO 7

For adults undergoing distal pancreatectomy for trauma (P), should routine splenectomy (I) or splenic preservation (C) be performed?

OUTCOME MEASURE TYPES

Relevant outcomes were established by the committee members a priori. Importance of each outcome was independently rated by each member of the subcommittee on a scale of 1 to 9 as described by the GRADE methodology.[23] Critical outcomes are scored 7 to 9, important outcomes are scored 4 to 6, and limited importance outcomes are scored 1 to 3. Outcome scores for each outcome for each PICO are presented in Table 1. Critical and important outcomes were considered in our review.

IDENTIFICATION OF REFERENCES

A systematic search of the MEDLINE database using PubMed was performed on December 9, 2014, with the assistance of a professional librarian using the following search terms: (“Pancreas/surgery” [MeSH] AND (“wounds and injuries” [MeSH Terms] OR (“wounds” [All Fields] AND “injuries” [All Fields]) OR “wounds and injuries” [All Fields])). Related articles and bibliographies of included studies and reviews were searched manually. We only included English-language retrospective and prospective studies from January 1965 until December 2014. Articles that did not describe ductal injuries (either by anatomic description or by formal grading system) were excluded.

Three hundred nineteen articles were screened for relevance. Fifty-two articles were reviewed in full by the subcommittee members. Fifteen additional articles were excluded because data were not grouped by pancreatic injury severity or treatment methodology and outcomes could not be extracted. Thirty-seven articles were included for data extraction (Fig. 1); included articles were single or multiple institution retrospective studies or case series, as well as a single prospective randomized trial that compared closed suction and sump for postoperative drainage of the pancreas. Twenty-nine articles were reviewed for PICOs 1 to 5, two articles were reviewed for PICO 6, and 13 articles were reviewed for PICO 7.

DATA EXTRACTION AND METHODOLOGY

Each article was reviewed by two subcommittee members to ensure concordance. If discordance occurred, a third subcommittee member re-reviewed the article. Data were then entered into a Microsoft Excel (Microsoft, Redmond, WA) spreadsheet. All entered data were checked in triplicate by the primary investigator to ensure accuracy. The quality of evidence was evaluated for each of the following domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias.

Within the literature, there was no uniform definition for pancreatic leak, fistula, sepsis, or mortality. Resectional management was defined as a procedure in which pancreatic tissue was removed by the surgeon in a manner that required transection of the pancreas (such as a distal pancreatectomy or a pancreaticoduodenectomy). Conversely, if no resection was performed, this was defined as nonresectional management; this generally included pancreatic repair, debridement, and placement of drains. Deaths were included if they were “pancreas-related” or not specified. Deaths attributed to causes other than the pancreatic injury were not extracted for pooled analysis but were noted for discussion. Intraoperative deaths and preoperative deaths were also not included in

TABLE 2. Treatment of Low-Grade Injury Diagnosed by CT (PICO 1)

PICO 1: Operative Compared With Nonoperative Management for Grade I/II Pancreatic Trauma

Quality Assessment							Summary of Findings				
							Study Event Rates (%)			Anticipated Absolute Effects	
No. Participants (Studies) Follow-up	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Nonoperative Management	With Operative Management	Relative Effect (95% CI)	Risk With Nonoperative Management	Risk Difference With Operative Management
Death											
68 (10 studies)	Serious *	Not serious	Serious *	Serious *	None	⊕○○○ VERY LOW	0/40 (0.0%)	0/28 (0.0%)	Not estimable	Study population 0 per 1000	0 fewer per 1000 (0 fewer to 0 more)
Chronic pancreatitis											
44 (4 studies)	Serious *	Not serious	Serious*	Serious *	None	⊕○○○ Very low	2/22 (9.1%)	0/22 (0.0%)	Not estimable	Study population 91 per 1,000	91 fewer per 1,000 (211 fewer to 29 more)
Pancreatic fistula or leak											
66 (7 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	3/44 (6.8%)	0/22 (0.0%)	Not estimable	Study population 68 per 1,000	68 fewer per 1,000 (143 fewer to 6 more)
Sepsis											
36 (3 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	0/14 (0.0%)	0/22 (0.0%)	Not estimable	Study population 0 per 1,000	0 fewer per 1,000 (0 fewer to 0 more)

*Small sample sizes, with no direct comparisons between groups, varying definitions of outcomes, few reported presence or absence of outcomes, inadequate power.

TABLE 3. Treatment of High-Grade Injury Diagnosed by CT (PICO 2)

PICO 2: Operative Compared With Nonoperative Management for Grade III/IV Pancreatic Trauma

Quality Assessment							Summary of Findings				
							Study Event Rates (%)			Anticipated Absolute Effects	
No. Participants (Studies) Follow-up	Risk of Bias	Inconsistency	indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With Nonoperative Management	With Operative Management	Relative Effect (95% CI)	Risk With Nonoperative Management	Risk Difference With Operative Management
Death											
40 (7 studies)	Serious *	not serious	serious *	serious *	none	⊕○○○ Very low	1/16 (6.3%)	1/24 (4.2%)	RR 0.67 (0.04–9.91)	Study population 63 per 1,000	20 fewer per 1,000 (164 fewer to 122 more)
Chronic pancreatitis											
27 (4 studies)	serious *	not serious	serious*	serious *	none	⊕○○○ Very low	0/11 (0.0%)	0/16 (0.0%)	not estimable	Study population 0 per 1000	0 fewer per 1,000 (0 fewer to 0 more)
Pancreatic fistula or leak											
39 (6 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	9/15 (60.0%)	7/24 (29.2%)	RR 0.49 (0.23–1.03)	Study population 600 per 1,000	308 fewer per 1,000 (616 fewer to 1 fewer)
Sepsis											
22 (3 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	1/9 (11.1%)	0/13 (0.0%)	Not estimable	Study population 111 per 1,000	111 fewer per 1,000 (316 fewer to 94 more)

*Small sample sizes, with no direct comparisons between groups, varying definitions of outcomes, few reported presence or absence of outcomes, inadequate power.

pooled analysis, because the committee felt that pancreatic injuries do not generally lead to immediate death; intraoperative and preoperative deaths are likely secondary to associated injuries. Pseudocysts and peripancreatic fluid collections that required intervention were included as pancreatic fistulae/leaks. Failure of nonoperative management was noted, although not a formal outcome for PICO questions, as a possible outcome for nonoperatively managed patients. This was defined as patients who required operative intervention after initial plan for nonoperative management. Data for each outcome were analyzed using STATA/SE, 14.0 (College Station, TX). Summary of findings tables were created using GRADEpro software (http://gdt.guidelinedevelopment.org/). Data were pooled and relative risk and risk differences were calculated, with 95% confidence intervals. Subcommittee members weighed the pooled data outcomes and literature quality to determine recommendations for each PICO question. The strength of the recommendations was based on the evidence, risk-versus-benefit ratio, and patient values.

RESULTS

Treatment of Low-Grade Injury Diagnosed by Ct (PICO 1)

For adult patients with grade I/II injuries to the pancreas identified by CT scan, should operative intervention or nonoperative management be performed?

Qualitative Synthesis

Overall, 124 patients in 11 studies were identified (Table 2).[2,5,15,24–31] The quality of evidence was very low for all outcomes due to inadequate power, lack of direct comparisons between groups, varying definitions of outcomes, and limited reporting of outcomes. Of these, 62 patients in 3 studies were in the operative group, and 62 patients over 10 articles had no operation. There were no mortalities and no reports of sepsis in either group; there were also no reports of pancreatitis or fistula in the operatively managed group. Two (9.1%) of 22 nonoperativly managed patients developed pancreatitis and three (6.8%) of 44 nonoperatively managed patients developed a fistula. One nonoperatively managed patient with a pseudocyst died from an unrelated complication.[27] Length of stay (LOS) was not consistently reported; one article reported mean LOS to be 33 days in the operative group. Four other articles reported mean LOS to be from 10 to 24 days. Intensive care unit (ICU) LOS was reported in one article in each group and was 16 days. LOS data could not be pooled for statistical analysis.

The largest study to describe nonoperatively managed patients was by Lee et al,[28] which described outcomes of hemodynamically stable blunt trauma patients. All patients underwent contrast-enhanced CT scan with a 72-second delay to obtain portal-venous phase images. Lacerations of more than 50% of pancreatic thickness were classified as "highly likely" to have injury of the main pancreatic duct, which was verified by ERCP, MRCP, or surgery. Of 22 nonoperatively managed patients without duct injury, one developed a fistula.

The largest study to address the operative arm was by Teh et al.[15] This study described the ability of CT scan to diagnose pancreatic injury. Thirty-eight patients had a CT scan performed, of whom 22 had operative management, after imaging, for grade I/II injuries. There were no pancreas-related complications in this group. In this study, CT was 91% sensitive and 91% specific for the identification of pancreatic duct injury. Velmahos et al.[14] also reported CT diagnostic accuracy in a multicenter analysis of 230 blunt trauma patients. CT scan was performed for 200 of the 230 patients, and an injury was missed in 30 (15%), resulting in an overall sensitivity of 85%. This group reported no deaths attributable to low-grade pancreatic injuries, although outcomes were not stratified by treatment and were not included in pooled data.

Recommendation

We conditionally recommend nonoperative management for grade I/II pancreatic injuries diagnosed by CT scan. Nonoperative management appears to have low morbidity. If the pancreatic duct is not definitively intact, it seems reasonable to further evaluate the duct with additional tests, such as ERCP or MRCP, because this may change the grade of the injury and therefore the recommended treatment plan.

RESULTS

Treatment of High-Grade Injury Diagnosed by Ct (PICO 2)

For adult patients with grade III/IV injuries to the pancreas identified on CT scan, should operative intervention or nonoperative management be performed?

Qualitative Synthesis

Overall, 103 patients were identified in 8 articles (Table 3).[2,15,20,21,27,30–32] The quality of evidence was very low for all outcomes due to inadequate power, lack of direct comparisons between groups, varying definitions of outcomes, and limited reporting of outcomes of interest. Eighty-seven patients were operatively managed, and 16 patients were managed nonoperatively. Mortality data were available for 24 patients in the operative group and 16 in the nonoperative group; one patient died in each group. Twenty-nine percent (7 of 24) of operatively managed patients developed a fistula, compared with 60% (9 of 15) of patients who did not undergo an operation ($p = 0.09$). Sepsis was rarely reported, and there were no cases of chronic pancreatitis reported. For articles who reported patients who were operatively managed, mean LOS ranged from 17 to 104 days; this was 14 to 27 days in nonoperatively managed patients. These results could not be pooled to determine statistical significance.

The largest studies addressing this PICO were by Teh et al[15] (11 patients, all operatively managed), Kim et al,[27] and Pata et al.[30] (six patients, all nonoperatively managed). Kim et al.[27] described 11 patients; eight of those patients underwent an operation, whereas three patients underwent nonoperative management with stents placed at ERCP. All three nonoperatively managed patients had an intracapsular leak from the main pancreatic duct; two developed a pseudocyst. Of the eight patients who were managed with an operation, there were three pseudocysts; one patient died on hospital

day 48 after developing an enterocutaneous fistula and respiratory failure. We included this death in our pooled analysis, because it is unclear if the pancreatic injury contributed to the patient's death. In the article by Teh et al,[15] 11 patients with ductal injury underwent distal pancreatic resection; none of these patients died from pancreas-related complications and one patient developed a low-output fistula that resolved after 5 weeks. Pata et al.[30] reported six nonoperatively managed patients with grade III injuries, of whom two developed fistulae. One death was noted in the nonoperative management group, which occurred in a blunt trauma patient who clinically declined after a pancreatic stent was placed at 28 hours, and subsequently had a distal pancreatectomy at 60 hours. This patient died from sepsis on hospital day 5.[20]

Nonoperative management failures are important for clinician consideration, but were not statistically analyzed because this outcome only pertains to the nonoperative group. The largest series describing failure of nonoperative management of pancreatic injuries was described by Velmahos et al.,[14] who reported 97 patients with blunt pancreatic and duodenal injuries (mostly grade I or grade II) who were initially managed nonoperatively. Nonoperative management failed in 10% (six pancreatic injuries, three duodenal injuries, and one with both). Four patients with grade III or IV injuries to the pancreas and duodenum had nonoperative management attempted, and two failed (50%), both requiring operations for clinical decline. Complications after failure of nonoperative management was 30%, compared with patients who did not require surgery (8%), although this was not statistically significant.

Recommendation

We conditionally recommend operative management for grade III/IV pancreatic injuries diagnosed by CT scan. Although there was no statistically significant difference between groups for any single outcome, our group feels that there is a cumulative trend toward increased morbidity after nonoperative management. Treatment failures after nonoperative management occur regularly, and treatment delays likely contribute to morbid complications and death.

RESULTS

Operative Management of Low-Grade Injury (PICO 3)

For adults undergoing an operation who are intraoperatively found to have a grade I/II pancreas injury, should resectional or nonresectional management be performed?

Qualitative Synthesis

Overall, 299 patients were identified in 14 articles (Table 4).[5,24,25,29,31,33–41] The quality of evidence was very low for all outcomes due to inadequate power, lack of direct comparisons between groups, varying definitions of outcomes, and limited reporting of outcomes of interest. Twenty-seven patients were managed in the resection group, and 272 patients were managed in the nonresectional treatment group. Reported pancreas-related mortality in the resection group was 4.0% (1 of 25) versus 0.9% (1 of 115) in the nonresection group ($p = 0.33$). Fistula rates were 14.3% (3 of 21) in the resection group and 10.6% (19 of 180) the nonresection group ($p = 0.7$). Sepsis was not reported in the resection group, but developed in 2 (15.4%) of 13 nonresection patients. Intra-abdominal abscess formation was significantly higher in the resection group (42.9%) than in the nonresection group (8.7%) ($p = 0.0009$). LOS was not reported in the resection group; for patients without resection, mean LOS ranged from 7 to 27 days, and mean ICU LOS was reported in one article as 9 days. Again, LOS data could not be pooled for statistical analysis.

Many patients with a grade I or II pancreatic injury underwent operations to treat injuries to other organs. Pancreatic injury was often an incidental finding and was not surgically treated, or treated with drainage alone. Generally, patients had low complication rates and low mortality. Few articles reported resection for grade II injuries, although it may be difficult to distinguish a grade II or III injury in the operating room if the duct is not clearly visualized.

The largest contributor of data for the resection group was the article by Cogbill et al.[34] This group studied 74 patients who had pancreatic injuries managed by distal pancreatectomy, including 19 patients with grade II injuries. There was a single mortality (5%) within this group, eight (42%) intra-abdominal abscesses, and three (16%) pancreatic fistulae. It was not noted whether this death was attributable to pancreas-related morbidity, and it was included in the pooled analysis. Nonresection treatment strategies included pancreatography, drainage alone, or no drainage. There was one death, after a grade II injury treated by pancreatography, who developed pancreatic necrosis, sepsis, and multiple organ failure.[5]

Recommendation

We conditionally recommend nonresectional management for operative management of grade I/II pancreatic injuries. Our pooled data analysis suggests that mortality from pancreas-related causes are generally low in this population and that there were significantly more intra-abdominal abscesses in the resection group.

RESULTS

Operative Management of High-Grade Injury (PICO 4)

For adults already undergoing an operation who are intraoperatively found to have a grade III/IV pancreas injury, should resection or nonresection be performed?

Qualitative Synthesis

Overall, 314 patients were identified in 19 articles (Table 5).[15,19–21,24,25,29,31–42] The overall quality of evidence was very low for all outcomes due to inadequate power, lack of direct comparisons between groups, varying definitions of outcomes, and limited reporting of outcomes of interest. Of these, 275 patients were managed in the resection group and 39 patients were managed in the nonresection group. Mortality was significantly lower in the resection group than the nonresection group (8.6% vs. 27.2%, $p = 0.005$), as were fistulae (17.7% vs. 88.0%, $p < 0.0001$). Sepsis was infrequently reported, but was 11.1% (2 of 18) in the resection group and 40% (2 of 5) in non-resection group ($p = 0.19$). Intra-abdominal abscess

TABLE 4. Operative Management of Low-Grade Injury (PICO 3)

PICO 3: Resection Compared With Nonresectional Management for Operative Management of Grade I/II Pancreatic Trauma

Quality Assessment							Summary of Findings				
							Study Event Rates (%)			Anticipated Absolute Effects	
No. Participants (Studies) Follow-up	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With no Resection	With Resection	Relative Effect (95% CI)	Risk With no Resection	Risk Difference With Resection
Death											
140 (10 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	1/115 (0.9%)	1/25 (4.0 %)	RR, 4.60 (0.30–71.09)	9 per 1,000	Study population 31 more per 1,000 (48 fewer to 110 more)
Pancreatic fistula or leak											
201 (7 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	19/180 (10.5%)	3/21 (14.3%)	RR 1.35 (0.44–4.19)	106 per 1,000	Study population 37 more per 1,000 (119 fewer to 194 more)
Sepsis											
13 (2 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	2/13 (15.4%)	−/−	Not estimable	154 per 1,000	Study population No estimate
Abscess											
90 (6 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	6/69 (8.7%)	9/21 (42.8%)	RR 4.93 (1.98–12.25)	87 per 1,000	Study population 341 more per 1,000 (120 more to 563 more)

* Small sample sizes, with no direct comparisons between groups, varying definitions of outcomes, few reported presence or absence of outcomes, inadequate power.

TABLE 5. Operative Management of High-Grade Injury (PICO 4)

PICO 4: Resection Compared With Nonresection Management for Operative Management of Grade III/IV Pancreatic Trauma

Quality Assessment							Summary of Findings				
							Study Event Rates (%)			Anticipated Absolute Effects	
No. Participants (Studies) Follow-up	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With no Resection	With Resection	Relative Effect (95% CI)	Risk With no Resection	Risk Difference With Resection
Death											
231 (16 studies)	Serious*	Not serious	Serious*	Not serious	None	⊕○○○ Very low	9/33 (27.2%)	17/198 (8.6 %)	RR, 0.31 (0.15–0.65)	273 per 1,000	Study population 18 fewer per 1,000 (344 fewer to 30 fewer)
Pancreatic fistula or leak											
183 (11 studies)	Serious*	Not serious	Serious*	Not serious	None	⊕○○○ Very low	22/25 (88.0%)	28/158 (17.7%)	RR, 0.20 (0.14–0.29)	880 per 1,000	Study population 703 fewer per 1,000 (843 fewer to 562 fewer)
Sepsis											
23 (3 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	2/5 (40.0%)	2/18 (11.1%)	RR, 0.28 (0.05–1.51)	400 per 1,000	Study population 299 fewer per 1,000 (742 fewer to 164 more)
Abscess											
116 (6 studies)	Serious*	Not serious	Serious*	Serious*	None	⊕○○○ Very low	5/19 (26.3%)	24/97 (24.7%)	RR, 0.94 (0.41–2.15)	263 per 1,000	Study population 16 fewer per 1,000 (232 fewer to 200 more)

*Small sample sizes, with no direct comparisons between groups, varying definitions of outcomes, few reported presence or absence of outcomes, inadequate power.

TABLE 6. Routine Postoperative Fistula Prophylaxis With Octreotide (PICO 6)

PICO 6: Octreotide Compared With No Octreotide for Postoperative Prophylaxis in Patients Who Have Had an Operation for Pancreatic Trauma											
Quality Assessment							Summary of Findings				
							Study event rates (%)			Anticipated Absolute Effects	
No. Participants (Studies) Follow-up	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Quality of Evidence	With no Octreotide	With Octreotide	Relative Effect (95% CI)	Risk With no Octreotide	Risk Difference With Octreotide
Fistula											
104 (2 studies)	Serious*	Serious*	Serious*	Serious*	None	⊕○○○ Very low	28/76 (36.8%)	10/28 (35.7%)	RR, 0.97 (0.54–1.73)	368 per 1,000	Study population 11 fewer per 1,000 (219 fewer to 197 more)

*Small sample sizes, with no direct comparisons between groups, varying definitions of outcomes, few reported presence or absence of outcomes, inadequate power, dissimilar estimates of outcomes in studies.

formation was reported in 24.7% (24 of 97) patients in the resection group and 26.3% (5 of 19) patients in the non-resection group, $p = 1$. Mean hospital LOS range for the resection group was 21 to 22 days and 24 to 42 days in the nonresection group. Mean ICU LOS was reported in one study with six resected patients and was 6 days. LOS was not uniformly reported in a way that could be pooled for statistical analysis.

Mortality was difficult to extract. Of note, many studies were published before the widespread use of damage control principles. Many patients who did not receive a resection had concomitant injuries precluding intervention, which may be a confounder for higher mortality. Additionally, there were a higher number of ambiguous mortalities (unspecified whether they were pancreas-related) in the nonresectional group, whereas deaths in the resection group were specifically reported to be unrelated to the pancreatic injury and were excluded. If all-cause mortality is counted for both groups, mortality for the resection group rises, and the difference between groups is no longer statistically significant (15% vs. 27.2%, $p = 0.07$).

Patients with no resection typically had drainage with or without repair of pancreatic parenchyma. Two articles focusing on outcomes after "conservative" (no resection) management reported that all patients without resections developed fistulae.[29,36] In the resection group, fistula formation ranged from 10% to 50%.[15,20,24,25,31,34,39–41] These articles described that delayed pancreatic injury diagnosis was accompanied by a high complication rate; additionally, multiple articles described patients with missed injuries at the initial evaluation who subsequently died from sepsis.[32,37,38,40] High-grade pancreatic injuries should be promptly evaluated to ensure expeditious treatment.

Recommendation

We conditionally recommend resection for operative management of grade III/IV pancreatic injuries. Complications are frequent in both groups. In our pooled analysis, fistula development was associated with nonresection strategies. Pancreas-related mortality was higher in the nonresection group, but this finding was potentially confounded by incomplete mortality reporting and bias. Due to the very low quality of available data, this is a conditional recommendation.

RESULTS

Treatment of Grade V Injury (PICO 5)

For adults with total destruction of the head of the pancreas (grade V), should pancreaticoduodenectomy or surgical treatment other than pancreaticoduodenectomy be performed?

Qualitative Synthesis

Forty-one patients were identified in 13 articles, (see Tables, Supplemental Digital Content 1, http://links.lww.com/TA/A830).[19,24,25,31,32,36,38,40,41,43–45] The quality of evidence was very low for all outcomes due to very small groups and inadequate power, lack of direct comparisons between groups, varying definitions of outcomes, and limited reporting of outcomes of interest. Of these, 38 patients had a pancreaticoduodenectomy and five patients were managed without pancreaticoduodenectomy. Reported postoperative mortality was 33.3% (12 of 36) after pancreaticoduodenectomy and 40% (2 of 5) in the

non-pancreaticoduodenectomy group ($p = 1$). Fistula rates, sepsis, and intraabdominal abscess formation were not significantly different between groups (all $p > 0.05$), likely due to very small sample sizes. Mean hospital LOS was reported in one study of three pancreaticoduodenectomy patients (24 days); LOS was reported as 28 days for one non-pancreaticoduodenectomy patient, with 7 days in ICU.

As described in Patients and Methods, intraoperative and preoperative deaths are not included in our pooled analysis above. When these deaths are considered, mortality for these injuries rises to 73%. Because some studies did not report preoperative deaths, the true mortality from injuries associated with grade V injuries may exceed 73%. Four different surgeries were attempted on the five patients in the non-pancreaticoduodenectomy group. Two underwent damage control, both of whom died before a definitive procedure could be attempted.[19] One patient survived after debridement and packing and developed a fistula.[24] Two patients survived: one with a pyloric exclusion, gastroenterostomy, and drainage,[43] and the other after a pancreaticojejunostomy with a Roux-en-Y reconstruction.[40] Three studies reported the use of damage control methods. Amongst these studies, mortality was also high, at 27.3% (3 of 11 patients), with all three of the deaths occurring between the initial damage control procedure and definitive management.

Recommendation

No recommendation is given. The literature on this topic is limited and dated. Surgical and resuscitation strategies have evolved significantly to include damage control procedures and early balanced resuscitations, making our ability to interpret the available literature limited. Grade V injury to the pancreas is extremely morbid, and the intraoperative and immediate postoperative rate of death is high.

RESULTS

Routine Postoperative Fistula Prophylaxis With Octreotide (PICO 6)

For adult patients who have undergone an operation for pancreatic trauma, should routine octreotide prophylaxis or no octreotide be used?

Qualitative Synthesis

Somatostatin analogues have been used in elective surgery for reduction of clinically significant pancreatic leak/fistula. The use of octreotide to reduce pancreatic leak have had mixed results. Multiple studies in Europe have found to have reduced rates of pancreatic leak or fistula; however, similar studies in the United States as well as meta-analysis have not concurred.[46–48] Thus, routine use of octreotide has not been advocated for pancreatic leak or prevention of leak in elective surgery. Allen et al.[49] showed that the use of Pasireotide, a somatostatin analogue that has a longer half-life than octreotide reduced the postoperative leak, fistula, abscess rate when compared with placebo (9% vs. 21%, $p = 0.006$). This analogue has not been studied in the trauma patient population, and it is unclear whether these results would translate to the pancreatic leak/fistula rates in blunt pancreatic injury patients.

Two studies addressed the routine use of octreotide after pancreatic injury (Table 6).[50,51] The quality of evidence was very low, with no direct comparisons between groups, imprecise outcomes definitions, few reported outcomes, inadequate power, and dissimilar estimates of outcomes between studies. No difference was found for the development of fistulae between patients who received octreotide in the postoperative setting (35.7%) and those who did not (36.8%, $p = 0.8$). Additional uses for octreotide in the literature included fistula treatment and use as an adjunct to nonoperative management; these were not included in our analysis.

Nwariaku et al.[51] retrospectively studied 90 patients diagnosed intraoperatively with pancreatic injury. Of 80 survivors, 21 patients received octreotide (100 μg every 8 hours) and 55 did not; administration was not protocolized. The group that received octreotide had more severe pancreatic injuries (grades III, IV, V) compared with the group that did not (38% vs. 16%), but this was not statistically significant. Patients underwent a variety of procedures, including drainage, resection, and pancreaticoduodenectomy. The overall fistula rate was 40%, and there was no significant difference in fistula rate between patients who did and did not receive octreotide. In the subgroup of patients with higher-grade injuries (grades III-V), the fistula rate was 53%, with no difference between groups. There was also no statistical difference in duration of fistula drainage (25 ± 5 days in the octreotide group vs. 16 ± 2 days in the no octreotide group).

Amirata et al.[50] described 28 patients with pancreatic injury, of whom seven were treated with octreotide. Dosing was inconsistent, ranging from 150 to 600 μg per day. All seven patients treated with postoperative octreotide developed no complications, whereas six of the 21 patients not treated with octreotide developed pancreatic complications.

Recommendation

We conditionally recommend against the routine use of octreotide for postoperative prophylaxis related to traumatic pancreatic injuries to prevent fistula. Data are limited, but pooled data show no difference in outcomes between groups. The subcommittee concluded that the less invasive (no medication) strategy would be preferable with no difference in outcomes.

RESULTS

Routine Splenectomy With Distal Pancreatectomy (PICO 7)

For adults undergoing a distal pancreatectomy for trauma, should routine splenectomy or splenic preservation be performed?

Qualitative Synthesis

Two hundred thirty-four patients were identified in 13 articles, (see Tables, Supplemental Digital Content 1, http://links.lww.com/TA/A830).[28,32,35,37,38,40,42,52–56] The quality of evidence was very low due to lack of direct comparisons between groups, varying definitions of outcomes, few reported outcomes, and inadequate power. Splenectomy was performed in 154 patients, and 80 patients had a splenic preserving distal pancreatectomy. Splenic preservation was only used for

hemodynamically stable patients. Mortality was similar, 9.2% in the splenectomy group and 7.7% after splenic preservation ($p = 0.49$). Postoperative sepsis was also similar (21.1% vs. 21.6%, $p = 1$). Overwhelming postsplenectomy infection (OPSI) and blood loss were not reported. Total operative time was reported in two articles; mean operative time for distal pancreatectomy with splenectomy was 164 minutes in one article versus 285 minutes for a spleen-preserving distal pancreatectomy in a different article; these raw numbers do not account for additional procedures. Pachter et al[53] found that the operative time for the pancreatectomy part of the operation for patients who had splenic preservation was 51 minutes.

Splenic preservation can be technically challenging and is more time-consuming than a distal pancreatectomy but leads to the future benefit of a decreased risk of OPSI. Estimates suggest that the lifetime risk of OPSI is approximately 5% for patients who receive splenectomy for hematologic disorders, and lower for trauma patients.[57] One study suggests that the incidence of severe late OPSI after trauma splenectomy was 0.21 per 1000 person-years of exposure, with the majority occurring greater than 5 years after splenectomy.[58] No reports of OPSI were found in our review.

In these articles, mortality causes were ambiguous, but there was no difference in mortality between groups. Of note, one study of six cases of splenic salvage[55] reported two severe complications related to bleeding, one patient died from hemorrhagic shock, which developed within 12 hours postoperatively. One additional patient had a return to the OR for bleeding from the splenic vein and required a delayed splenectomy.

Recommendations

No recommendation is given. Existing data do not support either treatment modality, although splenic preservation was only considered for stable patients. If either the stability of the patient or the surgeon's ability to safely preserve the spleen is in doubt, a distal pancreatectomy with splenectomy is a reasonable choice.

USING THESE GUIDELINES IN CLINICAL PRACTICE

These guidelines represent a detailed summary of the literature regarding treatment for pancreatic trauma. Most studies are from large trauma centers and may not be applicable to all centers or all situations and are intended to inform the decision-making process rather than to replace clinical judgment. Pancreatic injuries without involvement of the pancreatic duct appear to have low morbidity, and therefore management without resection appears to be safe. Higher-grade injuries involving the pancreatic duct have increased attributable morbidity and mortality as well as potential for deterioration if treatment is delayed, and literature supports resection in these cases.

CONCLUSION

In summary, we propose the following recommendations:

(1) For adult patients with grade I or II injury to the pancreas identified on CT scan, we conditionally recommend nonoperative management.
(2) For adult patients with grade III or IV injury to the pancreas identified on CT scan, we conditionally recommend operative intervention.
(3) For adult patients with grade I or II injuries to the pancreas who are undergoing an operation, we conditionally recommend non-resectional management.
(4) For adult patients with grade III or IV injuries to the pancreas who are undergoing an operation, we conditionally recommend resectional management.
(5) For adult patients with grade V injuries to the pancreas who are undergoing an operation, we give no recommendation regarding whether a pancreaticoduodenectomy or a surgical procedure other than pancreaticoduodenectomy should be performed.
(6) For adult patients who have undergone an operation for pancreatic trauma, we conditionally recommend against the routine use of octreotide prophylaxis.
(7) For adult patients undergoing a distal pancreatectomy for pancreatic trauma, we give no recommendation regarding whether routine splenectomy or splenic preservation should be performed.

DISCLOSURE

Dr. Bokhari was a Bristol Myers Squibb panel participant in last 36 months and is on the Speaker panel for Abbott Point of Care.
Dr. Haut is the primary investigator of a contract (CE-12-11-4489) with the Patient-Centered Outcomes Research Institute (PCORI), entitled "Preventing Venous Thromboembolism: Empowering Patients and Enabling Patient-Centered Care via Health Information Technology." Dr. Haut receives royalties from Lippincott, Williams, Wilkins for a book, *Avoiding Common ICU Errors*. Dr. Haut is a paid consultant and speaker for the "Preventing Avoidable Venous Thromboembolism—Every Patient, Every Time" VHA IMPERATIV® Advantage Performance Improvement Collaborative and the Illinois Surgical Quality Improvement Collaborative.
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