

Pediatric Pancreatic Trauma: A Retrospective cohort study using the National trauma Database 2017–2020 Operative Versus Non-Operative Management

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Abstract

Introduction:

Blunt pancreatic trauma in the pediatric population is rare, carrying high morbidity and mortality. There are no standardized guidelines for managing pediatric pancreatic trauma, although recent trends have shifted towards prioritizing nonoperative management. This study analyzes outcomes in nonoperative versus operative pediatric pancreatic trauma.

Materials and Methods:

The National Trauma Database (USA) from 2017-2020 was analyzed to find pediatric patients with traumatic pancreatic injury. Patients were grouped by operative (OM) or nonoperative management (NOM). Statistical analysis and propensity matching were done for age and injury severity scoring (ISS). The primary outcome was hospital length of stay (LOS). Secondary outcomes included age, gender, ICU admission, ICU length of stay (ICU LOS), and mortality.

Results:

Of the 524,000 pediatric trauma cases from 2017-2020, 1569 patients (0.30%) presented with pancreatic trauma. More patients were managed nonoperatively (1263, 80.5%) compared with operatively (306, 19.5%) ($p < 0.001$). After propensity matching for age and ISS, the groups were balanced. Compared to NOM patients, OM patients had significantly longer hospital LOS (10.8 vs. 18.0 days), higher rates of ICU admissions (73.2% vs. 51.0%), and required longer ICU stays (3.88 vs. 5.80 days). Mortality was lower in the OM patients (3.27% vs. 13.7%).

Discussion:

Although rare, pediatric pancreatic trauma carries significant risks for mortality and complications. OM involves longer hospital and ICU stays but may improve survival in carefully selected patients.

Conclusion:

OM improves survival in pediatric trauma while NOM continues to be the strategy that is applied for the majority in this study. These findings support individualized strategies to improve outcomes in pediatric pancreatic trauma

Level of Evidence: III

1. Introduction

Pancreatic trauma is rare but is clinically significant and often is associated with high morbidity and mortality. The incidence of pancreatic trauma in the pediatric population accounts for less than 1.0% of all pediatric trauma cases and nearly 10.0% of all intra-abdominal trauma pediatric cases.¹⁻⁴ The

pancreas is the fourth most injured solid organ intra-abdominally, following the spleen, liver, and kidneys.^{1–4} Research has shown blunt force trauma to be the leading cause of pancreatic injuries secondary to motor vehicle and bicycle-related accidents, especially handlebar injuries. Other mechanisms include penetrating injuries such as stab or gunshot wounds, child abuse, and falls.^{1, 5–7} Pancreatic injuries secondary to trauma can be difficult to diagnose because of its anatomical location in the retroperitoneum. Symptoms are often insidious and non-specific, increasing the risk of morbidity and mortality.

The ideal management of pancreatic trauma, especially in the pediatric population, remains up for debate. Existing guidelines for management are mostly derived from studies in the adult population, highlighting the need for further pediatric-specific management guidelines.^{8, 10} Non-operative management (NOM) has remained the leading recommendation for pancreatic trauma, but this varies based on the grade of severity of the injury and clinical picture. Operative management (OM) often occurs with higher grade pancreatic injuries.^{1, 3, 4, 8, 9} This retrospective analysis uses the NTDB (2017–2020) to compare outcomes of NOM versus OM in pediatric pancreatic trauma and inform pediatric-specific management guidelines.

2. Materials and Methods

2.1 Study design and data source

We performed a retrospective analysis using the American College of Surgeons National Trauma Data Bank (NTDB) between the years 2017–2020. This is a data bank that has data voluntarily reported by nearly 700 participating hospitals across the United States. It is publicly available from the American College of Surgeons after signing a Data Use Agreement. Patients are de-identified, and includes information about the trauma itself, injuries sustained, EMS vitals and information about their hospital course in compliance with Health Insurance Portability and Accountability Act (HIPAA).¹⁵ As a result, informed consent was waived in this study as the data was fully anonymous prior to analysis.

2.2 Patient selection and inclusion criteria

All pediatric trauma patients, regardless of mechanism of injury (MOI), aged 1–18 were initially included in this STROBE compliant study. Using ICD-10-CM codes, only patients with pancreatic injury were included for further study; codes from S.36.2 in the ICD-10 were included in the study as injuries to the pancreas. Patients were then grouped into operative and nonoperative groups, which were determined using ICD-10-PCS codes for all procedures involving the pancreas provided in the NTDB. OM was defined as any surgical or endoscopic procedures involving the pancreas. The procedures were further subcategorized into open surgical intervention (e.g. distal pancreatectomy) or endoscopic intervention (e.g. endoscopic retrograde cholangiopancreatography [ERCP]) based on the ICD-10PCS code and inclusion of any interventions involving ‘pancreas’. NOM was defined as the absence of any pancreatic

interventional code. For the purposes of this study, endoscopic procedures were included within the OM because they represented actual interventions rather than conservative NOM and observation.

Patients who died in the emergency room ($n = 59$) prior to receiving any treatment were classified within the NOM group and analyzed in the overall cohort but were excluded from the mortality contingency table analysis. The patients were then separated by their age groups, 1–4, 5–9, 10–14, and 15–18, representing toddlers, children, adolescents, and teenagers, respectively. Mechanisms of injury were collected and initially separated into five categories for overall analysis. A more detailed mechanism of injury was collected by sorting through each code for MOI and using a numeric system, 1–10, to categorize further.

2.3 Variable definition and outcome measures

Demographic information was studied between the operative and nonoperative groups, including race, gender, and age. The study's primary outcome was hospital length of stay (LOS). Secondary outcomes included age, gender, ICU admission, ICU length of stay (ICU LOS), and mortality. Data regarding methods of injury was analyzed and grouped into the following: motor vehicle collision (MVC), gunshot wounds, bicycle-related accidents, child abuse, fall, off-road (ATV or other) vehicle, physical altercation / assault, motorcycle-related accident, stab wound, and other. Additionally, methods of injury were separated into blunt, penetrating, burn or other. 1:1 Propensity matching was performed to control for confounding variables such as age and ISS between the OM and NOM groups. These variables were the most likely to influence management allocation and outcomes NOM was compared with OM using propensity-matched data to analyze the outcomes of LOS, ICU admission, and mortality rates. After propensity matching, the differences between both age and ISS were not statistically significant. T-tests were used to analyze continuous variables, and chi-squared testing was performed for categorical variables. Data analysis was performed using IBM SPSS version 29 (Armonk, NY). P-values from t-tests and Pearson's chi-squared tests were calculated using SPSS. Patients with missing primary outcomes were excluded from the study and accounted for less than 2% of the data .

2.4 Statistical Analysis

To explore the effect that group differences could have on continuous variables (i.e. age, LOS, ICU LOS), we used three effect size statistics: Cohen's d , Hedge's g , and Glass's delta to determine the standardized mean differences using standard thresholds (small ≥ 0.2 , medium ≥ 0.5 , large ≥ 0.8). CI (95%) intervals for effect sizes were found using standard error formulas.

3. Results

3.1 Demographics

Between 2017 and 2020, 524,000 pediatric trauma cases were found in the NTDB. Of these cases, 1569 (0.30%) of pediatric trauma cases present with pancreatic trauma. After analyzing the demographics of patients, there was no statistical significance in sex between the NOM and OM groups ($p = 0.178$)

(Table 1). 306 (19.5%) of these 1569 patients underwent operative management (Table 2). These patients, on average, were older (11.26 vs. 12.78 years, $p < 0.001$). A significant difference existed in white patients between NOM and OM (743 (58.8%) vs. 155 (50.7%), $p < 0.001$); all other races did not reveal any statistically significant management strategies between OM and NOM.

Table 1
Demographics

Variable	Non-operative Management	Operative Management	p-value
Age Median (years)	11.61	12.78	< 0.001*
Race/Ethnicity			
American Indian	12 (1.0%)	6 (2.0%)	0.136
Asian	24 (1.9%)	8 (2.6%)	0.428
Black	311 (24.6%)	92 (30.1%)	0.051
Pacific Islander	10 (0.8%)	1 (0.3%)	0.382
Other	127 (10.1%)	35 (11.4%)	0.476
White	743 (58.8%)	155 (50.7%)	0.010*
Sex			
Male	862 (68.3%)	221 (72.2%)	0.178
Female	401 (31.8%)	85 (27.8%)	—

Table 2
Combined Table: Non-Propensity Matched vs. Propensity Matched

Variable	Non-operative (Non-Propensity)	Operative (Non-Propensity)	p-value	Non-operative (Propensity)	Operative (Propensity)	p-value
Total Patients	1263 (80.5%)	306 (19.5%)	< 0.001*	306 (50.0%)	306 (50.0%)	1
Age (years)	12.86	12.78	0.770	12.86	12.78	0.770
Hospital LOS	10.84	18.00	< 0.001*	10.73	18.00	< 0.001*
ICU Admission	644 (51.0%)	224 (73.2%)	< 0.001*	169 (55.2%)	224 (73.2%)	< 0.001*
ICU LOS	3.88	5.90	< 0.001*	3.71	5.90	0.020*
Mortality	172 (13.6%)	10 (3.3%)	< 0.001*	42 (13.7%)	10 (3.3%)	< 0.001*
ISS	20.48	21.50	0.150	20.48	21.50	0.096

3.2 Mechanism of Injury

The leading MOI causing pancreatic trauma in the pediatric population was MVC [401 patients (25.0%)], followed by gunshot wound [305 patients (19.0%)], “other” causes [234 patients (15.0%)], bicycle-related accidented [201 patients (13.0%)], child abuse [110 patients (7.0%)], fall (6.5%), off-road (ATV or other) vehicle [93 patients (6.5%)], physical altercation/assault [65 patients (4.1%)], motorcycle-related accidents [32 patients (2.0%)], and stab wounds [26 patients (1.7%)] (Table 3). Average ISS values reveal the following: MVC (25.43), gunshot wounds (26.44), other (21.21), bicycle-related accidents (11.99), child abuse (17.88), fall (13.42), off-road (ATV or other) vehicles (18.64), physical altercation/assault (10.28), motorcycle-related accidents (22.9), stab wounds (13.96). Categorizing across broader injury types found that blunt force trauma accounted for the majority of cases (n = 1142, 72.8%). Operative management was necessary in about 20% of the blunt trauma group (187/1142). However, penetrating injuries had the highest OM (n = 105, 33.0% of all penetrating injuries), with $p < 0.0001$. (Table 3)

Table 3
Mechanism of Injury, Injury Severity, and Management

Mechanism of Injury (MOI)	Total Patients	Percentage (%)	Avg ISS	Severity
Motor Vehicle Collision (MVC)	401	25.4	25.43	Severe
Gunshot Wound	305	19.3	26.44	Severe
Bicycle-related Accidents	201	12.8	11.99	Moderate
Stab Wound	26	1.7	13.96	Moderate
Child Abuse	110	7.0	17.88	Serious
Off-Road (ATV or other) Vehicle	93	5.9	18.64	Serious
Fall	102	6.5	13.42	Moderate
Physical Altercation / Assault	65	4.1	10.28	Moderate
Motorcycle-Related Accident	32	2.0	22.90	Serious
Other	234	14.8	21.21	Serious
Total	1569	100	—	—
Injury Type	Total	Non-Operative	Operative	p-value
Blunt	1142	955	187	< 0.001
Penetrating	322	217	105	
Burn	2	2	0	
Other	12	11	1	
Missing	91	78	13	
*ISS score values are based on the Abbreviated Injury Scale (AIS) system. 1–8 - minor,				
9–15 = moderate, 16–24 = serious, 25–49 = severe, 50–74 = critical, 75 = maximum				

3.4 Non-propensity matched outcomes

Cohen's d was calculated to determine effect size between NOM and OM across the primary and secondary outcomes: hospital LOS, ICU LOS, and age. The medium effect size of hospital LOS (Cohen's $d = -0.50$), a small-to-medium effect size for ICU LOS (Cohen's $d = -0.26$), and a small effect size among age (Cohen's $d = -0.22$) (Table 4).

Using non-propensity matched data, clinically, more patients who underwent OM were admitted into the ICU compared to NOM patients [224 (73.0%) vs 644 (51.0%), $p < 0.001$] (Table 2). These OM patients also had significantly longer hospital LOS (11 days vs. 18 days, $p < 0.001$) as well as longer ICU LOS (3.9 days vs. 5.9 days, $p < 0.001$). However, mortality rates were significantly lower among OM patients compared

to NOM patients [10 (3.3%) vs. 113 (11.8%), [p < 0.001]. We excluded the 59 patients who died in the ED for purposes of developing the 2x2 contingency table for this analysis.

After propensity matching balanced the groups, ISS remained statistically insignificant and age became statistically insignificant (p = 0.096, p = 0.770 respectively) (Table 2). There were 306 patients in each group for propensity matching, and significant differences between NOM and OM groups across the primary and secondary outcomes persisted: hospital LOS (10.7 days vs. 18.0 days, p < 0.001), ICU admission [169 (55.2%) vs. 224 (73.2%), p < 0.001], ICU LOS (3.71 days' vs 5.9 days, p = 0.020), and mortality rates [42 (13.7%) vs. 10 (3.27%) p < 0.001] (Table 2).

Table 4
Effect Size Summary Table

Variable	Glass's Δ [95% CI]	Hedges' g	Cohen's d
Age (years)	-0.215 [-0.340, -0.090]	-0.214	-0.215
ICU LOS	-0.270 [-0.400, -0.110]	-0.254	-0.255
Hospital LOS	-0.537 [-0.715, -0.281]	-0.497	-0.498
Grand Total	-1.022	-0.965	-0.968
Note: Negative values indicate higher means in the operative (surgery) group.			

3.5 Effect Size and propensity-matched outcomes

Further subgroup analysis revealed important clinical characteristics that were stratified by age, injury type, and ED course. 59 patients who died in the ED died before operative intervention and were classified as managed non-operatively for study purposes but excluded for assessing statistical differences in mortality. Teenagers represented a majority [(164/306) 54.0%] of the group who underwent operative intervention. When stratified by age, operative management was significantly more common in teenagers ages 15–18 (n = 164, 23.4%) when compared with toddlers ages 1–4 (n = 34, 15.1%) (p < 0.005), but OM rates were not statistically different from rates in other age groups. (Table 5).

Table 5
Clinical Outcomes Stratified by Management Approach

Outcome / Variable	Total	Operative	Non-operative	p-value
Died in ED	59	0	59	< 0.001*
Age Stratification	---	---	---	---
Age 1–4	225	34	191	0.005*
Age 5–9	320	57	263	
Age 10–14	323	51	272	
Age 15–18	701	164	537	
ICU Admission (Total)	868	224	644	---
Died in ICU	93	9	84	< 0.001
Survived ICU	775	215	560	
Surgical Approach	Total	Died	Survived	p-value
Endoscopic Surgery	261	10	251	0.182
Open Surgery	45	0	45	

3.6 Sub-group analysis and ED deaths

Regarding pancreatic injury type, a chi-squared analysis comparing OM vs NOM across injury types revealed a statistical difference ($p < 0.001$) (Table 6). The most common injury patients presented with was a contusion in an unspecified location ($n = 317$, 20.2%), which were mostly managed nonoperatively ($n = 300$, 94.6%). Alternatively, major lacerations to the body and tail of the pancreas as well as moderate lacerations of the body were significantly associated with operative management ($n = 47$, 52.8%; $n = 24$, 57.1%; $n = 27$, 41.5% respectively). These types of injuries are often deep and have a more severe effect, making operative management more likely. Minor lacerations of any region were managed nonoperatively in > 90% of cases. These injuries were low-grade or likely well-defined and consistent with severity-guided surgical decision making.

Table 6
Injury Data P < 0.001

Injury Description	Total Frequency	Total Percent	Operative Management Number of Patients	Operative Percent	Non-Operative Management Number of Patients	Non-Operative Percent
Contusion of body of pancreas, initial encounter	65	4.1%	10	3.3%	55	4.4%
Contusion of head of pancreas, initial encounter	116	7.4%	8	2.6%	108	8.6%
Contusion of tail of pancreas, initial encounter	98	6.2%	15	4.9%	83	6.6%
Contusion of unspecified part of pancreas, initial encounter	317	20.2%	17	5.6%	300	23.8%
Laceration of body of pancreas, unspecified degree, initial encounter	44	2.8%	13	4.3%	31	2.5%
Laceration of head of pancreas, unspecified degree, initial encounter	51	3.3%	8	2.6%	43	3.4%

3.7 ICU and procedure subgroups

Among the patients admitted to the ICU (n = 868), irrespective of management, most patients survived (n = 775, 89.3%). Further, of the admitted ICU patients, patients managed operatively had lower mortality (n = 9, 4.0%) compared to non-operative patients (n = 84, 13.0%) (p < 0.001).

Lastly, there was no significant difference when comparing procedure type and survival rates. There were no deaths reported among patients who underwent open procedures (n = 45), whereas there were

reported deaths among those who underwent endoscopic procedures (n = 10) (p = 0.182).

4. Discussion

4.1 Epidemiology and Mechanisms of Injury

Pancreatic trauma is rare, occurring < 1% of all traumas and 3.7–11% of abdominal trauma cases.^{1, 16, 17} While this male prevalence extends to the adult population, our research revealed no statistical significance of sex. Across age groups, teenagers had the most pediatric pancreatic trauma sustained, with descending prevalence in the adolescent, children, and infant groups (n = 701, 323, 320, and 225, respectively). The severity of injuries, as demonstrated in the data, is correlated MOI. The leading mechanism of pancreatic injury was MVC, accounting for 25% of all of our data's pancreatic injuries, consistent with existing literature.⁶ The use of seat belts and rapid deceleration are probably factors that are causative of pancreatic injury in this setting. Penetrating injuries secondary to gunshot wounds were the next leading cause of pancreatic injuries, followed by "other" causes such as horse- and pedestrian-related injuries, falls, and bicycle-related accidents.^{1, 4, 6, 7} Notably, MVCs and gunshot wounds present with higher ISS scores indicating more severe injury.

4.2 Operative vs. Nonoperative Management: Outcomes and Mortality

Although the OM group required more resource-intensive care – longer hospital LOS, increased ICU admission rates, and longer ICU stays – and were sicker on initial presentation, they had a lower mortality rate than NOM (3.30% vs. 11.8%). Previous studies have reported similar low mortality rates (2.4% – 6.1%) but did not demonstrate a mortality difference in management strategies.^{3, 11, 12}

In this study, all the operative mortality was in the endoscopic group and there was no mortality after open surgery. While current management trends in pediatric pancreatic trauma lean towards conservative or endoscopic intervention, our data suggests that treatment teams should consider open surgical intervention in major pancreatic trauma (Grade 3 and higher) with neck transection. Conservative management in this group may increase the risk of retroperitoneal sepsis and mortality. This study supports NOM for lower grade injuries. Previous literature also has described NOM as the standard for lower-grade injuries.^{1–3, 7, 8} Despite presumably lower injury severity as evidenced by short hospital LOS, fewer ICU admissions, and shorter ICU LOS, the NOM group had a higher mortality rate (13.7% vs 3.3%) in this study. While these numbers are likely skewed as we included all patients, including those who died in the ED as having been managed non-operatively, due to an intent to treat basis for the study. However, delayed complications in NOM group due to attempts at managing major pancreatic injuries conservatively, may further explain these findings.

It has been documented that approximately one-third of patients with pancreatic trauma who survive past the first 48 hours can go on to develop complications such as abscesses, wound complications,

septicemia, and multiorgan failure.^{18, 19} These factors may further explain the differences between NOM and OM group findings. Patients managed nonoperatively may have presented worse at baseline, leading to expiration before any surgery could be made or reach a physiological state wherein operative management may no longer be feasible. Further, this study did not find any significant difference in mortality rates between those who underwent endoscopic intervention and operative intervention and it is possible that establishing pancreatic drainage into the gastrointestinal tract (with endoscopic intervention) or obtaining control of a disrupted pancreas (as with OM) are equally important in major pancreatic injury. This is an important consideration that will need further study.

4.4 Firearm Injuries and Implications for U.S. Pediatric Trauma Protocols

Our data, drawn from domestic USA data, found that the second leading cause of pancreatic injury was due to gunshot wounds (GSW) in the pediatric population (Table 3). Globally, GSWs are not reported as a leading cause of pancreatic trauma in individuals < 18; unlike in adult and military populations.^{1, 13, 14, 20} One study observed that GSWs comprise most penetrating wounds that cause pancreatic trauma (n = 14, 87.5%).²¹ These findings are supported by broader national trends. According to the American Academy of Pediatrics (AAP), firearm injuries are the leading cause of death in children and adolescents in the United States in 2020.¹⁴ The United States has significantly higher rates than other higher-income countries.²² In summary, violence and high-velocity mechanisms lead to the most severe pancreatic injuries and in these cases we recommend consider early operative intervention, including debridement or resection as indicated in these cases.²³

Current pediatric trauma protocols are often based on adult data, limiting their applicability to the pediatric population.^{1, 8} These guidelines do not account for the differences in pediatric and adolescent anatomy and physiology.

4.5 Limitations and Future Directions

This paper has several limitations. Our study was a retrospective study using data from the NTDB. Innately, retrospective cohort studies introduce potential biases like selection bias. Moreover, this dataset is utilized among several different hospital systems, and there is limited control over the initial collection of this data. As a result, the potential for misclassification bias and missing dataset points are also introduced. The lack of other clinical details such as GCS scores, AAST pancreatic injury grade, and ductal involvement may skew the data. While the NTDB provides a robust amount of data, this data is voluntary and is mainly used by larger trauma centers. This data may not then reflect smaller community or more rural hospital data. Lastly, limitations specific to the NTDB include the lack of long-term outcomes such as long-term pancreatic function and quality of life were not noted.

Despite propensity matching for age and ISS, residual confounding from unmeasured variables — including pancreatic injury grade, ductal involvement, institutional decision making — cannot be

excluded. These factors more than likely influence both management selection and outcomes and represent the inherent limitations of retrospective database analyses.

The direction of this paper highlights the need for a prospective study. Creating a more tailored database specific to pediatric abdominal trauma can enhance reliable comparisons and provide more detailed information for guidelines regarding NOM vs. OM. Moreover, future research should include lab work (amylase and lipase levels), imaging, and operative findings to better define the severity of these pancreatic injuries. A scoring system tailored to pediatrics, combined with other predictive and biochemical markers can be integrated into hospital protocols and Electronic Medical Records (EMR)-tools to support decision making.

5. Conclusion

Pancreatic trauma in the pediatric population is a rare injury, yet remains clinically relevant due to its increased morbidity and mortality. In this retrospective analysis of the NTDB, OM was associated with lower mortality when compared with the the NOM, despite greater resource utilization and increased ICU LOS.

Nevertheless, these findings challned the assumption that NOM is universally superior in pancreatic trauma. The data further suggests that open surgical intervention may be necessary and associated with improved survival outcomes in pancreatic injuries (Grade 3+), while NOM or endoscopic procedures remain the appropriate for lower-grade injuries. The combined results of this study highlight the need to create pediatric trauma management guidelines based on pediatric data rather than those from existing adult-adapted guidelines.

Declarations

AI Declaration

During the preparation of this study, the authors used generative AI tools (ChatGPT 4, OpenAI) for suggestions to refine language only.

CRedit authorship contribution statement

Credit authorship contribution statement:

Amanda Gaccione: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Methodology and Writing – review and editing.

Sean Hurley: Data curation, Investigation, Methodology.

Anne Pierce: Formal analysis, Writing - review and editing, Data curation

Dr. Sathyaprasad C. Burjonrappa: Conceptualization, Investigation, Supervision, Writing - review and editing, Formal Analysis, Supervision

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References

1. WSES-AAST Expert Panel, Coccolini F, Kobayashi L, et al. Duodeno-pancreatic and extrahepatic biliary tree trauma: WSES-AAST guidelines. *World J Emerg Surg.* 2019;14(1):56. doi:10.1186/s13017-019-0278-6
2. Kopljar M, Ivandić S, Mesić M, et al. Operative versus non-operative management of blunt pancreatic trauma in children: Systematic review and meta-analysis. *Injury.* 2021;52:S49-S57. doi:10.1016/j.injury.2020.02.035
3. Englum BR, Gulack BC, Rice HE, Scarborough JE, Adibe OO. Management of blunt pancreatic trauma in children: Review of the National Trauma Data Bank. *Journal of Pediatric Surgery.* 2016;51(9):1526-1531. doi:10.1016/j.jpedsurg.2016.05.003
4. Jobst, MA, Canty, Sr., TG • Lynch, FP, Management of pancreatic injury in pediatric blunt abdominal trauma. *J Pediatr Surg.* 1999; 34:818-823, doi: 10.1016/s0022-3468(99)90379-2
5. Arkovitz, Marc S. MD; Johnson, Neil MD; Garcia, Victor F. MD. Pancreatic Trauma in Children: Mechanisms of Injury. *The Journal of Trauma: Injury, Infection, and Critical Care* 42(1):p 49-53, January 1997, doi:10.1097/00005373-199701000-00009.
6. Everson, E., Buschel, H., Carroll, J. et al. Paediatric pancreatic trauma in North Queensland: a 10-year retrospective review. *BMC Pediatr* 23, 88 (2023). doi: 10.1186/s12887-023-03904-7
7. Ravindranath A, Srivastava A, Yachha SK, et al. Childhood pancreatic trauma: Clinical presentation, natural history and outcome. *Pancreatology.* 2020;20(1):68-73. doi: 10.1016/j.pan.2019.10.008
8. Ho VP, Patel NJ, Bokhari F, et al. Management of adult pancreatic injuries: A practice management guideline from the Eastern Association for the Surgery of Trauma. *Journal of Trauma and Acute Care Surgery.* 2017;82(1):185-199. doi:10.1097/TA.0000000000001300
9. Sukhotnik I, Cohen N. Management of Blunt Pancreatic Trauma in Children: A Persistent Controversy-Case Report and Comprehensive Literature Review. *Children (Basel).* 2024 Jan 22;11(1):135. doi: 10.3390/children11010135. PMID: 38275445; PMCID: PMC10814196.

10. Moren A.M., Biffi W.L., Ball C.G., de Moya M., Brasel K.J., Brown C.V.R., Hartwell J.L., Inaba K., Ley E.J., Moore E.E., et al. Blunt pancreatic trauma: A Western Trauma Association critical decisions algorithm. *J. Trauma Acute Care Surg.* 2023;94:455–460. doi: 10.1097/TA.0000000000003794
11. Rauh JL, Neff LP, Forssten MP, Ribeiro MAF, Sarani B, Mohseni S. Contemporary management and outcomes of blunt traumatic American Association for the Surgery of Trauma Organ Injury Scale grades III and IV pancreatic injuries in children: A Trauma Quality Improvement Program analysis. *J Trauma Acute Care Surg.* 2024;97(3):365-370. doi:10.1097/TA.0000000000004270
12. Lu X, Gao H, Jiang K, Miao Y, Wei J. Management and Outcome of Blunt Pancreatic Trauma: A Retrospective Cohort Study. *World j surg.* 2023;47(9):2135-2144. doi:10.1007/s00268-023-07026-0
13. Amy Vertrees, Eric Elster, Rahul Jindal, Camillo Ricordi, Craig Shriver, Surgical Management of Modern Combat-Related Pancreatic Injuries: Traditional Management and Unique Strategies, *Military Medicine*, Volume 179, Issue 3, March 2014, Pages 315–319, doi:10.7205/MILMED-D-13-00375
14. Biffi, Walter L. MD; Ball, Chad G. MD; Moore, Ernest E. MD; West, Michaela MD; Russo, Rachel M. MD; Balogh, Zsolt MD; Kornblith, Lucy MD; Callcut, Rachael MD; Schaffer, Kathryn B. MPH; Castelo, Matthew BS; the WTA Multicenter Trials Group on Pancreatic Injuries. A comparison of management and outcomes following blunt versus penetrating pancreatic trauma: A secondary analysis from the Western Trauma Association Multicenter Trials Group on Pancreatic Injuries. *Journal of Trauma and Acute Care Surgery* 93(5):p 620-626, November 2022., doi: 10.1097/TA.0000000000003651
15. American College of Surgeons. (2023). *National Trauma Data Bank (NTDB)*. Retrieved [April 16, 2025], from <https://www.facs.org/quality-programs/trauma/quality/national-trauma-data-bank/>
16. O'Reilly, D., Bouamra, O., Kausar, A., Dickson, E., & Lecky, F. (2015). The epidemiology of and outcome from pancreatoduodenal trauma in the uk, 1989–2013. *The Annals of the Royal College of Surgeons of England*, 97(2), 125-130. Doi: 10.1308/003588414X14055925060712
17. Joos, É., Jong, N. d., Ball, C. G., Quigley, S., Trottier, V., Massé, M., ... & Vogt, K. (2021). Time to operating room matters in modern management of pancreatic injuries: a national review on the management of adult pancreatic injury at canadian level 1 trauma centers. *Journal of Trauma and Acute Care Surgery*, 90(3), 434-440. doi: 10.1097/TA.0000000000003025
18. Oláh, A., Issekutz, Á., Haulik, L., & Makay, R. (2003). Pancreatic transection from blunt abdominal trauma: early versus delayed diagnosis and surgical management. *Digestive Surgery*, 20(5), 408-414. doi: 10.1159/000072708
19. Recinos, G., DuBose, J. J., Teixeira, P. G., Inaba, K., & Demetriades D. (2009). Local complications following pancreatic trauma. *Injury*, 40(5), 516-520. doi: 10.1016/j.injury.2008.06.026
20. Chinnery, G., Krige, J. E. J., Kotze, U., Navsaria, P. H., & Nicol, A. J. (2011). Surgical management and outcome of civilian gunshot injuries to the pancreas. *British Journal of Surgery*, 99(Supplement_1), 140-148. doi: 10.1002/bjs.7761
21. Alemayehu, H., Tsao, K., Wulkan, M. L., Islam, S., Russell, R. T., Ponsky, T. A., ... & Iqbal, C. W. (2014). Multi-institutional experience with penetrating pancreatic injuries in children. *Pediatric Surgery International*, 30(11), 1107-1110. doi:10.1007/s00383-014-3599-2

22. Lee, L. K., Fleegler, E. W., Goyal, M. K., Doh, K. F., Laraque-Arena, D., Hoffman, B., ... & Delgado, A. (2022). Firearm-related injuries and deaths in children and youth. *Pediatrics*, 150(6). doi: 10.1542/peds.2022-060071
23. Krige JE, Beningfield SJ, Nicol AJ, Navsaria P. The Management of Complex Pancreatic Injuries. *South African Journal of Surgery. Suid-Afrikaanse Tydskrif Vir Chirurgie*. 2005;43(3):92-102. PMID: 16180395.

Figures

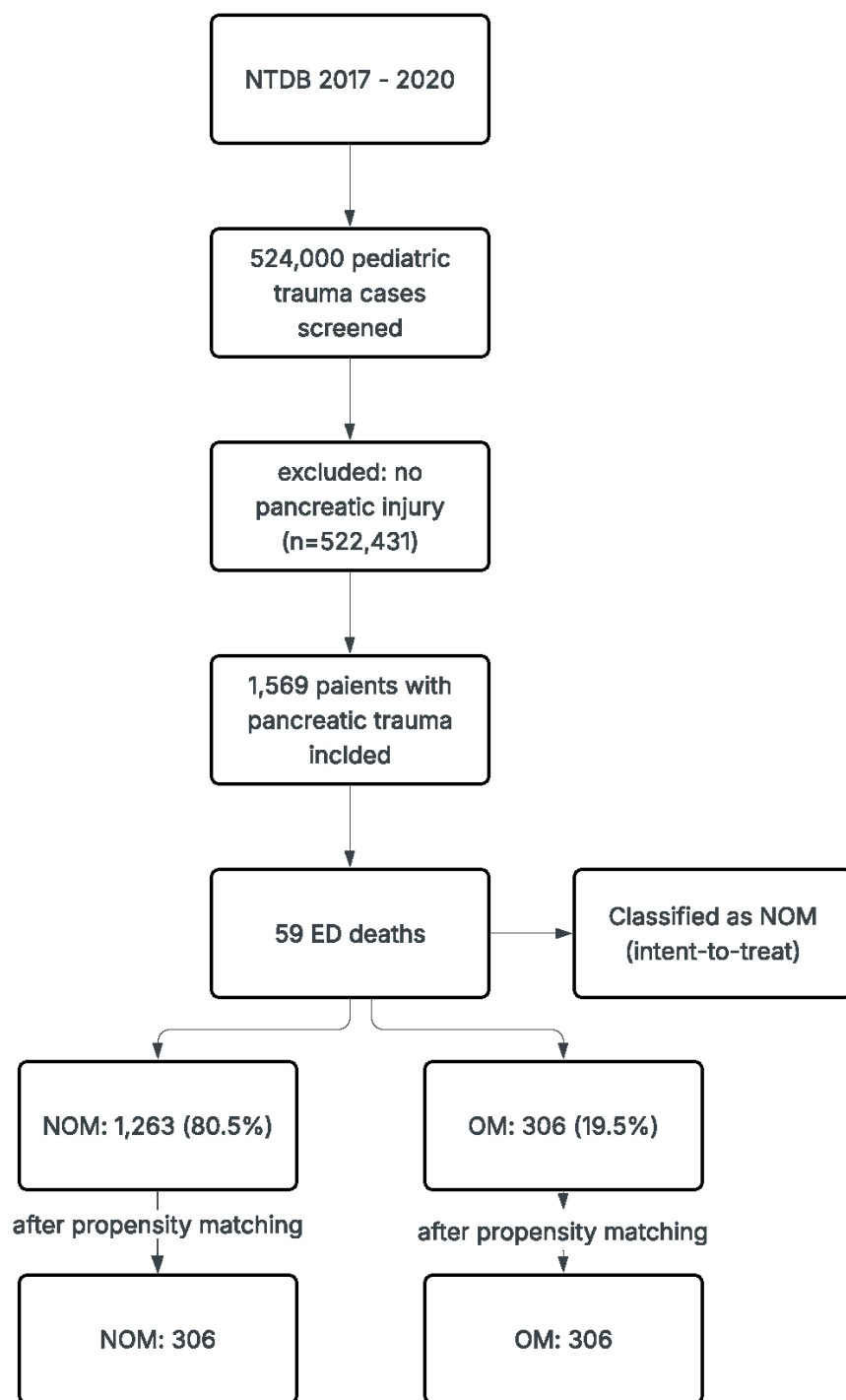


Figure 1

Participant Flow