

Emergency physicians should be aware of the ongoing changes in their practices and publish observations on what they believe are clinical changes in presentation of illness or injury due to atmospheric changes. In addition, the emergency physician must lobby to decrease the problem by the increased pollution controls and decrease fossil fuel consumption. The U.S. Environmental Protection Agency can't do it alone.¹¹ The world will only become more congested, and we all have to breathe the same recirculated air in our room called earth.

References

1. Chameides WL, Saylor RD, Cowling EB. Ozone pollution in the rural United States and the new NAAQS. *Science* 1997;276(5314):916.
2. Wilkening KE, Barrie LA, Engle M. Trans-Pacific air pollution. *Science* 2000;290(5489):65.
3. Finlayson-Pitts BJ, Pitts Jr. JN. Tropospheric air pollution: ozone, airborne toxics, polycyclic aromatic hydrocarbons, and particles. *Science* 1997;276(5315):1045.
4. Kaiser J. Evidence mounts that tiny particles can kill. *Science* 2000;289(5476):22.
5. Health effects of outdoor air pollution. Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society. *Am J Respir. Crit Care Med* 1996;153(1):3-50.
6. Hrubá F, Fabianová E, Koppová K, Vandenberg JJ. Childhood respiratory symptoms, hospital admissions, and long-term exposure to particulate matter. *J Expo Anal Environ Epidemiol*, 2001;11(1):33-40.
7. Bunker J, Krahl J, Baum K, Schroder O, Muller M, Westphal G, Ruhna P, Schulz TG, Hallier E. Cytotoxic and mutagenic effects, particle size and concentration analysis of diesel emissions using biodiesel and petrol diesel as fuel. *Arch Toxicol* 2000;74(8):490-8.
8. Peters A, Dockery DW, Muller JE, Mittleman MA. Increased particulate air pollution and the triggering of myocardial infarction. *Circulation* 2001;103(23):2810.
9. Petroschevsky A, Simpson RW, Thalib L, Rutherford S. Associations between outdoor air pollution and hospital admissions in Brisbane. *Arch Environ Health* 2001;56(1):37-52.
10. Ibaldo-Mulli A, Stieber J, Wichmann HE, Koenig W, Peters A. Effects of air pollution on blood pressure: a population-based approach. *Am J Public Health* 2001;91(4):571-7.
11. Kaiser J. Panel backs EPA and 'Six Cities' study. *Science* 2000;289(5480):711.

Original Research

Clinical Findings in Patients with Splenic Injuries: Are Injuries to the Left Lower Chest Important?

Aaron Schneir, MD*
James F. Holmes, MD†

* Division of Emergency Medicine,
UC San Diego School of Medicine and
† Division of Emergency Medicine,
UC Davis School of Medicine

Abstract: The purpose of this study was to describe the clinical findings in patients with splenic injury and to determine if isolated left lower chest injury may be the single clinical indicator of splenic injury. The medical records of all adult blunt trauma patients with splenic injury over a 14 month period were reviewed. Significant left lower chest injury was considered present if the patient had left sided pleuritic chest pain with tenderness to ribs 7-12 or if these ribs were visualized as fractured on any imaging study. Patients were considered to have clinical findings suggestive of splenic injury if they had prehospital or emergency department hypotension, abdominal pain or tenderness, a Glasgow coma scale < 15, or gross hematuria. Ninety patients had splenic injury. Thirty-nine (43%, 95% CI 33, 54%) patients had significant left lower chest injury. In five (6%, 95% CI 2, 12%) patients, injury to this portion of the chest was the single indicator of splenic injury. Nearly half the patients with splenic injury will have significant injury to the left lower chest and this finding may be the only indicator of splenic injury.

Introduction: The spleen is the most frequently injured abdominal organ following blunt trauma.¹ Splenic injuries may be life threatening even in the patient who appears hemodynamically stable with missed intra-abdominal injuries a leading cause of preventable death in trauma patients.² Rapid, initial diagnosis of splenic injuries is therefore crucial. Unfortunately, splenic injuries may be subtle and present without abdominal pain or tenderness even in the alert nonintoxicated patient.³⁻⁵ For this reason additional clinical and laboratory findings are required to identify those patients with splenic injuries.

In the setting of blunt trauma, hypotension, abdominal pain or tenderness, low/declining hematocrit and gross hematuria are all clinical findings associated with splenic injury. In addition, patients with decreased levels of consciousness are difficult to evaluate for splenic injury due to unreliable physical examinations.

Both the liver and spleen are protected from blunt injury by the lower chest wall. The presence of lower rib fractures may, therefore, suggest injury to the liver or spleen.⁶ Two prior studies have suggested that injury to the chest is an independent predictor of intra-abdominal injury and that patients with significant chest injury require abdominal computed tomography (CT) to delineate intra-abdominal injury.^{7,8}

The purpose of this study was to describe the clinical findings in patients with splenic injury and to determine the prevalence of significant left lower chest injury in patients with blunt splenic injury. Finally we attempted to determine if the finding of left lower chest injury might be the single clinical indicator of splenic injury.

Methods: The medical records of all patients over the age of 15 years who sustained blunt splenic injury over 14 months were reviewed. The study site is a Level 1 trauma center with an annual ED census of 65,000 patients. Patients with splenic injury were identified by discharge diagnosis, from review of the trauma registry, and official interpretations of abdominal computed tomography (CT) scans. Patients initially evaluated at an outside hospital and transferred to this institution were excluded.

Data was recorded on standardized data sheets and included both prehospital and ED history and physical examination findings. Prehospital records were examined for the presence of hypotension (systolic blood pressure < 90 mmHg) and complaints of abdominal pain or tenderness on abdominal examination. ED records were assessed for the mechanism of injury, vital signs, Glasgow coma scale (GCS), complaints of abdominal pain or tenderness on abdominal examination. The presence and location of chest tenderness as well as the quality of chest pain were abstracted. ED hypotension was defined as a systolic blood pressure < 90 mmHg on arrival or at anytime during ED evaluation. The presence of gross hematuria was recorded as was the results of serial hematocrit determinations. At the study institution, serial hematocrits are routinely obtained on blunt trauma patients while in the ED. A decline in hematocrit > 6% points during ED evaluation was considered to represent a significant decrease in hematocrit and a drop to this degree results in abdominal CT scanning at the study site.

Significant left lower chest injury was considered present based on abnormal findings either on physical examination or radiologic studies. Via radiographic evaluation, significant left lower chest injury was considered present if plain chest radiograph or abdominal CT demonstrated left sided rib fractures to any of ribs seven through 12.⁶ On physical examination, significant left lower chest injury was considered present if patients were diagnosed with left sided chest wall tenderness (ribs 7-12) associated with pleuritic chest pain. All patients' hospital courses were reviewed to identify those patients undergoing laparotomy, diagnosis at laparotomy, and therapy at that time.

Patients were considered to have clinical findings suggestive of splenic injury if any of the following were present: a decreased level of consciousness (GCS < 15), prehospital or ED hypotension (systolic blood pressure < 90 mmHg), complaints of abdominal pain, abdominal tenderness on examination, a hematocrit drop > 6% points on serial measurements, or gross hematuria. Patients with a GCS < 15 were considered to have unreliable abdominal examinations. Patients were considered to

have significant left lower chest injury as an isolated predictor of splenic injury if they had significant left lower chest injury in the absence of all the previous defined indicators of splenic injury. All patients with significant left lower chest injury as an isolated predictor of splenic injury had all additional injuries documented.

The study was exempted from review by the institution's Human Subjects Review Committee. Continuous variables are displayed as the mean \pm one standard deviation. Confidence intervals (CI) are calculated where appropriate. Data analysis was performed using STATA 5.0 for windows statistical software⁹

Results: Ninety patients had blunt splenic injury during the study period. The mean age of the patients was 37.9 \pm 17.5 years (range 16 to 84 years). The mechanisms of injury for these 90 patients were as follows: motor vehicle collision 55 (61%), automobile versus pedestrian 9 (10%), assault 8 (9%), motorcycle accident 4 (4%), automobile versus bicycle 3 (3%), and other 11 (13%). History, physical examination, and laboratory evaluations for all patients are depicted in Table 1.

Thirty-nine (43%, 95% CI 33, 54%) patients had significant left lower chest injury diagnosed by physical examination or radiologic studies. Eighty-nine patients had chest radiographs performed (one patient was unstable for chest radiography and underwent immediate ED thoracotomy). Eleven (12%, 95% CI 6, 21%) patients had left lower rib fractures visualized on plain chest radiographs. Forty-seven patients underwent abdominal CT and 18 (38%, 95% CI 25, 54%) had left lower rib fractures identified on that CT. Four of the patients with rib fractures identified on CT scan had these rib fractures also identified on plain chest radiography. An additional 14 (16%, 95% CI 9, 25%) patients had significant left lower chest injury solely on physical examination.

Fifty-six patients underwent laparotomy. At laparotomy, 44 patients had splenectomy, six had splenorrhaphy, and six had no intervention to the spleen. Seven (8%) patients expired.

Eighty-five (94%, 95% CI 88, 98%) patients had clinical findings (GCS < 15, prehospital or ED hypotension, abdominal pain or tenderness, declining hematocrit, or gross hematuria) suggestive of splenic injury. All five (6%, 95% CI 2, 12%) patients without these clinical findings suggestive of splenic injury had significant left lower chest injury. One of these five patients required splenectomy on day four after injury. The clinical findings in these five patients are depicted in Table 2.

Discussion: The majority of patients with blunt splenic injury will have signs or symptoms of splenic injury. Over half had abdominal tenderness and nearly half had significant injury to the left lower chest. This low rate for abdominal tenderness may be deceptive, as 40% of the patients with splenic injury had decreased levels of consciousness, potentially resulting in the inability to evaluate the abdomen for tenderness.

All five patients in this study without definitive signs and symptoms of splenic injury had significant left lower chest injury. In three of these patients, injury to the chest overlying the spleen was diagnosed solely on physical examination and one of these patients required splenectomy. Only one of these five patients had additional injuries (left hemothorax, left pneumothorax, and a left anterior shoulder dislocation) and none of these five patients were intoxicated.

Despite the trend in nonoperative management of splenic injuries, especially in children, early diagnosis of splenic injury is indeed essential.^{10,11} Although delayed splenic rupture has been documented in patients with initially normal abdominal CT scans, this entity is more often a delayed diagnosis of splenic injury.¹²⁻¹⁴ The most conservative approach would employ imaging all patients with isolated left lower chest injury. This is the current standard at our institution.

Two prior studies have suggested definitive abdominal evaluation (abdominal CT or DPL) for all patients with major chest injury.^{7,8} These studies, however, do not specifically evaluate injury to the chest overlying the spleen. Only one prior study focused on injuries to the left lower chest.⁶ This study evaluated the association between intra-abdominal injury and lower rib fractures (7-12) and suggested that patients with lower rib fractures and multiple injuries are at significant risk for intra-abdominal injury.

This study has several limitations. It is retrospective and therefore dependent on history and physical examination findings documented by the examining physicians. It is possible that physicians did not document the presence of chest wall tenderness and pleuritic chest pain. This would lead to underestimating the prevalence of significant left lower chest injury in patients with splenic injury. Not all patients presenting to the study site during the study period underwent abdominal CT or laparotomy. Therefore, some patients with splenic injury may not have had their injury detected. The importance of unidentified splenic injuries that do not become clinically apparent, however, is unclear.

This study consisted of patients presenting to a level 1 trauma center. Patients seen at this type of facility routinely have more severe mechanisms of injury than those do at other centers. Finally, we were unable to identify patients with left lower chest injury without splenic injury. Therefore, we could not determine the positive predictive value of significant left lower chest injury of splenic injury.

Conclusions: Most patients with splenic injury will have abdominal tenderness or a decreased level of consciousness. Nearly half the patients with splenic injury have significant injury to the left lower chest, and a small percentage of patients will have left lower chest injury as the single indicator of splenic injury. A prospective study is warranted to determine if abdominal imaging is necessary in all patients with isolated left lower chest injury.

References

1. Esposito TJ, Gamelli RL: Injury to the spleen. In: Feliciano DV, Moore EE, Mattox KL editors: Trauma. 3rd edition, Stamford: Appleton & Lange; 1996; 525-550.
2. Muckart DJ, Thomson SR: Undetected injuries: a preventable cause of increased morbidity and mortality. *Am J Surg* 1991; 162:457-460.
3. Ferrera PC, Verdile VP, Bartfield JM, et al: Injuries distracting from intraabdominal injuries after blunt trauma. *Am J Emerg Med* 1998; 16:145-150.
4. Davis JJ, Cohn I, Nance FC: Diagnosis and management of blunt abdominal trauma. *Ann Surg* 1974; 183:672-677.
5. Rodriguez A, DuPriest RW, Shatney CH: Recognition of intra-abdominal injury in blunt trauma victims. *Am Surg* 1992; 48:456-459.
6. Schurink GWH, Bode PJ, van Luijt PA, van Vugt AB: The value of physical examination in the diagnosis of patients with blunt abdominal trauma: a retrospective study. *Injury* 1997; 28:261-265.
7. Mackersie RC, Tiwary AD, Shackford SR, Hoyt DB: Intra-abdominal injury following blunt trauma. *Arch Surg* 1989; 124:809-813.
8. Grieshop NA, Jacobson LE, Gomez GA, et al: Selective use of computed tomography and diagnostic peritoneal lavage in blunt abdominal trauma. *J Trauma* 1995; 38:727-731.
9. StataCorp: Stata statistical software. Release 5.0. College Station, TX: Stata Corporation; 1997.
10. Bain IM, Kirby RM: 10 year experience of splenic injury: an increasing place for conservative management after blunt trauma. *Injury* 1998; 29:177-182.
11. Etten EV, Popta TV, Luyt PV, et al: Changes in the diagnosis and treatment of traumatic splenic rupture: a retrospective analysis of 99 consecutive cases. *Eur J Emerg Med* 1995; 2:196-200.
12. Benjamin CI, Engrav LH, Perry JF Jr.: Delayed rupture or delayed diagnosis of rupture of the spleen. *Surg, Gyn & Obstret* 1976; 142:171-172.
13. DiGiacomo JC, Rotondo MF, Kauder DR, Scwab CW: Delayed splenic hematomas: an injury in evolution. *Surgery* 1998; 123:478-479.
14. Kluger Y, Paul DB, Raves JJ, et al: Delayed rupture of the spleen myths, facts, and their importance: case reports and literature review. *J Trauma* 1994; 36:568-571.

TABLE 1
Characteristics of the 90 Patients with Blunt Splenic Injury

	Present	Percentage (95% CI)	Data unavailable*
Prehospital hypotension	15	18% (10 – 28%)	6
ED hypotension			
Initial	14	16% (9 – 26%)	3
Developed	11	12% (6 – 21%)	3
Complaints of abdominal pain	22	24% (16 – 35%)	
Abdominal tenderness	51	57% (46 – 67%)	
Glasgow coma scale < 15	36	40% (40 – 62%)	
Hematocrit decline > 6% points	7	11% (4 – 21%)	28
Gross Hematuria	11	12% (6 – 21%)	

CI = confidence interval

ED = emergency department

* Data unavailable indicates medical records without this information available. Hematocrit decline was not able to be determined in 28 patients as they were transported from the ED prior to a second hematocrit being obtained.

TABLE 2
Characteristics of the five patients with significant left lower chest injury as the sole indicator of splenic injury

Age	Mechanism	Radiographic Rib Fracture	Additional Injuries	Therapy
25	Assault	CXR, Abdominal CT	None	Observation
30	MVC	Abdominal CT	None	Observation
33	Assault	None	Head laceration	Splenectomy
39	MVC	Abdominal CT	None	Observation
40	Auto v. Ped	CXR, Abdominal CT	Hemopneumothorax Shoulder dislocation	Observation

CXR = plain chest radiograph

CT = computed tomography

MVC = motor vehicle collision,

Auto v. Ped = automobile versus pedestrian

EMS Column

Howard Michaels, MD

I have reviewed the proposed guidelines for EMT-1s from the State EMSA agency. This upgrading of EMT skills, while primarily for rural areas, can be used on a selective basis by local agencies to provide higher quality EMT services and smooth coordination of services when working with paramedics.

There are eight new procedures and the removal of one skill. The State has removed the option for EMT-1s to intubate, but have added the possible use of the following procedures and medications:

1. Albuterol by a nebulizer or by a hand held metered dose inhaler
2. Sublingual nifedipine
3. Oral administration of ASA

4. Glucagon by I-M injection
5. Epinephrine 1:1,000 by sub-q injection
6. Naloxone by I-M injection
7. Oral administration of activated charcoal
8. Blood glucose check

There is also the addition of two new skills for rural counties, the starting of IVs and giving IV glucose. While the new skills will overlap with the current availability of paramedics in many areas, the new procedures should be considered by all departments to improve their level of patient care. These procedures can be used to enhance the team concept of Pre-hospital care.

Dr. Michaels has 25 years of EMS experience in the Bay Area and works at Regional Medical Center in San Jose, California. He can be reached at: grendel32@aol.com