Western Trauma Association Critical Decisions in Trauma: Management of pancreatic injuries

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The Western Trauma Association (WTA) develops algorithms to provide guidance and recommendations for particular practice areas but does not establish the standard of care. The WTA algorithms are based on the evidence available in the literature and the expert opinion of the task force in the recent time frame of the publication. The WTA considers use of the algorithm to be voluntary. The ultimate determination regarding its application is to be made by the treating physician and health care professionals with full consideration of the individual patient's clinical status as well as available institutional resources; it is not intended to take the place of health care providers' judgment in diagnosing and treating particular patients.

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This is a recommended management algorithm from the Western Trauma Association addressing the diagnostic evaluation and management of pancreatic injuries in adult patients. Because there is a paucity of published prospective randomized clinical trials that have generated Class I data, the recommendations herein are based primarily on published observational studies and expert opinion of Western Trauma Association members. The algorithm (Fig. 1) and accompanying comments represent a safe and sensible approach that could be followed at most trauma centers. We recognize that there will be patient, personnel, institutional, and situational factors that may warrant or require deviation from the recommended algorithm. We encourage institutions to use this guideline to formulate their own local protocols.

The algorithm contains letters at decision points; the corresponding paragraphs in the text elaborate on the thought process and cite the pertinent literature. The annotated algorithm is intended to (*a*) serve as a quick bedside reference for clinicians; (*b*) foster more detailed patient care protocols that will allow for prospective data collection and analysis to identify best practices; and (*c*) generate research projects to answer specific questions concerning decision making in the management of adults with pancreatic injuries.

Injuries to the pancreas present a significant challenge, for a number of reasons. First, while the deep, central position of the pancreas affords the organ some degree of protection, its retroperitoneal location confounds the clinical detection of injury. Second, physiologic functions contribute to a disturbingly high incidence of complications following injury, and morbidity is exacerbated by delays in diagnosis and treatment. Third, the infrequency of these injuries has resulted in a lack of significant management experience among practicing trauma surgeons. Consequently, trauma to the pancreas is associated with relatively poor outcomes that have not improved significantly during the past two decades, despite advances in trauma and critical care management.[1]

ANNOTATED TEXT FOR THE ALGORITHM

A. Pancreatic injuries are generally recognized either by computed tomographic (CT) scan or at exploratory laparotomy (LAP). Patients who have abdominal pain or tenderness or

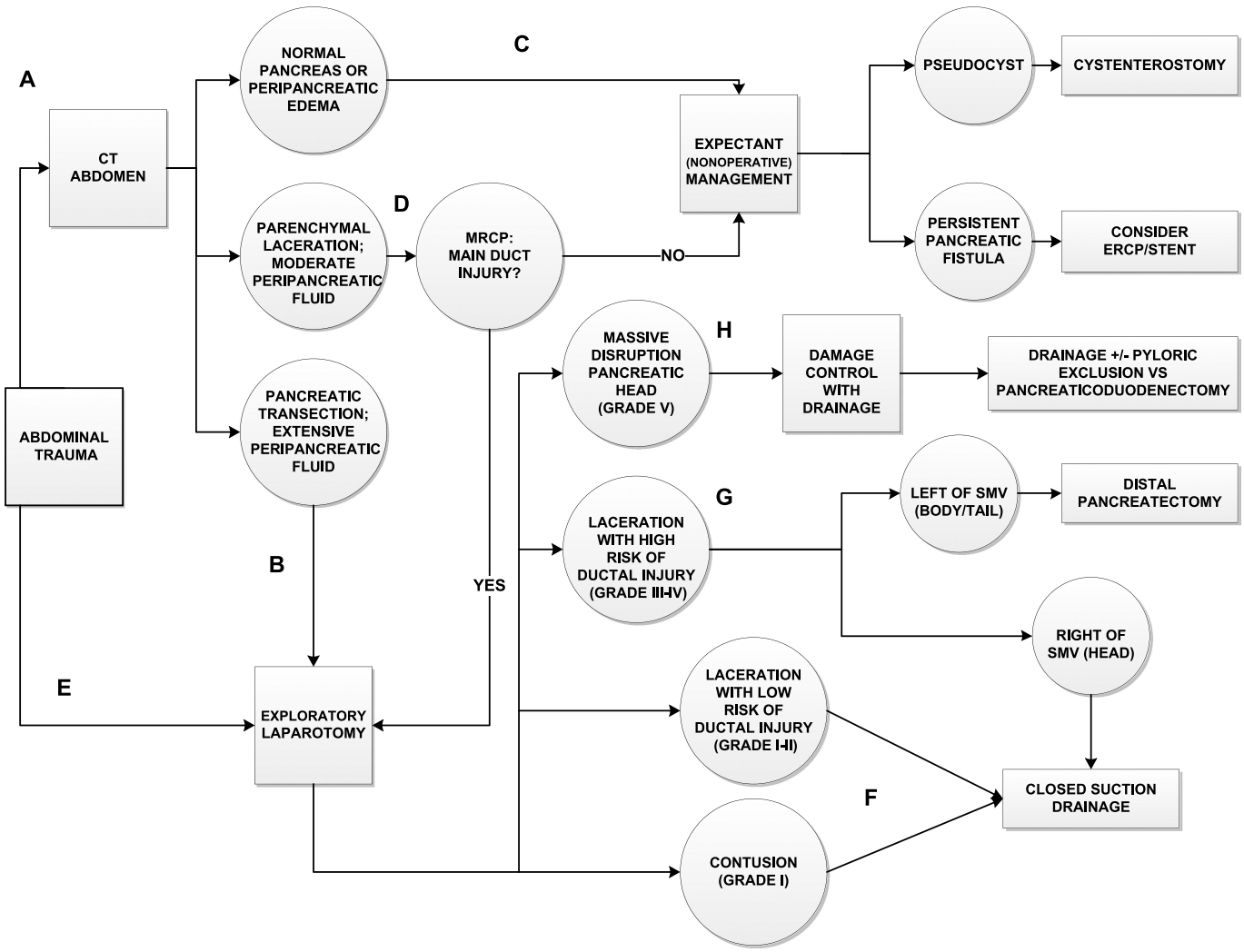

Figure 1. Western Trauma Association management algorithm for pancreatic injuries.

TABLE 1. AAST Pancreas Organ Injury Scale

Grade*		Injury Description
I	Hematoma	Major contusion without duct injury or tissue loss
	Laceration	Major laceration without duct injury or tissue loss
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference
III	Laceration	Distal transection or parenchymal injury with duct injury
IV	Laceration	Proximal (to right of superior mesenteric vein) transection or parenchymal injury
V	Laceration	Massive disruption of pancreatic head

*Advance one grade for multiple injuries to the same organ.
Adapted from Moore et al[7] with permission from Lippincott Williams & Wilkins.

who have sustained a high-risk injury mechanism should undergo abdominal CT scan at the time of presentation. Patients who later develop abdominal pain or tenderness need further evaluation. Leukocytosis, unexplained metabolic acidosis, or fever may also herald an occult injury. The utility of serum amylase and lipase assays has been debated, and enzyme levels should not be relied upon to either diagnose or exclude pancreatic injury. The noninvasive diagnosis of pancreatic injuries can be challenging. The primary nonoperative diagnostic modality for pancreatic injury is CT scanning. Findings may be subtle, particularly when the imaging is performed within 12 hours of injury.[2] Specific signs of injury include fractures or lacerations of the pancreas, active hemorrhage from the gland, or contusion, edema or hematoma of the parenchyma. Nonspecific findings include peripancreatic blood or fat stranding.[2] The reported sensitivity and specificity of earlier-generation helical CT scan for pancreatic injuries was in the range between 70% and 80%.[2,3] Subsequent data suggested that multidetector row CT (MDCT), with imaging timed during the portal venous phase, could achieve 100% accuracy of not only pancreatic injuries but also pancreatic ductal injuries.[4] However, a recent American Association for the Surgery of Trauma (AAST) multicenter study questions the accuracy of 16- and 64-MDCT for detecting pancreatic injury in general and pancreatic ductal injury specifically. Although specificity was better than 90%, the sensitivity of MDCT for either injury was only 47% to 60%.[5] Ultimately, the accuracy of CT is dependent on not just the technology but also the technique, the timing after injury, and the skills of the interpreting clinician. In the face of a normal initial CT scan, if a pancreatic injury is clinically suspected, CT should be repeated.

B. CT scan evidence of pancreatic transection or extensive peripancreatic fluid warrants LAP. These findings are associated with a higher risk of pancreatic ductal disruption, which is the major determinant of prognosis.[1]

C. With liberal application of sensitive MDCT imaging, many low-grade injuries are diagnosed in patients who have no other indications for LAP. While recognizing that most of the related morbidity is caused by ductal disruption, nonoperative management (NOM) has been suggested for low-grade injuries. Most of the literature to date has been pertained to pediatric patients. A case series from Toronto reported feasibility and safety of the approach.[6] Among 25 patients who presented early after injury, 14 had contusions (AAST-Organ Injury Scale grade was not reported, Table 1[7]), of whom 2 developed pseudocysts, which resolved spontaneously. The other 11 patients had lacerations or transections; 5 of them developed pseudocysts, of whom 4 required drainage. More recently, studies have compared outcomes of patients managed with operation (OM) versus NOM, including Grade IV injuries.[8,9] Overall length of stay did not differ in either series. Wood et al.[8] reported that after OM, 21% had pancreatic complications, 57% had nonpancreatic complications, and 11% were readmitted. In contrast, in the group undergoing NOM, 73% had pancreatic complications, 20% had nonpancreatic complications, and 40% were readmitted. Complication rates were higher among those with endoscopic retrograde cholangiopancreatography (ERCP)–proven duct injuries. In the multicenter experience reported by Paul and Mooney,[9] length of stay was not different between OM and NOM. Morbidity was 45% after OM and 35% with NOM. Among the patients in the OM group, 15% developed pseudocysts, 10% developed fistulae, and 15% developed reoperations. In the NOM group, 35% developed pseudocysts. The interpretation of the data is confounded by selection bias, whereby the less severely injured were more likely to undergo NOM, and thus, prospective studies with long-term outcomes are warranted. There is not a great deal of literature in adults, but the approach seems safe. Duchesne et al.[10] suggest that patients with apparent Grade I or II injuries could be managed nonoperatively if ductal disruption is excluded by magnetic resonance cholangiopancreatography (MRCP) or ERCP. Of 35 patients managed in this way, 5 (14%) failed, 3 with pancreatic abscess and 2 with missed bowel injuries. In the multicenter trial of New England trauma centers,[11] 69 (41%) of 170 patients with pancreatic or combined pancraticoduodenal injuries (96% were Grade I or II) were managed nonoperatively, with 7 (10%) failing. The recurring themes in the reports of NOM are that (*a*) it is safe to manage patients with Grade I and II injuries nonoperatively; (*b*) it is important to identify Grade III injuries or higher, that is, main pancreatic ductal disruption; and (*c*) distal main ductal disruptions are best managed operatively to avoid pancreatic duct–related complications.

In sum, with MDCT having a specificity of better than 90%,[4,5] it seems reasonable to pursue NOM in the asymptomatic or minimally symptomatic patient with no or nonspecific findings of pancreatic injury on CT scan. Worsening symptoms

or clinical condition warrants repeat CT scanning, and new evidence of high-grade pancreatic injury or other operative lesions should prompt consideration of LAP. Peripancreatic fluid collections or other nonspecific findings should be addressed based on the expertise and resources of the trauma team and institution. Peripancreatic fluid collections may be drained operatively or percutaneously. Evaluation of the pancreatic duct may reveal a Grade III injury. The decision to proceed to LAP versus endoscopic management depends on local expertise and resources. Several small case series have suggested encouraging results of early endoscopic transpapillary pancreatic duct stenting;[12,13] however, Lin et al.[14] identified a consistent occurrence of major ductal strictures and noted that in their institution, operative management had a lower complication rate. In contrast, endoscopic transpapillary pancreatic duct stenting may be effective in managing later complications of duct injuries.[12] Large pancreatic pseudocysts may be treated with endoscopic stenting or cyst enterostomy. Pancreatic fistulae will require drainage.

D. In between those with obvious indications for LAP and those with minor injuries, the paucity of data in this area hampers the creation of firm guidelines. The following several factors influence the decision making: (1) CT scan is not completely accurate in identifying duct injuries (Grade III);[5] (2) higher-grade injuries are associated with greater morbidity and mortality;[15] and (3) delays to intervention are associated with greater morbidity.[15] Consequently, the most conservative approach would be to attempt to exclude main duct injury early; thus, patients with CT or clinical evidence suggesting possible ductal injury, if not undergoing LAP, should have MRCP or ERCP. As it is noninvasive, MRCP is preferred for diagnosis.[12,16,17] If there is a Grade III injury or higher, the patient should undergo LAP. This recommendation is based on the better outcomes reported with surgery versus early endoscopic transpapillary pancreatic duct stenting[14] and the possibility of missed hollow viscus injuries.[10]

E. It is critical that thorough exploration and examination of the pancreas and duodenum are performed during LAP, particularly when there is a retroperitoneal hematoma, bile staining, fat necrosis, or edema in the supramesocolic region. Intraoperative evaluation of the duodenum and head of the pancreas begins with full mobilization achieved by the Kocher maneuver to the midline with coincident mobilization and medial rotation of the hepatic flexure of the colon. This provides exposure of the anterior and posterior surfaces of the second and third portions of the duodenum as well as the head and uncinate process of the pancreas. The body and tail of the pancreas are examined by a division of the gastrocolic ligament and reflection of the stomach cephalad. Insertion of a curved retractor in the lesser sac allows full inspection of the anterior surface of the pancreas from the head to tail and from superior to inferior surfaces. In cases of extensive hemorrhage in the region of the neck of the pancreas suspected to originate from the juncture of the portal vein behind the pancreas, the pancreas should be divided without hesitation. A stapling device will allow for rapid exposure of the injured vessel and hemorrhage control of the pancreas. Further exposure of the posterior surface of the pancreas is accomplished by division of the retroperitoneal attachments along the inferior border of the pancreas and retraction of the pancreas cephalad. Additional mobilization of the spleen and reflection of the spleen and tail of the pancreas from the left to the midline is a useful technique for further evaluation of the remaining areas of the pancreas. Most injuries sustained in penetrating trauma will be discovered with direct exploration.

F. Grade I and II. When Grade I and II injuries are discovered intraoperatively, the vast majority can be treated with no more than surgical hemostasis and drainage.[18–20] Even capsular tears that are not bleeding are not repaired and may be simply drained with closed suction drainage. Drainage is used liberally because many minor appearing injuries will drain for several days. Unnecessary attempts at repair of lacerations without evidence of ductal disruption can result in late pseudocyst formation, whereas the vast majority of controlled, minor pancreatic fistulae are self-limited and easily managed with soft closed suction drains. The drains are usually removed within a few days, as long as the amylase concentration in the drain is less than that of serum. If amylase levels are elevated, drainage is continued until there is no further evidence of pancreatic leak. Prolonged gastric ileus is common with even minor pancreatic injuries, so enteral access with a jejunostomy feeding tube should be considered in the setting of Grade II injuries or higher. Since the composition of most standard tube feeding increases the pancreatic effluent volume and amylase concentration, lower fat and higher pH (4.5) elemental diets are less stimulating to the pancreas and are particularly well suited for use in needle catheter jejunostomies.[21]

G. Grade III Distal transection or parenchymal injury with main pancreatic duct disruption are best managed operatively to prevent pancreatic ascites or a major fistula. Most ductal injuries can be identified by either preoperative studies in the stable patient or intraoperatively. The anatomic division between the head and body of the pancreas is the neck, where the superior mesenteric artery (SMA) and superior mesenteric vein (SMV) pass behind the pancreas. This anatomic division will provide an estimated 50% of pancreatic tissue. Management decisions are based on the anatomic location of the parenchymal and duct injury (i.e., proximal vs. distal). Ductal injuries at or distal to the neck are treated definitively with distal pancreatectomy.[22,23] In the vast majority of patients, distal resection should leave no concern for later pancreatic endocrine or exocrine function. Intraoperative ductography does not seem to be warranted, as the Memphis group has recently demonstrated that clinical assessment can determine high versus low risk of main ductal injury.[23] Patients felt to be at high risk of ductal disruption undergo distal pancreatectomy, while those at low risk are managed with closed suction drains.[23] In the Memphis experience, morbidity

seems to have decreased owing to a reduction in pancreatic resections.[24]

The major morbidity following distal resection is pancreatic fistula, which is in turn associated with infectious and metabolic complications. The optimal surgical technique to avoid fistula has yet to be identified. In fact, a recent prospective randomized trial found equivalent rates of pancreatic fistula following stapled (36%) compared with hand-sewn (37%) resection.[25]

Grade IV. The Memphis group has also promoted drainage alone for duct injuries in the pancreatic head.[23,24] Simple drainage is associated with pancreas-related morbidity rates of less than 15%. However, the effectiveness of this technique with major ductal injury remains to be established.

H. Grade V. Fortunately rarely encountered, these injuries may require pancreaticoduodenectomy. Indications for this procedure generally include massive unreconstructable injury to the head of the pancreas, including the intrapancreatic bile duct and proximal main pancreatic duct, and avulsion of the ampulla of Vater from the duodenum with destruction of the second portion of the duodenum. Although it has been suggested that pancreaticoduodenectomy can be performed with reasonably good outcomes,[26] these injuries are usually encountered with the patient in poor physiologic condition, so the principles of damage control initially apply.[27] Indeed, Seamons et al.[28] recently reinforced the concept that pancreatic resection during damage control is ill advised. Once the patient condition improves, the reconstruction is performed. In addition to improved physiologic status, there are tissue changes that facilitate reconstruction. Pancreatogastrostomy reconstruction may be preferable to pancreaticojejunostomy in these circumstances, for physiologic and anatomic reasons.[29] One must also be mindful of the potential for complications if stents are used.[30]

Grade IV and V pancreatic injuries are often combined with duodenal injuries. The pyloric exclusion procedure as described by Vaughan et al.[31] is preferred. The duodenal injury is repaired and is "protected" by gastric diversion. To accomplish this, a gastrotomy is created along the greater curve of the stomach adjacent to the pylorus, the pylorus is oversewn from the inside with nonabsorbable monofilament suture, and a gastrojejunostomy is created with a loop of jejunum. A long jejunal limb should be used to prevent reflux of enteric contents to the duodenum. If a fistula develops, it is a functional end duodenal fistula, which is usually easier to manage than a higher output lateral fistula. A jejunostomy is used in this setting to ensure a route for enteral nutrition. Even in the setting of an end fistula, the patient will often tolerate an oral diet after 10 days to 14 days. The pylorus usually opens within 6 weeks to 12 weeks; therefore vagotomy is not usually performed.

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DISCLOSURE

The authors declare no conflicts of interest.

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