An analysis of predictors of morbidity after stab wounds of the pancreas in 78 consecutive injuries

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ABSTRACT

INTRODUCTION Penetrating injuries of the pancreas may result in serious complications. This study assessed the factors influencing morbidity after stab wounds of the pancreas.

METHODS A retrospective univariate cohort analysis was carried out of 78 patients (74 men) with a median age of 26 years (range: 16–62 years) with stab wounds of the pancreas between 1982 and 2011.

RESULTS The median revised trauma score (RTS) was 7.8 (range: 2.0–7.8). Injuries involved the body ($n=36$), tail ($n=24$), head/uncinate process ($n=16$) and neck ($n=2$) of the pancreas. All 78 patients underwent a laparotomy. Sixty-five patients had AAST (American Association for the Surgery of Trauma) grade I or II pancreatic injuries and thirteen had grade III, IV or V injuries. Eight patients (10.3%) had an initial damage control operation. Sixty-nine patients (84.6%) had drainage of the pancreas only, six had a distal pancreatectomy and one had a pancreaticoduodenectomy.

Most pancreas related complications occurred in patients with AAST grade III injuries; eight patients (10.2%) developed a pancreatic fistula. Four patients (5.1%) died. Grade of pancreatic injury (AAST grade I–II vs grade III–V injuries, $p<0.001$), RTS (odds ratio [OR]: 5.01, 95% confidence interval [CI]: 1.46–17.19, $p<0.007$), presence of shock on admission (OR: 3.31, 95% CI: 1.16–9.42, $p=0.022$), need for a blood transfusion (OR: 6.46, 95% CI: 2.40–17.40, $p<0.001$) and repeat laparotomy ($p<0.001$) had a significant influence on the development of general complications.

CONCLUSIONS Although mortality was low after a pancreatic stab wound, morbidity was high. Increasing AAST grade of injury, high RTS, shock on admission to hospital, need for blood transfusion and repeat laparotomy were significant factors related to morbidity.

KEYWORDS

Pancreas – Injury – Stab wound – Morbidity

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Injuries of the pancreas are encountered infrequently. They occur in less than 5% of penetrating abdominal trauma but may result in substantial morbidity and mortality when treatment is delayed or inappropriate.^{1–3} Pancreatic injuries seldom occur in isolation because of the intimate relationship to surrounding organs. The anatomical proximity of the portal and superior mesenteric veins and inferior vena cava to the head and neck of the pancreas make these structures particularly vulnerable to penetrating injuries of the proximal pancreas.⁴

Outcome is determined by the cause and grade of the pancreatic injury, the number and severity of associated injuries, and the speed and quality of surgical intervention.^{5,5} Previous reports have suggested that associated organ injury is a more important predictor of outcome than the severity of injury to the pancreas.⁶ Overall morbidity rates exceed 30%, especially when the liver, duodenum, colon and major visceral veins are involved.^{7,8} Mortality may reach 46%, and is highest in the elderly and those who are haemodynamically unstable,

correlating closely with the number of associated injuries, which are detrimental to outcome.⁹

The absence of a universally acceptable classification has prevented accurate comparisons between series.³ As pancreatic injuries are uncommon and most series have small numbers, some studies include all patients with blunt and penetrating pancreatic injuries^{7,9,10} while others combine gunshot and stab wounds of the pancreas.^{1,6,11} Several substantial reports detailing pancreatic injuries have been published in the past, including from our own institution,^{4,12,13} but none have explicitly evaluated the consequences of stab wounds of the pancreas.^{1,6,15} The present study examined the factors associated with morbidity and mortality of stab wounds of the pancreas in a high volume academic trauma referral centre.

Methods

The study design was a single centre retrospective cohort analysis of all adult patients with stab wounds of the

pancreas treated between January 1982 and December 2011. The study used a registered fit for purpose departmental database that documents the details of all patients with pancreatic injuries treated at the level 1 trauma centre and the hepatopancreatobiliary and surgical gastroenterology units at Groote Schuur Hospital, Cape Town. The study was approved by the University of Cape Town ethics and research committee and the protocol conformed to the ethical guidelines of the Declaration of Helsinki.

Data collection

Data relating to each patient were entered on a standardised password protected Access® database (Microsoft, Redmond, WA, US) and analysed using Access® and Excel® (Microsoft) as specified in our previous publications.^{4,11,12} Data fields comprised demographic information (age and sex), mechanism of injury, time from injury to trauma centre admission, vital signs on admission (systolic blood pressure, heart rate) and details of the clinical examination including information on associated extra-abdominal injuries. The trauma scores recorded comprised the Glasgow coma scale, revised trauma score (RTS), abbreviated injury scale and injury severity score. Operative findings and associated intra-abdominal injuries, anatomic location and grade of the pancreatic injury, surgical procedure performed, operative time, postoperative course and length of hospital stay were recorded.

Definitions

Shock was defined as a systolic blood pressure of <90mmHg pre or intraoperatively. The severity of the pancreatic injury was graded according to the organ injury scaling system of the American Association for the Surgery of Trauma (AAST).¹⁴ Morbidity was considered for complications directly related to the pancreatic injury (eg bleeding from the pancreas, peripancreatic fluid collections and pancreatic fistulas). Peripancreatic fluid collections were diagnosed on computed tomography (CT). All patients' drain amylase levels were measured postoperatively. The International Study Group on Pancreatic Fistula (ISGPF) definition of drain amylase three times the normal serum amylase value on or after postoperative day 3 was used to determine a postoperative pancreatic fistula (POPF).¹⁵ The three ISGPF grades of POPF (A, B and C) were used. Infectious complications were defined in accordance with the Society of Critical Care Medicine guidelines.¹⁶ Septic shock was defined according to standard accepted criteria from the Society of Critical Care Medicine consensus statement.¹⁷ Abscesses were defined as purulent fluid collections that required surgical or percutaneous ultrasonography guided catheter drainage. Mortality was defined as any cause of death in hospital after a pancreatic injury.

Operative management of pancreatic injury

Initial resuscitation followed *Advanced Trauma Life Support*® guidelines. All patients in this study underwent an urgent laparotomy because of persisting shock with evidence of major intra-abdominal bleeding or an acute abdomen and signs of peritonitis. Operative management of the pancreatic injury

was according to a specific operative strategy, details of which have been described previously.^{4,12,15} In brief, the principles applied were urgent control of intra-abdominal bleeding, closure of visceral perforations to prevent contamination of the peritoneal cavity, and rapid volume replacement to correct acidosis, coagulopathy and hypothermia.

Minor lacerations of the body and tail of the pancreas remote from the pancreatic duct without visible duct damage were managed by external drainage. Major lacerations of the body or tail of the pancreas with likely duct injury were treated by distal pancreatectomy. Unstable patients or those *in extremis* with major associated organ and visceral vascular injuries had an initial damage control operation, which comprised a truncated laparotomy followed by continued resuscitation and correction of haemodynamic, metabolic and physiological defects in the intensive care unit (ICU), and definitive surgery at a subsequent operation.

Statistical analysis

Analysis of categorical variables used Pearson's chi-squared test and odds ratios (ORs) with 95% confidence intervals (CIs). When the Shapiro–Wilk test indicated that numerical variables were not normally distributed, the non-parametric Mann–Whitney U test or Student's t-test were used, when appropriate. Statistically significant variables that were potential risk factors were incorporated in the model for logistic regression analysis. A *p*-value of <0.05 was considered statistically significant. The data were analysed using Stata® 11 (StataCorp, College Station, TX, US).

Results

During the study period, 417 patients were treated for pancreatic injuries and 78 of these had stab wounds that involved the pancreas. The median age of the 78 patients was 26 years (range: 16–62 years). The vast majority (74/78, 95%) were men and the median RTS was 7.8 (range: 2.0–7.8). Twenty-two patients (28%) were in shock (systolic blood pressure <90mmHg) on admission to hospital.

Anatomical site and severity of injury

Eighteen patients had injuries of the proximal pancreas involving the head, neck or uncinate process of the pancreas, thirty-six had an injury of the body of the pancreas and twenty-four injuries involved the tail of the pancreas (Fig 1). Sixty-five patients (83%) had AAST grade I or II pancreatic injuries and thirteen (17%) had grade III, IV or V pancreatic injuries (Table 1).

Surgical management

Each of the 78 patients underwent a laparotomy. The median time to operation after admission to the trauma centre was 3 hours (range: 0.1–80 hours). Eight patients (10%) underwent urgent surgery for an acute abdomen or shock not responding to fluid resuscitation. Seventy patients were stable after the initial resuscitation. Seventeen of these had stab wounds involving the limbs, chest, neck and head, and underwent additional imaging before laparotomy.

Figure 1 Transection of the neck of the pancreas (arrow) following a stab wound

Associated injuries to other organs

Only 4 patients (5%) had an isolated pancreatic injury while the remaining 74 patients had 98 associated intra-abdominal injuries involving the liver ($n=34$, 45%), stomach ($n=34$, 45%), diaphragm ($n=24$, 32%), spleen ($n=13$, 17%), colon ($n=12$, 16%), duodenum ($n=7$, 9%) or kidney ($n=4$, 5%). Three-quarters ($n=58$, 78%) of the 74 patients had 1 or 2 associated injuries while 16 (22%) had 3 or more associated intra-abdominal injuries (Table 1).

Associated vascular injuries

A quarter ($n=18$, 23%) of the 78 patients had associated vascular injuries involving the inferior vena cava ($n=7$, 9%), left gastric artery ($n=2$), splenic artery ($n=2$), mesenteric vein ($n=2$), middle hepatic vein ($n=1$), aorta ($n=1$), portal vein ($n=1$), renal artery ($n=1$) and renal vein ($n=1$). An associated vascular injury did not correlate significantly with morbidity ($p<0.063$).

Surgery

The 78 patients had a total of 81 laparotomies to treat the pancreatic injuries. Eight patients (10%) with major pancreatic and associated injuries had initial damage control surgery (DCS) necessitated by major blood loss, acidosis, coagulopathy and hypothermia. Sixty-nine patients (85%) had drainage of the pancreas after haemostasis and four had a distal pancreatectomy as the primary procedure. Three patients underwent a secondary pancreatic procedure once stable, which included a pancreaticoduodenectomy, a distal pancreatectomy and splenectomy, and a distal pancreatectomy alone.

The 8 patients who underwent DCS had a median RTS of 5.4 (range: 2.0–7.8) and received a median of 17 (range: 4–32) units of blood. Seven of the eight patients were shocked on admission to hospital. Five patients also had associated vascular injuries and three had three or more adjacent organ injuries. During the damage control laparotomy, all eight patients had control of bleeding and drainage only. During a subsequent laparotomy, one patient with an AAST grade V pancreaticoduodenal injury required a pancreaticoduodenectomy. In the DCS group, two of the four survivors underwent one repeat laparotomy each. The 4 survivors each received a median of 16 (range: 4–28) units of blood.

Seven patients (9%) had injuries involving both the pancreas and duodenum. Two patients had AAST grade I pancreatic injuries, three had grade II pancreatic injuries, one had a grade IV pancreatic injury and one had a grade V pancreatic injury. One patient (mentioned previously) required a pancreaticoduodenectomy, and in the remaining six patients, the pancreatoduodenal injuries were treated with primary duodenal repair, intraluminal duodenal tube drainage, a feeding jejunostomy and closed suction drainage of the pancreas.

Morbidity

Eighteen patients (23%) required ICU admission. The median ICU and total hospital stay was 4 days (range: 1–41 days) and 8 days (range: 1–149 days) respectively. Forty-one patients (53%) did not have postoperative complications and

Table 1 AAST (American Association for the Surgery of Trauma) grade of pancreatic injury and associated injuries and morbidity

AAST grade	Associated abdominal injuries			Associated vascular injuries	Systemic complications	Intra-abdominal complications	Pancreatic complications
	0	1, 2	3+				
I ($n=43$)	2*	34	7	5 (12%)	8 (19%)	3 (7%)	2 (5%)
II ($n=22$)	2*	15	5	10 (46%)	13 (59%)	4 (18%)	3 (14%)
III ($n=10$)	0	8	2	1 (10%)	5 (50%)	6 (60%)	10 (100%)
IV ($n=2$)	0	1	1	1 (50%)	2 (100%)	1 (50%)	0 (0%)
V ($n=1$)	0	0	1	1 (100%)	1 (100%)	1 (100%)	0 (0%)

*4 isolated pancreatic injuries

had a median hospital stay of 6 days (range: 4–11 days). Of the remaining 37 patients (47%), 29 had systemic complications, 15 intra-abdominal complications and 15 pancreas specific complications. The systemic complications included pneumonia ($n=9$), atelectasis ($n=7$), acute respiratory distress syndrome ($n=3$), pleural effusion ($n=3$), sepsis ($n=4$), disseminated intravascular coagulopathy ($n=3$), bleeding ($n=5$) and renal failure ($n=2$). The 15 intra-abdominal complications included subphrenic abscess ($n=8$), enterocutaneous fistula ($n=3$), bowel obstruction ($n=2$), gastric outlet obstruction ($n=2$), anastomotic leak ($n=2$), bile leak ($n=3$) and wound sepsis ($n=2$). The median hospital stay for patients with complications was 13 days (range: 1–149 days), which was significantly longer than for those without complications ($p<0.05$) (Table 2).

There was no significant difference between the sites of the pancreatic injury (head and neck vs body vs tail) with regard to general complications ($p=0.673$). In contrast, the pancreatic injury grade had a significant influence on the development of general complications (AAST grade I–II vs grade III–V injuries, $p<0.001$) (Table 2).

Eight patients (10%) developed a pancreatic fistula as a complication of the pancreatic injury. Five pancreatic fistulas resolved spontaneously on conservative management alone after a median of 4.4 weeks (range: 1–6 weeks). Three persistent fistulas required endoscopic intervention with retrograde cholangiopancreatography, pancreatic duct sphincterotomy and pancreatic duct stenting with placement of a 7Fr pancreatic duct stent, and these resolved within ten days. Three patients had symptomatic pancreatic fluid collections identified on CT, which resolved after treatment with percutaneous ultrasonography catheter drainage. Three patients presented subsequently after discharge with a symptomatic pancreatic pseudocyst, which was treated with endoscopic pseudocyst drainage (Fig 2). Most pancreas related complications occurred in patients with AAST grade III injuries (Table 2).

Factors associated with morbidity

Increasing RTS, presence of shock, the need for a blood transfusion and volume of blood transfused, AAST grade of injury and the need for a repeat laparotomy were significant predictors of morbidity on univariate analysis (Table 2). Surprisingly, there was no significant association between likelihood of morbidity and need for DCS, associated abdominal injuries or vascular injuries. A likely explanation is that although there was a trend, the small numbers in the samples did not achieve statistical significance. Similarly, controlling for all confounders, the multivariate analysis did not show a significant association between the risk factors because of a lack of statistical power.

Mortality

Mortality correlated with pancreatic injury severity. The mortality rate for grade I, II and III injuries was 1.3% compared with 100% for grade IV and V injuries. Four (5.1%) of the seventy-eight patients died. All four (median RTS: 4.9, range: 2.0–7.8) had initial DCS. Three of these were

shocked on admission with a systolic blood pressure of <90 mmHg. In the first of the four deaths, a 19-year-old man underwent repair of a right renal vein and inferior vena cava laceration during initial DCS. He had a pancreaticoduodenectomy for a grade V pancreatic injury 4 days later but required further laparotomies for sepsis 6, 15 and 17 days later. He developed acute respiratory distress syndrome due to a multidrug resistant *Acinetobacter* and *Pseudomonas*, and died of multiorgan failure.

The second patient who died, a 25-year-old man, arrived shocked and hypothermic, and underwent DCS to control bleeding from stab wounds to the inferior vena cava, liver, duodenum and pancreas. Despite transfusion of 14 units of blood and control of bleeding, he died of multiorgan failure.

The third patient, a 30-year-old man, arrived intubated and ventilated with a gunshot injury to the head, chest and leg as well as an abdominal stab wound. He had a thoracotomy to control bleeding from the lung, and a laparotomy to suture gastric perforations and drain a grade II laceration of the body of the pancreas. He died subsequently as a result of the gunshot injury to his head.

The fourth patient who died, a 30-year-old man, was shocked on arrival at hospital. He underwent initial DCS with pack control of a bleeding grade IV liver injury as well as DCS for a grade V duodenal injury, a grade IV pancreatic injury and a grade IV colonic injury. Two days later, the duodenum and colon were repaired, and the pancreatic injury was drained. He had 3 further laparotomies to drain sepsis 4, 10 and 13 days later but died of multiple organ failure 17 days after the initial injury. Four of the eight patients who had DCS died (mean: 10 days, median: 9.5 days, range: 1–20 days).

Discussion

The data in this study reflect the largest single centre evaluation of the consequences of stab wounds of the pancreas. They show that while mortality was low, morbidity was high. Most stab wounds of the pancreas resulted in AAST grade I and II injuries, which were minor, whereas the minority had major AAST grade III, IV and V injuries. Almost all patients had associated intra-abdominal injuries owing to the close anatomical relationship of surrounding organs and vital visceral veins. As a consequence, a fifth of patients had at least three associated intra-abdominal organ injuries.

Complications associated with pancreatic trauma in this study increased exponentially as the grade of injury advanced. Other significant predictors of morbidity in this study were increasing RTS, shock on admission to hospital, amount of blood loss, need for transfusion, blood volume transfused and the requirement for a repeat laparotomy. Several investigators have reported an increased incidence of infectious complications following pancreatic trauma when associated with hollow viscus injuries, particularly colon injuries.^{1,6} All patients in the current series who developed wound infections or intra-abdominal abscesses had associated intestinal or liver injuries.

Table 2 Univariate analysis of factors associated with overall morbidity

	All patients (n=78)	Patients with complications (n=37)	Patients with no complications (n=41)	p-value	OR	95% CI
Sex						
Male	74	34 (91.9%)	40 (97.6%)	0.257	0.28	0.03–2.85
Female	4	3 (8.1%)	1 (2.4%)			
Mean age (SD)	28.36 (8.97)	27.76 (7.22)	28.90 (10.36)	0.996	–	–
Median age (range)	26.5 (16–62)	26 (18–49)	27 (16–62)			
Revised trauma score				0.007	5.01	1.46–17.19
2.0–7.2	17	13 (35.1%)	4 (9.8%)			
7.8	61	24 (64.9%)	37 (90.2%)			
Presence of shock				0.022	3.31	1.16–9.42
Yes	22	15 (40.5%)	7 (17.1%)			
No	56	22 (59.5%)	34 (82.9%)			
Patients transfused				<0.001	6.46	2.40–17.40
Yes	35	25 (67.6%)	10 (24.4%)			
No	43	12 (32.4%)	31 (75.6%)			
Median blood transfused in units (range)	8 (1–32)	9 (2–32)	2.5 (1–8)	0.001	–	–
Damage control surgery				0.099	3.77	0.71–20.02
Yes	8	6 (16.2%)	2 (4.9%)			
No	70	31 (83.8%)	39 (95.1%)			
AAST grade				<0.001	*	–
I, II	65	24 (64.9%)	41 (100%)			
III, IV, V	13	13 (35.1%)	0 (0%)			
Pancreatic injury site				1.0	1.0	0.29–3.39
Head and neck	18	9 (24.3%)	9 (21.9%)			
Body	36	16 (43.2%)	20 (48.8%)			
Tail	24	12 (32.4%)	12 (29.3%)			
Associated abdominal injuries				0.176	2.16	0.70–6.69
0–2 organs**	62	27 (73.0%)	35 (85.4%)			
≥3 organs	16	10 (27.0%)	6 (14.6%)			
Associated injured organs				0.153	0.52	0.21–1.28
Liver	34	13 (35.1%)	21 (51.2%)			
Stomach	34	15 (40.5%)	19 (46.3%)			
Diaphragm	24	12 (32.4%)	12 (29.3%)			
Spleen	13	9 (24.3%)	4 (9.8%)			
Colon	12	7 (18.9%)	5 (12.2%)			
Duodenum	7	4 (10.8%)	3 (7.3%)			
Kidney	4	3 (8.1%)	1 (2.4%)			
Patients with associated vascular injuries				0.063	2.8	0.93–8.46
Yes	18	12 (32.4%)	6 (14.6%)			
No	60	25 (67.6%)	35 (85.3%)			
Repeat laparotomy				<0.001	*	–
Yes	16	16 (43.2%)	0 (0%)			
No	62	21 (56.8%)	41 (100%)			
Median total LOS in days (range)	9 (1–149)	13 (1–149)	7 (4–11)	<0.001	–	–
ICU admission				0.003	5.63	1.65–19.21
Yes	18	14 (37.8%)	4 (9.8%)			
No	60	23 (62.2%)	37 (90.2%)			
Median ICU LOS in days (range)	8.5 (1–41)	16 (1–41)	2.5 (1–4)	0.062	–	–
Outcome				0.046	*	–
Alive	74	33 (89.2%)	41 (100%)			
Died	4	4 (10.8%)	0 (0%)			

OR = odds ratio; CI = confidence intervals; SD = standard deviation; AAST = American Association for the Surgery of Trauma;
LOS = length of stay; ICU = intensive care unit
*Exact confidence levels not possible with zero count cells
**Four patients had an isolated pancreatic injury

In the present study, the overall mortality rate was 5% and half the deaths were in patients who were shocked with major associated vascular injuries. Other investigators have reported major bleeding from associated vascular injuries to be a significant factor in early deaths.^{1,6,10,11} In our study, a quarter of patients had vascular injuries compared with a third of patients with associated vascular trauma in other studies.^{1,10,11,20,25} In this study, early mortality resulted from uncontrolled bleeding or severe

The anatomical and physiological complexities found in combined injuries of the pancreas and duodenum have prompted a selection of operative methods of treatment ranging from simple closure and drainage to complex procedures involving attempts to defunction the duodenum.^{11,26-28} As a result of the wide range of possible injuries, no one method or formula can be applied consistently to all pancreatoduodenal injuries.^{26,29} Our data confirm that combined pancreatoduodenal injuries often occur in conjunction with multiple other intra-abdominal injuries. Owing to the large number of injury permutations involving the pancreas and duodenum, no one form of therapy is appropriate for all patients.^{30,31} As shown in our study, the duodenal injuries were managed by careful tissue debridement, primary repair using a single layer of interrupted absorbable sutures, and both intraluminal tube decompression and external drainage, thereby avoiding complex reconstructive procedures during the acute injury.³²

Study limitations

Several limitations are evident when interpreting the results of this study. Our analysis is based on a select high risk surgical cohort at a single tertiary referral academic centre and the cohort is therefore unlikely to be representative of admissions to community-based hospitals. Another concern is that intensive care management of patients who have undergone surgery for major pancreatic trauma has advanced substantially since the inception of this study. These changes should not, however, have influenced data analysis as this was a longitudinal cohort study.

An additional substantive limitation is that although this study is the largest of its kind to date, the sample size of the group with AAST grade III–V pancreatic injuries was relatively small, which increases the possibility of a type 2 error. On the other hand, a strength enhancing the robustness of the data is that the study was conducted in a single centre in a defined and homogenous population of consecutive patients using uniform entry criteria.

Conclusions

Our analysis showed that although mortality was low after pancreatic stab wounds, morbidity was high. Significant predictors of morbidity in this study were an increasing AAST grade of pancreatic injury, a high RTS, shock on admission to hospital, the need for a blood transfusion and a repeat laparotomy. The majority of patients in this study had grade I or II pancreatic injuries with neither substantial tissue loss nor a main duct injury and after control of bleeding they were treated effectively with external drainage alone. More advanced grade injuries of the body and tail were managed by resection. It should be stressed that these conclusions apply specifically to civilian stab wounds of the pancreas and cannot be extrapolated to other mechanisms of pancreatic injury.

References

- Vasquez JC, Coimbra R, Hoyt DB, Fortlage D. Management of penetrating pancreatic trauma: an 11-year experience of a level-1 trauma center. *Injury* 2001; **32**: 753–759.
- Subramanian A, Dente CJ, Feliciano DV. The management of pancreatic trauma in the modern era. *Surg Clin North Am* 2007; **87**: 1,515–1,532.
- Chrysos E, Athanasakis E, Xynos E. Pancreatic trauma in the adult: current knowledge in diagnosis and management. *Pancreatol* 2002; **2**: 365–378.
- Chinnery GE, Krige JE, Kotze UK *et al*. Surgical management and outcome of civilian gunshot injuries to the pancreas. *Br J Surg* 2012; **99 Suppl 1**: 140–148.
- Krige JE, Beningfield SJ, Nicol AJ, Navsaria P. The management of complex pancreatic injuries. *S Afr J Surg* 2005; **43**: 92–102.
- Young PR, Meredith JW, Baker CC *et al*. Pancreatic injuries resulting from penetrating trauma: a multi-institution review. *Am Surg* 1998; **64**: 838–843.
- Al-Ahmadi K, Ahmed N. Outcomes after pancreatic trauma: experience at a single institution. *Can J Surg* 2008; **51**: 118–124.
- Ankouz A, Elbouhadouti H, Lamrani J *et al*. Pancreatic transection due to blunt trauma. *J Emerg Trauma Shock* 2010; **3**: 76–78.
- Scolley JM, Yip VS, Garden OJ, Parks RW. A population-based study of pancreatic trauma in Scotland. *World J Surg* 2006; **30**: 2,136–2,141.
- Kao LS, Bulger EM, Parks DL *et al*. Predictors of morbidity after traumatic pancreatic injury. *J Trauma* 2003; **55**: 898–905.
- Ivatury RR, Nallathambi M, Rao P, Stahl WM. Penetrating pancreatic injuries. Analysis of 103 consecutive cases. *Am Surg* 1990; **56**: 90–95.
- Farrell RJ, Krige JE, Bornman PC *et al*. Operative strategies in pancreatic trauma. *Br J Surg* 1996; **83**: 934–937.
- Krige JE, Kotze UK, Hameed M *et al*. Pancreatic injuries after blunt abdominal trauma: an analysis of 110 patients treated at a level 1 trauma centre. *S Afr J Surg* 2011; **49**: 58, 60, 62–64.
- Moore EE, Cogbill TH, Malangoni MA *et al*. Organ injury scaling, II: Pancreas, duodenum, small bowel, colon, and rectum. *J Trauma* 1990; **30**: 1,427–1,429.
- Bassi C, Dervenis C, Butturini G *et al*. Postoperative pancreatic fistula: an international study group (ISGPF) definition. *Surgery* 2005; **138**: 8–13.
- Bone RC, Balk RA, Cerra FB *et al*. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Chest* 1992; **101**: 1,644–1,655.
- Dellinger RP, Levy MM, Carlet JM *et al*. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock: 2008. *Crit Care Med* 2008; **36**: 296–327.
- Heitsch RC, Knutson CO, Fulton RL, Jones CE. Delineation of critical factors in the treatment of pancreatic trauma. *Surgery* 1976; **80**: 523–529.
- Antonacci N, Di Saverio S, Ciaroni V *et al*. Prognosis and treatment of pancreaticoduodenal traumatic injuries: which factors are predictors of outcome? *J Hepatobiliary Pancreat Sci* 2011; **18**: 195–201.
- Hwang SY, Choi YC. Prognostic determinants in patients with traumatic pancreatic injuries. *J Korean Med Sci* 2008; **23**: 126–130.
- Recinos G, DuBose JJ, Teixeira PG *et al*. Local complications following pancreatic trauma. *Injury* 2009; **40**: 516–520.
- Smego DR, Richardson JD, Flint LM. Determinants of outcome in pancreatic trauma. *J Trauma* 1985; **25**: 771–776.
- Akhrass R, Yaffe MB, Brandt CP *et al*. Pancreatic trauma: a ten-year multi-institutional experience. *Am Surg* 1997; **63**: 598–604.
- Lewis G, Krige JE, Bornman PC, Terblanche J. Traumatic pancreatic pseudocysts. *Br J Surg* 1993; **80**: 89–93.
- Funnell IC, Bornman PC, Krige JE *et al*. Endoscopic drainage of traumatic pancreatic pseudocyst. *Br J Surg* 1994; **81**: 879–881.
- Moore JB, Moore EE. Changing trends in the management of combined pancreatoduodenal injuries. *World J Surg* 1984; **8**: 791–797.
- Jones RC. Management of pancreatic trauma. *Ann Surg* 1978; **187**: 555–564.
- Talving P, Nicol AJ, Navsaria PH. Civilian duodenal gunshot wounds: surgical management made simpler. *World J Surg* 2006; **30**: 488–494.
- Timaran CH, Martinez O, Ospina JA. Prognostic factors and management of civilian penetrating duodenal trauma. *J Trauma* 1999; **47**: 330–335.
- Feliciano DV, Martin TD, Cruse PA *et al*. Management of combined pancreatoduodenal injuries. *Ann Surg* 1987; **205**: 673–680.
- Krige JE, Beningfield SJ, Bornman PC. Management Strategies in Pancreatic Trauma. In: Johnson C, Taylor I. *Recent Advances in Surgery* 29. London: Royal Society of Medicine Press; 2006. pp95–118.
- Rickard MJ, Brohi K, Bautz PC. Pancreatic and duodenal injuries: keep it simple. *ANZ J Surg* 2005; **75**: 581–586.