Published in final edited form as:
J Pediatr Surg. 2016 September ; 51(9): 1526–1531. doi:10.1016/j.jpedsurg.2016.05.003.

Management of blunt pancreatic trauma in children: Review of the National Trauma Data Bank☆,☆☆

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Abstract

Purpose—This study aims to examine the current management strategies and outcomes after blunt pancreatic trauma in children using a national patient registry.

Methods—Using the National Trauma Data Bank (NTDB) from 2007–2011, we identified all patients ≤18 years old who suffered blunt pancreatic trauma. Patients were categorized as undergoing nonoperative pancreatic management (no abdominal operation, abdominal operation without pancreatic-specific procedure, or pancreatic drainage alone) or operative pancreatic management (pancreatic resection/repair). Patient characteristics, operative details, clinical outcomes, and factors associated with operative management were examined.

Results—Of 610,402 pediatric cases in the NTDB, 1653 children (0.3%) had blunt pancreatic injury and 674 had information on specific location of pancreatic injury. Of these 674 cases, 514 (76.3%) underwent nonoperative pancreatic management. The groups were similar in age, gender, and race; however, pancreatic injury grade > 3, moderate to severe injury severity, and bicycle accidents were associated with operative management in multivariable analysis. Children with pancreatic head injuries or GCS motor score < 6 were less likely to undergo pancreatic operation. Overall morbidity and mortality rates were 26.5% and 5.3%, respectively. Most outcomes were similar between treatment groups, including mortality (2.5% vs. 6.7% in operative vs. nonoperative cohorts respectively; p = 0.07).

Conclusion—Although rare, blunt pancreatic trauma in children continues to be a morbid injury. In the largest analysis of blunt pancreatic trauma in children, we provide data on which to base future prospective studies. Operative management of pancreatic trauma occurs most often in children with distal ductal injuries, suggesting that prospective studies may want to focus on this group.

☆IRB Approval: Duke Medicine IRB for Clinical Investigations; IRB ID: Pro00052035; Approval Date: 1/27/2014.

☆☆Presented at the American Academy of Pediatrics National Conference, San Diego, CA, October 11–14, 2014.

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Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003.

Keywords

Blunt trauma; Pancreas; Surgery; Management; Outcomes

Pancreatic injuries are rare, with an incidence of 0.4% of traumas presenting in both adult and pediatric populations [1–3]. The rate of pancreatic involvement may be closer to 10% in cases of significant blunt trauma, and the morbidity associated with these injuries can exceed 60% [4]. The management of blunt pancreatic injury in children has been a source of continued controversy, particularly in cases of ductal disruption, with ongoing debate over the advantages of early definitive resection versus nonoperative management, including potential drainage and delayed repair or resection [5–7]. A recent systematic review concluded that no randomized trials exist to address the question of operative vs. nonoperative management in children with grade III–V blunt pancreatic injuries [8]. Even prior observational studies have been limited by small sample size or lack of generalizability owing to single institutional case series [4,6,9,10].

Given the lack of robust data defining optimal management strategies and expected outcomes in pediatric blunt pancreatic trauma, we used a large, national trauma registry to (1) evaluate the current incidence of blunt pancreatic trauma in the United States, (2) describe the patient characteristics and injury patterns, (3) examine short-term outcomes, and (4) analyze current management strategies.

1. Methods

1.1. National Trauma Data Bank

Supported by the American College of Surgeons and collecting trauma-specific data from more than 900 trauma centers and other hospitals, the National Trauma Data Bank (NTDB) is a rich tool for trauma-related health care providers and researchers. Details of data collection, quality assurance, and the NTDB patient population have been previously published [11,12].

1.2. Study population

Trauma patients ≤18 years of age and captured in the NTDB from 2007–2011 were included for analysis. Abdominal trauma was defined as an abbreviated injury scale (AIS) abdominal score of ≥2. Patients were further classified as having pancreatic trauma based on International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code indicating pancreatic injury (Appendix 1 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). Cases without specific data on pancreas injury location were excluded from the primary analysis.

Details of case demographics, injuries, and clinical outcomes are captured in specific data fields by the NTDB. Data on associated injuries and severity, location and grade of pancreatic trauma, and operative procedures were extracted from AIS, ICD-9 diagnosis, and ICD-9 procedure codes (Appendices 1 and 2 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). Patients were categorized as undergoing nonoperative

pancreatic management (non-OPM: no abdominal operation, abdominal operation without pancreatic-specific operation, or pancreatic drainage alone) or operative pancreatic management (OPM: primary pancreatic resection or repair). Patients were classified into the most aggressive pancreatic procedure (i.e. if a patient had a pancreatic resection and drainage, they were classified as having pancreatic resection). A subgroup analysis was performed to examine only patients with pancreatic duct injuries (grade ≥ 3).

1.3. Outcomes

Our primary outcome was management strategy, as defined above. Pancreatic drainage was defined as operative or percutaneous drainage. Internal drainage via endoscopic retrograde cholangiopancreatography (ERCP) could not be differentiated from ERCP without drainage. Secondary outcomes were mortality and major complications, including the following: acute respiratory distress syndrome (ARDS), wound infection, pneumonia, and sepsis (defined by ICD-9 diagnosis codes). LOS (length of stay) and discharge disposition were also evaluated.

1.4. Statistical analysis

Patient demographic and injury details, operative management, and clinical outcomes were described in the overall population and compared by management strategy (OPM vs. non-OPM). Categorical variables were described with frequency and percentages, and continuous variables were described using median and interquartile ranges. Categorical variables were compared using Pearson's chi-squared or Fisher's exact test, and ANOVA was used for continuous variables.

Using generalized linear models, a multivariable logistic regression was developed to identify factors independently associated with operative management, after accounting for other demographic and injury characteristics. A backward stepwise variable selection method was used, which originally included the following variables: age, gender, race, year of admission, pancreatic injury severity and location, injury severity score (ISS), shock on admission (defined as age-based hypotension), [13] heart rate > 120 on admission, oxygen saturation < 90% on admission, mechanism of injury, Glasgow Coma Scale (GCS) motor < 6, and other significant abdominal injury (AIS ≥ 3). An interaction term between pancreatic injury location and grade was examined. Missing data were handled using complete case analysis, with cases that contained any missing data points being excluded. Hosmer–Lemeshow goodness-of-fit test, calibration plots, and the C-statistic from the area under the curve (AUC) were used to assess model performance and assumptions and found to be appropriate (Appendix 3 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). p Values of <0.05 were considered significant. R version 3.02 (R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analyses.

2. Results

Of 610,402 pediatric cases in the NTDB during the study period, 1653 children (0.3%) suffered blunt pancreatic injury (Fig. 1). Blunt pancreatic injury occurred in 0.6% of patients with abdominal injuries (all abdominal injuries: n = 257,261), and 78.5% of all pancreas injuries (all pancreatic injuries: n = 2153). After exclusion of cases without specific pancreas

injury location, 674 cases (40.8%) remained for complete case analysis. Patients missing data on pancreatic injury location demonstrated similar characteristics to the cohort who had specific injury location data. Notably, operative intervention was greater in those patients with specific pancreas injury location data compared to children without specific pancreatic location, including pancreatic resections (19.6% vs. 8.3%, $p < 0.001$) and splenectomy (14.2 vs. 8.2%; $p < 0.001$).

Of the 674 cases with complete data on pancreas injury location, 514 (76.3%) underwent non-OPM. The non-OPM and OPM groups were similar in age, gender, and race (Table 1). Injury characteristics differed between groups (Table 2), with patients undergoing non-OPM more likely to have a GCS < 13 ($p = 0.02$) and a pancreatic head injury ($p < 0.001$). OPM patients had higher overall injury severity ($p < 0.01$), higher rates of pancreatic body injuries ($p = 0.02$), and higher rates of grade 3 or higher pancreatic injuries ($p < 0.001$), with a granular examination of OPM rates by pancreatic injury location and grade provided in Fig. 2. No significant differences were seen in mechanism of injury or associated abdominal organ injuries.

The most common procedure for associated injuries in this patient population was splenectomy (14.2%); which differed significantly when comparing non-OPM and OPM patients (7.4% vs. 36.2%; $p < 0.001$). OPM patients were more likely to undergo a number of different procedures (Table 3). Overall in-hospital mortality was 5.3% in all children with pancreatic injury, with no statistically significant difference between OPM and non-OPM patients in unadjusted analysis (2.5% vs. 6.2%, $p = 0.07$; Table 4). Major complications occurred in more than 25% of cases, including acute respiratory distress syndrome (ARDS, 8.1%), pneumonia (7.5%), and wound infection (3.7%), with only the latter being significantly different between groups (OPM: 9.5% vs. non-OPM: 1.6%; $p < 0.01$). Median length of stay (LOS) was 8 days, which was longer in OPM vs. non-OPM in unadjusted comparison (11 vs. 7 days; $p < 0.001$).

In multivariable logistic regression to identify potential drivers of the decision to operate on a pancreatic injury, several factors demonstrated a significant association with the use of operative management after variable selection and adjustment for potential confounders (Fig. 2), including age > 15 years (AOR: 1.6, 95% CI: 1.1–2.5), pancreas injury grade 4 (AOR: 4.2, 95% CI: 1.9–9.3), pancreas injury grade 5 (AOR: 9.2; 95% CI: 3.9–22.1), moderate to severe ISS (AOR: 2.3, 1.4–3.8), and bicycle (AOR: 2.0, 1.1–3.4) or struck injuries (AOR: 1.9, 1.1–3.4). Pancreatic head injuries and decreased mental status on presentation (GCS motor score < 6) were associated with non-OPM. Notably, other significant abdominal injuries and vital signs on presentation did not demonstrate an association with operative management. A subsequent analysis to examine the interaction between pancreatic duct injury (grade ≥ 3) and pancreatic injury location found no significant interactions, indicating that the role of ductal injury on operative planning was independent of its location. It should be noted that the interpretation of grade 5 pancreatic injuries is complicated by these injuries being obligate pancreatic head injuries. Because odds ratios are multiplicative, a grade 5 injury will always include both the OR of 9.2 (grade 5 injury) and 0.4 (pancreatic head injury), which provide a combined adjusted OR of 3.7 before consideration of other factors (Fig. 3).

In further analysis of patients with pancreatic duct injury (grade ≥ 3), we found that nearly half of these patients underwent OPM. Pancreatic head injuries were more prevalent at 60%, as was the presence of pancreatic injury to multiple anatomic segments. Measures of injury were generally higher in the pancreatic duct injury subset. In particular, compared to non-OPM patients without ductal injury, non-OPM patients with ductal injuries showed dramatically increased markers of injury, including the following: 71% with ISS ≥ 15 (vs. 45% in patients without ductal injury), 22% with significant liver injury (vs. 11%), and 43% with tachycardia or hypotension (vs. 31%). When focused on patients with ductal injuries, the OPM and non-OPM groups did not have statistically significant differences in injury characteristics or outcomes.

3. Discussion

The optimal management of pancreatic trauma continues to be the source of controversy among pediatric surgeons. We have described the injury patterns, management strategies, and clinical outcomes for children with blunt pancreatic injury in the largest population of pediatric pancreatic trauma that the authors are aware of. Pancreatic injury represents 0.3% of all pediatric traumas presenting to NTDB centers and 0.6% of significant abdominal trauma. Pancreatic trauma remains a morbid condition, with a mortality rate of 5% and major complications affecting approximately 1 in 4 children. Nearly 25% of patients undergo a pancreas-specific operation as part of their management. Higher-grade pancreatic injuries and increased overall injury severity were associated with operative pancreatic management, whereas pancreatic head injuries were associated with nonoperative management. These data should be used to plan randomized studies that will provide unbiased results on the optimal management of pancreatic trauma, potentially focusing on distal ductal injuries, where the use of surgery occurs most often.

Pancreatic injury has been reported to have an incidence of 0.4 per 100,000 in the adult population [14] and 0.3–0.4% of presenting pediatric traumas [2,3]. Potentially biased by a referral base of more complex cases being transferred from smaller hospitals to pediatric trauma centers, studies have also indicated that pancreatic injuries occur in nearly 10% of all abdominal trauma [6]. The current study examined more than a half-million trauma presentations in the US. These data confirm previous estimates of pancreatic injury incidence and add a more comprehensive examination of this population, including injury mechanism, pancreatic injury location, concomitant injuries, and procedures. The majority of pancreatic injuries arise from MVC; however, bike injuries and struck injuries make up important minorities at 24% and 17%, respectively. Previous studies reporting results from academic centers have reported lesser rates of MVC with higher incidence of bicycle injuries [4,6], potentially owing to more urban study populations. Injuries were evenly divided between pancreatic head, body, and tail trauma. Although this dataset does not provide the ability to review CT or operative reports to understand the exact location of injury, these findings do call into question the classic teaching that pancreatic injuries occur most commonly at the neck where the pancreas is lying across the spinal column.

Wide variations in morbidity and mortality have been reported in cases of pediatric pancreatic injury, with mortality being 3–17% [1,15,16]. While historical data demonstrate

improved outcomes compared to adult pancreatic trauma, with morbidity and mortality rates of 50% and >10%, respectively [17], these injuries remain serious. Given the large sample size, contemporary cohort, and national generalizability, the current report provides reliable estimates of morbidity and mortality at 26.5% and 5.3%, respectively, which can be used as a reference for clinician and family member expectations.

Recent studies on the management of pancreatic trauma continue to fuel the debate about nonoperative vs. surgical management in this patient population. Studies in adults have demonstrated a trend towards nonoperative strategies for these injuries [17], and numerous groups have emphasized nonoperative management even in cases of complete pancreas transection [18–20]. More recently, several authors have advocated earlier surgical intervention for cases of ductal injury [4,6,21], and the introduction of laparoscopic management in pancreas trauma may impact the risk–benefit ratio for these children [22,23]. Current studies suffer from small sample size, limited number of participating centers, and their observational nature, such that a recent Cochrane report has drawn attention to the need for randomized data to be applied to the question of optimal management strategy, with current data being of inadequate quality for a metaanalysis to be performed [8].

To better understand current management strategies for pediatric pancreatic injuries after blunt trauma, we performed a multivariable analysis to identify potential drivers of surgical decision making. These data demonstrate the lack of consensus with nearly 25% of pancreas injuries undergoing pancreatic surgery. Pancreatic injury grade > 3 showed a significant association with operative management as did more severe overall injuries; however, only half of children with a grade 3 or higher injury were taken to the OR for a pancreatic procedure. Decreased mental status and pancreatic head injuries were associated with nonoperative management. While it would appear that grade 5 injuries were strongly associated with operative management (OR: 9.2), these injuries being obligate pancreatic head injuries (OR: 0.4) complicates the interpretation of the odds ratios. These ORs will always be multiplied to provide an adjusted OR of 3.7 for grade 5 injuries before consideration of other factors. These data would promote initial studies to be implemented in more distal pancreatic injuries involving the pancreatic duct, where surgery is currently being used most often. However, with more than 50% of grade 5 injuries of the pancreatic head undergoing pancreatic surgery, this population also clearly needs further examination.

No correlation was found for the use of non-OPM in cases with other abdominal injuries or hemodynamic instability, which one might have expected if there was increased use of a damage control strategy in patients with other major sources of morbidity. These findings may relate to a lack of granularity about the patient's clinical course, and future studies will need to address both intraoperative and perioperative factors that may lead surgeons to favor a more aggressive surgical plan vs. a damage control strategy, particularly when facing a ductal injury.

While this study has leveraged the largest sample of available trauma data in the US, it suffers from several limitations. Its observational nature allows the possibility of bias from unmeasured confounders including clinical deterioration and specific radiologic or intraoperative findings. This study lacks longitudinal follow-up and a number of pancreatic

specific outcomes such as pseudocyst formation or the ability to tolerate nutrition by mouth, which will be critical to further studies on this topic. Finally, the NTDB used for this analysis is a convenience sample rather than a population-based dataset; therefore, the incidence reported is specific to the NTDB centers, although given the wide participation in this program, this concern may be minimal.

In conclusion, the current study finds that pancreatic injuries occur in 0.3% of all traumas and 0.6% of all abdominal traumas within the NTDB, a national trauma registry. Mortality and major morbidity were 5% and 26.5%, respectively, indicating the continued difficulty managing these patients. Higher grades of pancreatic injury and overall injury severity were strongly associated with the use of operative pancreatic management, while pancreatic head injuries were associated with nonoperative pancreas management. With inadequate current evidence for operative decision making in cases of pancreatic injury, these data provide the largest sample of pediatric pancreatic trauma on which to base randomized studies that are urgently needed to address the current management controversy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

1. Akhrass R, Yaffe MB, Brandt CP, et al. Pancreatic trauma: a ten-year multi-institutional experience. Am Surg. 1997; 63:598–604. [PubMed: 9202533]
2. Jobst MA, Canty TG Sr, Lynch FP. Management of pancreatic injury in pediatric blunt abdominal trauma. J Pediatr Surg. 1999; 34:818–23. [PubMed: 10359187]
3. Keller MS, Stafford PW, Vane DW. Conservative management of pancreatic trauma in children. J Trauma. 1997; 42:1097–100. [PubMed: 9210548]
4. Iqbal CW, St Peter SD, Tsao K, et al. Operative vs nonoperative management for blunt pancreatic transection in children: multi-institutional outcomes. J Am Coll Surg. 2014; 218:157–62. [PubMed: 24440062]
5. Canty TG Sr, Weinman D. Management of major pancreatic duct injuries in children. J Trauma. 2001; 50:1001–7. [PubMed: 11428378]
6. Mattix KD, Tataria M, Holmes J, et al. Pediatric pancreatic trauma: predictors of nonoperative management failure and associated outcomes. J Pediatr Surg. 2007; 42:340–4. [PubMed: 17270545]
7. Wood JH, Partrick DA, Bruny JL, et al. Operative vs nonoperative management of blunt pancreatic trauma in children. J Pediatr Surg. 2010; 45:401–6. [PubMed: 20152361]
8. Haugaard MV, Wettergren A, Hillingso JG, et al. Non-operative versus operative treatment for blunt pancreatic trauma in children. Cochrane Database Syst Rev. 2014; 2:Cd009746.
9. Arkovitz MS, Johnson N, Garcia VF. Pancreatic trauma in children: mechanisms of injury. J Trauma. 1997; 42:49–53. [PubMed: 9003257]
10. Kouchi K, Tanabe M, Yoshida H, et al. Nonoperative management of blunt pancreatic injury in childhood. J Pediatr Surg. 1999; 34:1736–9. [PubMed: 10591583]
11. American College of Surgeons Committee on Trauma. National Trauma Data Bank 2013: annual report 2014. 2014. Available from: www.facs.org/trauma/ntdb/pdf/ntdb-annual-report-2013.pdf
12. American College of Surgeons Committee on Trauma. National Trauma Data Bank: user manual 2011. 2012. Available from: www.facs.org/trauma/ntdb/pdf/ntdbmanual2011.pdf
13. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2010; 122:S876–908. [PubMed: 20956230]

14. Nilsson E, Norrby S, Skullman S, et al. Pancreatic trauma in a defined population. Acta Chir Scand. 1986; 152:647–51. [PubMed: 2436405]
15. Haugaard MV, Penninga L, Ifaoui IB, et al. Pancreatic trauma in children–operative versus non-operative treatment. Ugeskr Laeger. 2012; 174:115–9. [PubMed: 22248845]
16. Bosboom D, Braam AW, Blickman JG, et al. The role of imaging studies in pancreatic injury due to blunt abdominal trauma in children. Eur J Radiol. 2006; 59:3–7. [PubMed: 16781837]
17. Ragulin-Coyne E, Witkowski ER, Chau Z, et al. National trends in pancreaticoduodenal trauma: interventions and outcomes. HPB. 2014; 16:275–81. [PubMed: 23869407]
18. Shilyansky J, Sena LM, Kreller M, et al. Nonoperative management of pancreatic injuries in children. J Pediatr Surg. 1998; 33:343–9. [PubMed: 9498414]
19. Tataria M, Nance ML, Holmes JH, et al. Pediatric blunt abdominal injury: age is irrelevant and delayed operation is not detrimental. J Trauma. 2007; 63:608–14. [PubMed: 18073608]
20. Wales PW, Shuckett B, Kim PC. Long-term outcome after nonoperative management of complete traumatic pancreatic transection in children. J Pediatr Surg. 2001; 36:823–7. [PubMed: 11329598]
21. Maeda K, Ono S, Baba K, et al. Management of blunt pancreatic trauma in children. Pediatr Surg Int. 2013; 29:1019–22. [PubMed: 23982392]
22. Leva E, Huscher C, Rode H, et al. Management of traumatic complete pancreatic fracture in a child: case report and review of literature. J Laparoendosc Adv Surg Tech A. 2008; 18:321–3. [PubMed: 18373468]
23. Reynolds EM, Curnow AJ. Laparoscopic distal pancreatectomy for traumatic pancreatic transection. J Pediatr Surg. 2003; 38:E7–9.

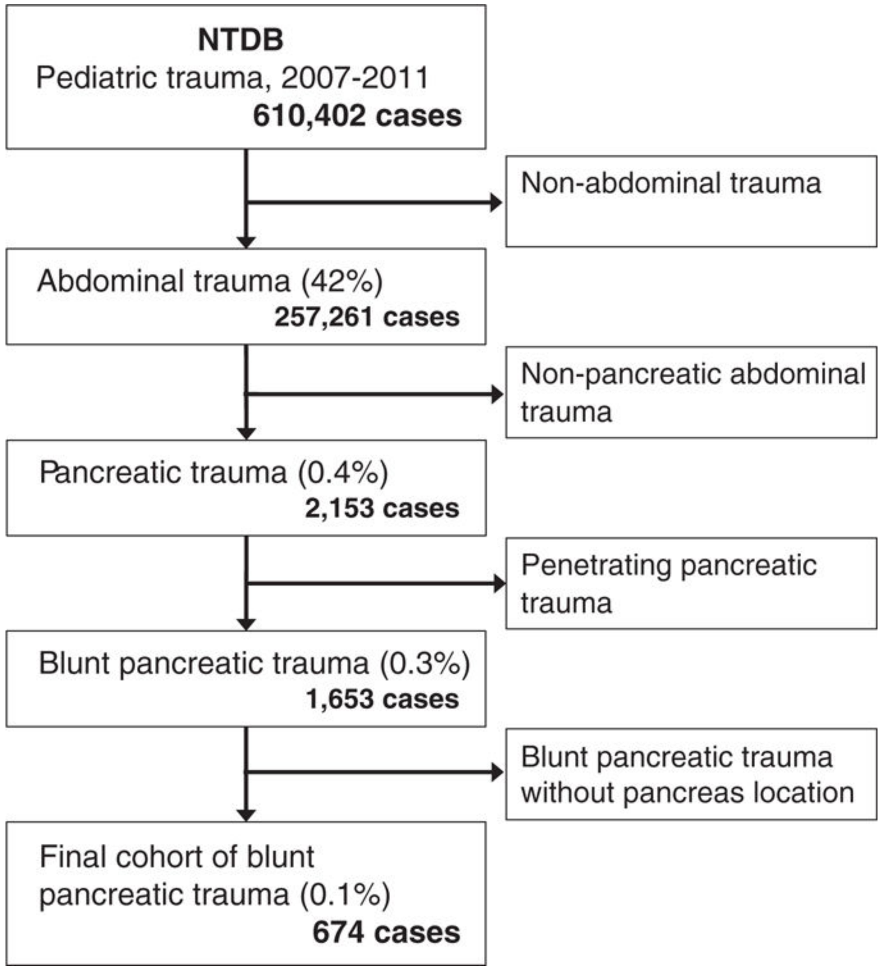

Fig. 1.
Final study population. Percentages represent percent of total pediatric trauma.

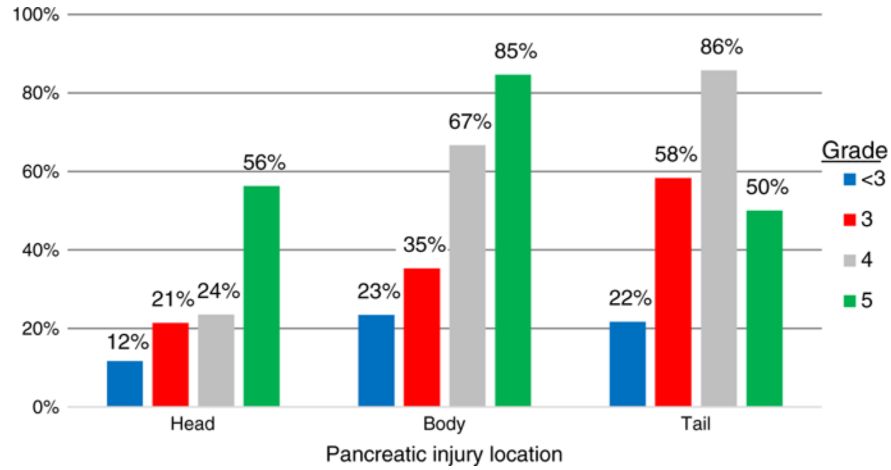

Fig. 2.
Rates of operative pancreatic management (OPM) by location and grade of pancreatic injury
Percentages represent rates of OPM for each subgroup. Patients with grade 5 injuries and tail or body injury locations indicate additional location of pancreatic injuries other than the pancreatic head, as grade 5 injuries are obligate pancreatic head injuries.

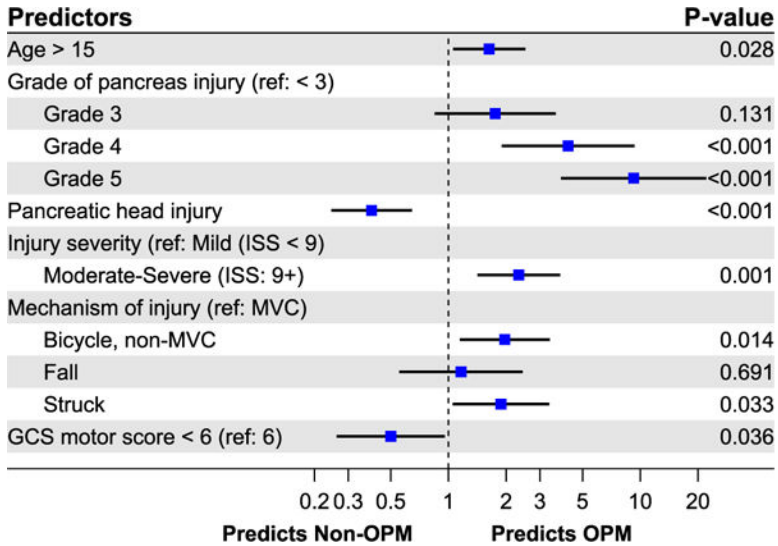

Fig. 3.

Adjusted odds ratios for factors associated with operative vs. nonoperative pancreatic management. Blue dots represent point estimate and black lines represent 95% confidence interval. Abbreviations: ref. – reference, ISS – injury severity score, MVC – motor vehicle collision, GCS – Glasgow Coma Scale, OPM – operative pancreas management; Non-OPM – nonoperative pancreatic management.

Table 1

Patient characteristics by management strategy.

	Overall	Non-OPM	OPM	p Value
N	674	514 (76.3%)	160 (23.7%)	
Age (years)				0.12
<2	4 (0.6%)	2 (0.4%)	2 (1.2%)	
2–5	75 (11.1%)	61 (11.9%)	14 (8.8%)	
6–11	231 (34.3%)	181 (35.2%)	50 (31.2%)	
12–15	143 (21.2%)	113 (22.0%)	30 (18.8%)	
16–18	221 (32.8%)	157 (30.5%)	64 (40.0%)	
Female	200 (29.7%)	145 (28.2%)	55 (34.4%)	0.16
Race/Ethnicity				0.17
White	477 (70.8%)	366 (71.2%)	111 (69.4%)	
Black	76 (11.3%)	63 (12.3%)	13 (8.1%)	
Hispanic	71 (10.5%)	48 (9.3%)	23 (14.4%)	
Other Race	50 (7.4%)	37 (7.2%)	13 (8.1%)	
Insurance				0.42
Private	374 (67.6%)	292 (68.7%)	82 (64.1%)	
Medicare/Medicaid	152 (27.5%)	111 (26.1%)	41 (32.0%)	
No insurance	27 (4.9%)	22 (5.2%)	5 (3.9%)	
Region				0.13
Midwest	155 (23.8%)	128 (25.8%)	27 (17.5%)	
Northeast	99 (15.2%)	77 (15.5%)	22 (14.3%)	
South	206 (31.7%)	154 (31.0%)	52 (33.8%)	
West	190 (29.2%)	137 (27.6%)	53 (34.4%)	

OPM – operative pancreas management; Non-OPM – nonoperative pancreatic management.

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Table 2

Injury characteristics by management strategy.

	Overall	Non-OPM	OPM	p Value
N	674	514 (76.3%)	160 (23.7%)	
Pancreas				
Head	242 (35.9%)	196 (38.1%)	46 (28.7%)	0.04
Body	231 (34.3%)	163 (31.7%)	68 (42.5%)	0.02
Tail	243 (36.1%)	178 (34.6%)	65 (40.6%)	0.20
Pancreas injury grade				<0.001
<3	569 (84.4%)	459 (89.3%)	110 (68.8%)	
3	41 (6.1%)	25 (4.9%)	16 (10%)	
4	32 (4.7%)	16 (3.1%)	16 (10%)	
5	32 (4.7%)	14 (2.7%)	18 (11.2%)	
Associated injuries (AIS ≥3)				
Spleen	143 (21.2%)	102 (19.8%)	41 (25.6%)	0.15
Liver	77 (11.4%)	57 (11.1%)	20 (12.5%)	0.73
Stomach	2 (0.3%)	2 (0.4%)	0 (0%)	0.99
Small bowel	20 (3.0%)	15 (2.9%)	5 (3.1%)	0.99
Colon	5 (0.7%)	3 (0.6%)	2 (1.2%)	0.34
Kidney	38 (5.6%)	25 (4.9%)	13 (8.1%)	0.17
ISS				<0.01
Mild (ISS ≤ 8)	221 (32.8%)	190 (37.0%)	31 (19.4%)	
Moderate (ISS 9–14)	133 (19.7%)	93 (18.1%)	40 (25.0%)	
Severe (ISS 15–24)	134 (19.9%)	95 (18.5%)	39 (24.4%)	
Extremely Severe (ISS ≥ 25)	186 (27.6%)	136 (26.5%)	50 (31.2%)	
Pulse in ED > 120 bpm	183 (27.2%)	141 (27.4%)	42 (26.2%)	0.85
Shock	39 (5.8%)	32 (6.2%)	7 (4.4%)	0.50
GCS motor < 6	96 (14.2%)	82 (16.0%)	14 (8.8%)	0.03
GCS total < 13	99 (14.7%)	85 (16.5%)	14 (8.8%)	0.02
Major head injury	98 (14.5%)	81 (15.8%)	17 (10.6%)	0.14
Mechanism of injury				0.21
MVC	376 (55.8%)	295 (57.4%)	81 (50.6%)	
Bicycle, non-MVC	133 (19.7%)	94 (18.3%)	39 (24.4%)	
Fall	59 (8.8%)	47 (9.1%)	12 (7.5%)	
Struck	95 (14.1%)	68 (13.2%)	27 (16.9%)	
Other	11 (1.6%)	10 (1.9%)	1 (0.6%)	

OPM – operative pancreas management; Non-OPM – nonoperative pancreatic management; AIS – Abbreviated Injury Scale; ISS – Injury Severity Score; ED – Emergency Department; bmp – beats per minute; GCS – Glasgow Coma Scale; MVC – Motor Vehicle Collision.

Table 3

Operative or interventional procedures by management strategy.

Procedure	Overall	Non-OPM	OPM	p Value
N	674	514 (76.3%)	160 (23.7%)	
Splenectomy	96 (14.2%)	38 (7.4%)	58 (36.2%)	<0.001
Diaphragm repair	6 (0.9%)	4 (0.8%)	2 (1.2%)	0.63
Gastric repair	8 (1.2%)	5 (1.0%)	3 (1.9%)	0.40
Duodenal repair	16 (2.4%)	10 (1.9%)	6 (3.8%)	0.31
Small bowel resection	8 (1.2%)	6 (1.2%)	2 (1.2%)	0.99
Small bowel repair	26 (3.9%)	12 (2.3%)	14 (8.8%)	<0.01
Colon resection	9 (1.3%)	4 (0.8%)	5 (3.1%)	0.04
Colon repair	18 (2.7%)	15 (2.9%)	3 (1.9%)	0.59
Nephrectomy	5 (0.7%)	4 (0.8%)	1 (0.6%)	0.99
Liver resection	6 (0.9%)	4 (0.8%)	2 (1.2%)	0.63
Liver repair	15 (2.2%)	10 (1.9%)	5 (3.1%)	0.37
Pancreatic drainage	26 (3.9%)	21 (4.1%)	5 (3.1%)	0.81
ERCP	19 (2.8%)	14 (2.7%)	5 (3.1%)	0.79
TPN	43 (6.4%)	27 (5.3%)	16 (10.0%)	0.05

OPM – operative pancreas management; Non-OPM – nonoperative pancreatic management; ERCP – endoscopic retrograde cholangiopancreatography; TPN – total parenteral nutrition.

Table 4

Clinical outcomes by management strategy.

	Overall	Non-OPM	OPM	p Value
N	674	514 (76.3%)	160 (23.7%)	
Complications				
Any major complication	92 (26.5%)	62 (23.6%)	30 (35.7%)	0.04
ARF	6 (1.7%)	5 (1.9%)	1 (1.2%)	0.99
ARDS	28 (8.1%)	21 (8.0%)	7 (8.3%)	0.99
Wound infection	13 (3.7%)	5 (1.9%)	8 (9.5%)	<0.01
Pneumonia	26 (7.5%)	17 (6.5%)	9 (10.7%)	0.29
Sepsis	11 (3.2%)	8 (3.0%)	3 (3.6%)	0.73
LOS days, median (IQR)	8 (5, 15)	7 (4, 13)	11 (8, 17)	<0.001
ICU days, median (IQR)	3.5 (2, 6)	3 (2, 6)	4 (2, 7)	0.22
Ventilator days, median (IQR)	4 (2, 7)	3 (2, 7)	4 (2, 7)	0.95
Discharge location				0.14
Home	498 (77.9%)	373 (77.2%)	125 (80.1%)	
Home Health	32 (5.0%)	20 (4.1%)	12 (7.7%)	
Rehabilitation	24 (3.8%)	18 (3.7%)	6 (3.8%)	
SNF	18 (2.8%)	16 (3.3%)	2 (1.3%)	
Transfer	31 (4.9%)	24 (5.0%)	7 (4.5%)	
Mortality	36 (5.3%)	32 (6.2%)	4 (2.5%)	0.07

OPM – operative pancreas management; ARF – acute renal failure; ARDS – acute respiratory distress syndrome; LOS – length of stay; ICU – intensive care unit; SNF – skilled nursing facility; IQR – interquartile range.