



## The worldwide variation in epidemiology of pancreatic injuries

Due to the relative rarity of trauma to the pancreas, experience with pancreatic injury is highly variable among surgeons. Considerable differences exist in epidemiology, aetiology, management and outcomes around the globe [1]. Higher rates of penetrating injuries have traditionally been reported from regions with excessive access to and frequent use of handguns in civilian populations, most notably in South Africa and the United States [2–6]. Audits on pancreatic trauma done outside regions of high prevalence of penetrating injuries have been rare to come across, although some have been reported [7,8]. Thus, the current report from Japan [9] in this issue of *Injury* is timely and sheds some further light on the spectrum of pancreatic injuries as seen in a nationwide cohort. The nationwide data report allows to compare the likes and dislikes between other regions as well as outcomes associated with this overall rare organ injury (Table 1).

The study from the Japan Trauma Data Bank [9] included 294,274 patients recorded in the database, of which 30,442 had one or more abdominal injuries, and 743 (0.25% of all trauma and 2.4% of abdominal trauma) had a pancreatic injury. Data were collected over a 14-year period from a total of 269 hospitals reporting data to the registry, which only testifies to the rarity of this injury overall. Overall mortality was 175% among patients with pancreatic injury (including multi-trauma patients), but for isolated pancreatic injuries (about 30% of all pancreatic injuries) the mortality was reported almost 4 times lower at 4.7%. Men predominated among the injured at 72%, and median age of injury presentation was 45 years. Road traffic accidents was the predominant mechanism of injury (78%) and it is worth noting that in this Japanese study, suicide/suicide attempts accounted for over 13% of injuries, which were twice the number as personal assaults at 7.3% [9]. This is worth noting as injury patterns are reflected in the broader societal and cultural differences between regions, some of which are amenable to intervention (e.g. traffic regulations and safety prescriptions) and others that are more difficult to modify (e.g. societal pressures; historic traditions and cultural components). One should keep this in mind when comparing data and outcome between regions.

In a register study from the UK [8] based on the Trauma Audit and Research Network (TARN) database from 1989 to 2013, there were 356,534 trauma patients of which 24,595 with abdominal trauma (4.7% of all injuries). In the TARN series, a total of 1155 patients (0.32% of all injured patients) sustained pancreatoduodenal injuries [8]. Of note, the pancreas was injured in but 724 of these (excluding isolated duodenal injuries), thus the selected pancreatic injury rate was 0.20% of all injuries or, 2.9% of all

abdominal injuries [8]. The numbers very much fits in line with the study from Japan and is in line with a previous study from Scotland that found 111 of 52,676 patients (0.21%) having sustained pancreatic trauma [7] over a decade. Road traffic accidents seems to predominate in the patterns reported across these studies.

A further study from the National Trauma Databank (NTDB) in the USA [4] investigated all injuries in patients  $\geq 14$  years of age during the time period 2007–2011 [4]. Among 2.8 million registered trauma patients, they found 8386 (0.3% of all) patients with pancreatic injuries.

One of the most notable differences in the epidemiology of pancreatic injuries refers to the mechanism of injury. In a large report from the Groote Shur Hospital in Cape Town, South Africa including 473 patients with pancreatic injuries the period between 1990 to 2015, a total of 73% of these resulted from penetrating injuries (55% from gunshot wounds; 18% from stab injuries). This stands in contrast to reports from the other geographic regions (Table 1), even to the rate at 39% of injuries due to penetrating trauma in the US. Notably, Japan report the lowest rate among the nationwide studies, with 15% of pancreatic injuries due to a penetrating mechanism (Table 1). In another single-centre study from a tertiary hospital in India, the reported rate of penetrating mechanism was about 7% for pancreatic injuries, with road traffic injuries as by far the most frequent injury mechanism [10].

A timely and correct diagnosis of pancreatic injury has remained a challenge up until modern times [11–13]. The organ injury severity system has allowed for a common template of injury severity reporting [14], but description can sometimes be difficult and inaccurate and based on variable information (e.g. based on scans, operative exposure or autopsy). Outcomes reported are highly variable across reported series, with attempts at defining ‘good’ from ‘bad’ injuries [15] through various suggested scoring schemes [16]. Management is highly variable with several options to consider based on presentation, severity and available resources [1]. Management is also highly variable across age-groups, even within countries. Notably, attempts at systematically pooling the best available data for management and improved decision-making leaves a fairly low grade of evidence available for this particular injury [1,17–19], and even more so for children [20–22]. As most injuries are reported in the low-grade range (grades I–III) were non-operative management is more likely, the data available for the high-grade injuries are even more scarce. Thus, comparing data and making prediction models based on the reported outcomes across studies is a dubious task for many reasons. For one, mortality is highly variable and usually associated with other injuries (e.g. multiple

**Table 1**  
Registry studies of pancreatic injuries covering a defined geographic region.

Origin	Period	Pancreatic (n)	All* (%)	Abd. (%)	Blunt (%)	Morb (%)	Mort (%)
Japan	2004–2017	743	0,25	2,4	85%	n.r.	17,5%
UK	1989–2013	724	0,20	2,9	82%	n.r.	B:21,2% P:16,8%
Scotland	1992– 2002	111	0,21	n.r.	66%	n.r.	46,0%
USA	2007– 2011	8386	0,30	3,6	61%	53%	21,2%

\*Abd', denotes 'abdominal injuries'; 'morb', denotes 'morbidity'; 'mort', denotes 'mortality'. B, denotes 'blunt'; P, denotes 'penetrating'.

\* All, denotes of all trauma patients in the study/register.

organ and body regions) and thus it is really hard to tell as to what extent the pancreatic injury contributed to the mortality, let alone if mortality had a causality to the pancreatic injury.

Also, among the 4 studies (Table 1) there is difference in how mortality was reported and for whom, e.g. most reported in-hospital mortality (so not specified as 30-days or 90-days mortality, which has become more common for other conditions) and a variation if they did, or did not, include patients who arrived at hospital and were declared dead on arrival. Also, deaths from isolated pancreatic injuries are rare and overall too few to arrive at reasonable conclusions. Further, the morbidity is similarly difficult to account for and, if reported at all, may be a combined effect of the total injury burden rather than the specific pancreatic injury. Also, only the US-NTDB study gave an estimate of morbidity in the data (at just over 50%) based on associated comorbidity codes in the register [4]. As a consequence, it may be difficult to tease out the injury specific mortality and morbidity from large databases, and more granular data is needed from institutional or specifically tailored prospective studies (e.g. institution-based; quality registry based data sets etc) to arrive at better estimates for such data overall [2,6,23].

Thus, as the Japanese investigators found only moderate accuracy in outcome prediction by using the pancreatic injury mortality score (PIMS) tool [16] suggested by the Cape Town group, this may simply be related to the difficulty in applying a score derived from a completely different dataset of pancreatic injuries. The main reason for this may rest in the difference in the two cohorts from South Africa and Japan, with the South African cohort having a higher rate of severe penetrating gunshot wounds requiring operative intervention among other differences [16]. One may perceive that the ability to predict outcomes to be improved if patient groups could be matched for baseline characteristics, although this may not be a feasible task at the moment. However, it is reassuring to see the factors of outcome related to organ injury severity, age of patient, physiology on arrival and coexistence of other severe injuries, as reflected in the 'good, bad and ugly' scenario anecdotally presented previously [15].

The difficulties in comparing these registry-based cohorts set aside, it is of importance to continue to gather, analyse and report data on both frequent and rare injuries from different registries around the globe. More regions and countries are developing and maturing nationwide registries with opportunities to gather data for comparison of rare type of injuries, even if the granular level of details may not satisfy every need or bring answer to every question. Only by comparing the data between regions may we better appreciate the variation in prevalence, management and outcomes specific to our own trauma system. And, obviously, we can learn more from each other.

### Declaration of Competing Interest

None of the authors have any financial or otherwise conflicts reported to this article.

### References

- [1] Søreide K, Weiser TG, Parks RW. Clinical update on management of pancreatic trauma. *HPB (Oxford)* 2018;20(12):1099–108.
- [2] Krige JE, Kotze UK, Setshedi M, Nicol AJ, Navsaria PH. Prognostic factors, morbidity and mortality in pancreatic trauma: a critical appraisal of 432 consecutive patients treated at a Level 1 Trauma Centre. *Injury* 2015;46(5):830–6.
- [3] Phillips B, Turco L, McDonald D, Mause E, Walters RW. A subgroup analysis of penetrating injuries to the pancreas: 777 patients from the National Trauma Data Bank, 2010–2014. *J Surg Res* 2018;225:131–41.
- [4] Kuza CM, Hirji SA, Englum BR, Ganapathi AM, Speicher PJ, Scarborough JE. Pancreatic injuries in abdominal trauma in US adults: analysis of the national trauma data bank on management, outcomes, and predictors of mortality. *Scand J Surg* 2019;1457496919851608.
- [5] Alemayehu H, Tsao K, Wulkan ML, et al. Multi-institutional experience with penetrating pancreatic injuries in children. *Pediatr Surg Int* 2014;30(11):1107–10.
- [6] Mohseni S, Holzmacher J, Sjolín G, Ahl R, Sarani B. Outcomes after resection versus non-resection management of penetrating grade III and IV pancreatic injury: a trauma quality improvement (TQIP) databank analysis. *Injury* 2018;49(1):27–32.
- [7] Scollay JM, Yip VS, Garden OJ, Parks RW. A population-based study of pancreatic trauma in Scotland. *World J Surg* 2006;30(12):2136–41.
- [8] O'Reilly DA, Bouamra O, Kausar A, Malde DJ, Dickson EJ, Lecky F. The epidemiology of and outcome from pancreatoduodenal trauma in the UK, 1989–2013. *Ann R Coll Surg Engl* 2015;97(2):125–30.
- [9] [authors]. Epidemiological state, predictive model for mortality, and optimal management strategy for pancreatic injury: a multicentre nationwide cohort study. *Injury* 2019 in press.
- [10] Gupta A, Kumar S, Yadav SK, et al. Magnitude, severity, and outcome of traumatic pancreatic injury at a level I trauma center in India. *Indian J Surg* 2017;79(6):515–20.
- [11] Leppaniemi AK, Haapiainen RK. Risk factors of delayed diagnosis of pancreatic trauma. *Eur J Surg* 1999;165(12):1134–7.
- [12] Schellenberg M, Inaba K, Bards JM, et al. Detection of traumatic pancreatic duct disruption in the modern era. *Am J Surg* 2018;216(2):299–303.
- [13] McKechnie PS, Kerslake DA, Parks RW. Time to CT and surgery for HPB trauma in Scotland prior to the introduction of major trauma centres. *World J Surg* 2017;41(7):1796–800.
- [14] Moore EE, Cogbill TH, Malangoni MA, et al. Organ injury scaling, II: pancreas, duodenum, small bowel, colon, and rectum. *J Trauma* 1990;30(11):1427–9.
- [15] Søreide K. Pancreas injury: the good, the bad and the ugly. *Injury* 2015;46(5):827–9.
- [16] Krige JE, Spence RT, Navsaria PH, Nicol AJ. Development and validation of a pancreatic injury mortality score (PIMS) based on 473 consecutive patients treated at a level 1 trauma center. *Pancreatol* 2017;17(4):592–8.
- [17] 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. *J Trauma Acute Care Surg* 2017;82(1):185–99.
- [18] Naik-Mathuria BJ, Rosenfeld EH, Gosain A, et al. Proposed clinical pathway for nonoperative management of high-grade pediatric pancreatic injuries based on a multicenter analysis: a pediatric trauma society collaborative. *J Trauma Acute Care Surg* 2017;83(4):589–96.
- [19] Potoka DA, Gaines BA, Leppaniemi A, Peitzman AB. Management of blunt pancreatic trauma: what's new? *Eur J Trauma Emerg Surg* 2015;41(3):239–50.
- [20] Haugaard MV, Wettergren A, Hillingsø JG, Gluud C, Penninga L. Non-operative versus operative treatment for blunt pancreatic trauma in children. *Cochrane Database Syst Rev* 2014(2):Cd009746.
- [21] Antonsen I, Berle V, Søreide K. Blunt pancreatic injury in children. *Tidsskr Nor Lægeforen* 2017;137(17).
- [22] Koh EY, van Poll D, Goslings JC, et al. Operative versus nonoperative management of blunt pancreatic trauma in children: a systematic review. *Pancreas* 2017;46(9):1091–7.
- [23] Lin BC, Chen RJ, Hwang TL. Lessons learned from isolated blunt major pancreatic injury: surgical experience in one trauma centre. *Injury* 2019, doi: <http://dx.doi.org/10.1016/j.injury.2019.05.027> pii: S0020-1383(19)30323-7 [Epub ahead of print].

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