SELECTED PRESENTATIONS FROM
SCIENTIFIC ASSEMBLY 2001

Course Title: Trauma Care in the 21st Century: Thinking Outside the Box
Faculty: Michael A. Gibbs, MD, FACEP
Course #/Date: WE-222, October 17, 5:00 pm – 6:00 pm, Room 305

Course Objectives assigned:

Upon completion of this course, the participant will be able to:

- Discuss the effect of new imaging studies on the evaluation of trauma patients.
- Describe the accuracy, risks, and cost-effectiveness of the new diagnostic modalities.
- Discuss the management of asymptomatic trauma patients at risk for occult injuries.

TRAUMA CARE – THINKING OUTSIDE OF THE BOX

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Objectives:

This session will provide a discussion of the recent literature on **diagnostic imaging in the acutely injured patient;** focusing on:

1. Current recommendations for imaging in minor brain injury
2. A review of recent NEXUS data on cervical spine imaging
3. An update on the use of CT and TEE in chest trauma
4. A discussion of the role of CT abdominal trauma

5. A review of recent literature on emergency ultrasound

Neuroimaging In The Patient With Minor Brain Injury

Can a reliable clinical decision rule be used to determine which patients require neuroimaging following minor brain injury?

Haydel MJ. Indications for Computed Tomography in Patients with Minor Head Injury. *NEJM* 2000; 343:100-105.

The goal of this study was to develop a clinical decision rule to identify which patients need (and do not need) neuroimaging following minor head trauma. The study was divided into two phases. During Phase 1 clinical findings in 520 patients with minor head injury (GCS=15, [+] LOC, normal neurologic examination) were recorded. All patients underwent cranial CT. 36 patients (6.9%) had positive scans. All patients with positive scans had one or more of seven findings: [1] headache, [2] vomiting, [3] age over 60 years, [4] drug or alcohol intoxication, [5] deficits in short-term memory testing, [6] physical evidence of trauma above the clavicles, and [7] seizure. During Phase 2, the sensitivity and specificity of the criteria for predicting a positive scan were evaluated in a group of 909 patients. 57 (6.3%) had positive scans. All patients with positive CT scans had at least one of the findings. In this group of patients, the sensitivity of the seven findings was 100% (95% CI 95-100%).

Comment: This article represents an important step towards the development of a reliable clinical decision rule to guide neuroimaging in patients with minor brain injury. Further multicenter prospective validation will be needed before these criteria can be widely applied.

Can patients with MHI and an [-] CT be sent home from the ED?

Livingstone DH. Emergency Discharge of Patients With a Negative Cranial Computed Tomography Scan After Minimal Head Injury. *Ann Surg* 2000; 232:126-132.

The purpose of this study was to prospectively evaluate the incidence of “delayed” intracranial injury in patients sustaining minor head injury (defined as a GCS 14-15, [+] LOC and/or amnesia). All patients were scanned and admitted for observation. A total of 2152 patients from 4 Level I trauma centers were enrolled. 1,788 (83%) had negative scans, 217 (10%) were positive and 199 (5.5%) were equivocal. In

the CT [-] group 4 patients eventually required pharmacologic ICP management and 1 patient with multiple facial fractures and a depressed skull fracture required craniotomy for fracture fragment elevation. All five had persistent neurologic impairment that would have justified a longer period of observation. The NPV of a normal CT scan was 99.7%.

Comment: This study supports the premise that patients who have no intracranial injury on cranial CT, and no persistent neurologic findings or other indications for admission can be safely discharged from the emergency department *without* a period of observation.

Cervical Imaging In Blunt Trauma

Who needs radiography?

Hoffman JR. Validity of a Set of Clinical Criteria to Rule Out Injury to the Cervical Spine in Patients with Blunt Trauma. *NEJM* 2000; 343:94-99.

NEXUS was a prospective, multicenter, observational study of a decision rule used to identify patients at low risk of cervical spine injury, and thus not requiring cervical radiography. The decision instrument required patients to meet five criteria in order to be classified as low risk: [1] no midline cervical tenderness, [2] no focal neurologic deficit, [3] normal alertness, [4] no intoxication, and [5] no painful distracting injury. 34,069 patients at 21 academic and non-academic medical centers were evaluated. Physicians were asked to assess each of the clinical criteria *before* radiographs were available. No efforts were made to influence physician ordering of radiographs; these were obtained at the discretion of the treating clinician. The decision rule identified all but 8 or 818 patients who had cervical spine injury (sensitivity 99.0% [95% CI 90.0-99.6%]; NPV 99.8% [95% CI 99.6-100%], specificity 12.9%, PPV 2.7%). Only two of the patients classified as unlikely to have an injury according to the decision rule met the preset definition of a clinically significant fracture, and one of these two patients required surgical stabilization.

Comment: All emergency physicians should be intimately familiar with the results of this trial. The NEXUS criteria will have a significant impact on our practice, and a study of this size will never be repeated. The inter-rater reliability of these criteria is substantial, although it should be remembered that they can be subjective.[1] The assessment of a “distracting” injury is particularly subjective and problematic. Ullrich[2] prospectively evaluated 778 patients and found that 264 (34%) had distracting painful injuries (DPIs). Fractures accounted for the majority of DPIs (154 or 58%), 42 (16%) were soft-tissue injuries or lacerations, and 86 (34%) were due to a variety of other entities, including visceral, crush, burn, or other miscellaneous injuries. Among the 37 (5%) patients with cervical fractures, 20 (54%) had a DPI, including three (8%) who had DPI as the only indication for cervical radiography.

[1]Mahadevan S. *Ann Emerg Med* 1998; 31:197-201.
[2]Ullrich A. *Acad Emerg Med* 2001; 8:25-29.

Goldberg W. Distribution and patterns of blunt traumatic cervical spine injury. *Ann Emerg Med* 2001; 38:17-21.

Review of the NEXUS database to describe the level and location of cervical injury. The second cervical vertebrae was the most common level of injury [286 (24%)]. 470 fractures (39.3%) occurred at C6 and C7.

Comment: While cervical fractures occur at all levels, the upper and lower vertebrae are the most likely to be injured. This becomes especially relevant because these are the two most difficult regions to define radiographically. Pay close attention!

Panacek EA. Test performance of the individual NEXUS low-risk clinical screening criteria for cervical spinal injury. *Ann Emerg Med* 2001; 38:22-25.

Secondary analysis of the NEXUS database to determine the contribution of each of the 5 individual criteria to the overall sensitivity of the decision instrument. In the patients with injury, no one criteria was found in the majority of patients. 50% of patients had midline tenderness. 30% of patients had only one criteria, half of these had only midline tenderness.

Comment: Don't cut corners or hang your hat on any 1 criteria. It is interesting to note that a significant number of patients with injury and only one criteria did not have midline tenderness.

Which X-rays should be obtained?

A. Is The Cross Table Lateral View Sufficient?

No! It has been demonstrated that the use of a cross table lateral view alone is inadequate to rule-out cervical spine injury, with a sensitivity of between 57% and 85%. The addition of the AP and odontoid views to the cross table lateral increased the sensitivity from 83% to 99%. For this reason, at least three views should be obtained in all cases.

B. Three Views Or Five?

The issue of whether the oblique views is routinely needed remains an area of controversy. These views are held by some to be essential because they provide superior visualization of the posterior column (pedicles, articular pillars, neural foramina, and lamina). Turetsky et

al[1] found that the oblique views demonstrated certain fractures not detected on the three-view series. Conversely, Freemyer et al[2] found no fractures or dislocations detected on the five-view series that were not identified on the three-view series. While there is no consensus concerning the necessity for routine oblique radiographs in cervical trauma, these views may be useful in evaluating poorly visualized areas of the posterior column. In addition, the supine oblique view provides excellent definition of the cervicothoracic junction, and may be used instead of the often-inadequate swimmer's view. [3,4] Ireland et al[5] compared 60 patients whose cervical spines were imaged with swimmer's views to evaluate the cervicothoracic junction to those of 62 patients whose junctions were imaged with bilateral supine oblique radiographs. Oblique views identified the junction adequately in 38% compared to 37% in the swimmer's group. However, the facet joints and posterior elements were fully evaluable in 70% of those imaged obliquely compared to only 37% in the swimmers group. It is reasonable to use the oblique view selectively, after a three-view series has been evaluated.

Mower WR. Use of plain radiography to screen for cervical spine injuries. *Ann Emerg Med* 2001; 38:1-7.

Review of the NEXUS database to document the efficacy plain film radiography and to categorize the frequency and type of injuries missed. A "standard" 3-view series was obtained in all patients, with additional imaging studies at physician discretion. 237 patients (0.67% of total, 29% of injury group) with inadequate films had missed injuries. 23 patients with adequate films had missed injuries (0.069% of total, 2.8% of injury group); 3 of these (0.36% of injury group) were unstable.

Comment: in patients with adequate radiographs, the number of significant missed injuries is very small, although not zero. More importantly, you should *never ever* settle for inadequate radiographs.

C. What Is The Role Of Flexion-Extension Views?

Neurologically intact patients with persistent neck pain **and tenderness** despite normal radiographs should have flexion-extension views performed to exclude ligamentous injury. It is essential that the patient be alert and cooperative, as all neck movement must be patient-initiated and discontinued immediately should pain occur. Manipulation of the neck to overcome spasm is absolutely contraindicated. Filming in the erect position is preferred because this position better demonstrates ligamentous instability.[6]

Pollack CV. Use of flexion-extension radiographs of the cervical spine in blunt trauma. *Ann Emerg Med* 2001; 38:8-11.

Review of the NEXUS database to describe the contribution of flexion-extension films to radiographic evaluation. Of 818 patients with cervical injury, 86 (10.5%) underwent F/E testing. 2 patients (0.24% of total, 2.3% of F/E group) sustained stable bony injuries detected only on F/E views, but all of these had other injuries detected on rountine cervical imaging.

Message: while F/E have been recommended for patients with persistent neck pain and normal radiographs, these contribute little to decision-making.

D. Indications For CT?

CT has proven to be an excellent method for evaluating c-spine fractures and dislocations. Its advantages include speed, availability, axial imaging, and excellent detail. Contemporary scanners detect between 95% and 100% of cervical fractures; a significantly higher sensitivity than plain-film radiography. So, when should this effective, albeit expensive technology be used? The traditional approach reserves CT imaging to delineate bony anatomy at the level of identified or suspected fractures and dislocations, in those cases where the upper or lower cervical spine cannot be adequately visualized, and in patients with persistent pain and/or neurologic deficit despite normal plain films. A more aggressive strategy suggests that complete cervical helical scanning may be appropriate and cost-effective in severely injured patient at high-risk for cervical fracture.[7] In the majority of cases a selective approach seems reasonable. Local practice should be driven collaboratively by emergency physicians, trauma and spine surgeons and radiologists.

Special mention should be made of the intubated patient. Because the presence of an endotracheal tube may alter the radiographic appearance of upper cervical anatomy, a significant number of high cervical injuries may be missed on plain films. Several authors have suggested that patients undergoing cranial tomography for the evaluation of traumatic brain injury should have CT imaging extending through the upper cervical spine (C1 and C2).[8,9]

Summary Recommendations For Cervical Imaging:

•Obtain cervical radiography in blunt trauma patients with:

-Neck pain and midline cervical tenderness
-Altered mental status including intoxication
-Focal neurological deficits
-Distracting painful injury

•A 3-view series should be considered the "minimal standard"

•Obtain obliques when the 3-view is inconclusive, or the cervicothoracic junction is not well visualized

•Flexion-extension films are indicated in the patient with normal radiographs and suspected ligamentous injury (although the yield of these films is low

•Use CT selectively:

-To delineate anatomy at the level of injury
-To define areas not well visualized with plain-films
-Neurologic deficit/persistent pain and normal films
-C_1-C_2 in the intubated patient

[1]Turetsky DB. *Ann Emerg Med* 1993; 22:685-688.
[2]Freemyer B. *Ann Emerg Med* 1989; 18:818.
[3]ichols CG. *Ann Emerg Med* 1987; 16:640-642.
[4]Davis JW. Case report. *J Trauma* 1989; 29:891-893.
[5]Ireland AJ. *J Accid Emerg Med* 1998; 15:151-4.
[6]Lewis LM. 1991; 20:117-121.
[7]Berne J. *J Trauma* 1999; 47:896.
[8]Link TM. *Radiology* 1995; 196:741-745.
[9]Blacksin MF. *AJR* 1995; 165:1201-1204.

Blunt Chest Injury

Should chest CT be obtained routinely in patients with severe blunt chest trauma?

Bridges KG. CT detection of occult pneumothorax in multiple trauma patients. *J Emerg Med* 1993; 11:179-186.

Retrospective chart review of 90 trauma patients ultimately found to have pneumothoraces. In 35 cases (38.8%), the initial supine chest x-ray failed to detect a pneumothorax, and the diagnosis was made on CT scan of the chest or abdomen within 2 hours of admission. In 15 of these cases (43.8%), identification of the pneumothorax on CT scan resulted in an alteration of management, including chest tube placement in 10 patients and intensified monitoring in 5 patients. Detection was especially important in patients who were on positive-pressure ventilation.

Omert L. Efficacy of thoracic computerized tomography in blunt chest trauma. *American Surgeon* 2001; 67:660-64.

This study examined whether thoracic CT (TCT) provided additional information to routine CXR findings, and whether this information changed management. Blunt trauma patients were enrolled prospectively based either on physical and radiographic findings (Group 1; n=110), or on mechanism of injury alone (Group 2; n=59). TCT identified injuries not seen on CXR in 66% of patients in Group 1 and 39% of patients in Group 2. A significant change in management occurred in 20% of patients in Group 1 and 5% of patients in Group 2. This included chest tube placement (6), aortography with diagnosis of TAD (3), spinal fracture diagnosis and repair (1), and chest tube reposition (2). TCT appeared to be most helpful in patients with radiographic evidence of chest injury.

Comments: When deciding whether or not to obtain this expense imaging study, you should first ask yourself:

1. Is the patient high-risk (eg: intubated, unstable)?
2. Will the patient be in the CT scanner for other studies?
3. Will an upright CXR tell you what you need to know?
4. Will the upper cuts of the abdominal CT be sufficient?
5. What are you looking for on chest CT?

What Is The Most Effective Way To Diagnose Traumatic Aortic Disruption?

Chest Radiography

All patients suffering major blunt trauma should have a CXR, even in the absence of physical complaints related to the thorax. In the immobilized patient a supine AP film will usually be obtained initially. Whenever possible, this should be followed by any upright or reverse trendeleburg film (this should not delay resuscitation and definitive care). Chest X-ray abnormalities are seen in 90-95% of cases of TAD, although they all have a low specificity (5-10%) A large number of radiographic findings have been described in association with TAD. We must remember that:

- •An abnormal mediastinum equals of a *mediastinal hematoma.*
- •A mediastinal hematoma does not equal TAD
- •10%-20% of patients with a MH have aortic injury.

<u>The Wide Mediastinum</u>

The wide mediastinum represents an accumulation of blood medial to the pleural surface of the lung A wide mediastinum has been defined in several ways:

- •>8cm supine
- •>6cm erect
- •>7.5 at the aortic knob
- •Mediastinal/torso ratio > 0.25 @ the aortic knob

A few caveats:

- •The mediastinal shadow will be wider with recumbency and hypoaeration
- •Subjective interpretation of mediastinal widening is important
- •Other causes of mediastinal widening:
  - -Venous injury (azygous/hemiazygous vein)
  - -Intercostal, spinal, mammary artery injury
  - -Thoracic spine fracture
  - -Mediastinal emphysema
  - -Misplaced central venous catheter

<u>Aortic Contour/Aortopulmonary Window</u>

Very subjective but very important. Loss of smooth aortic contour and obliteration of the aortopulmonary window may be the only findings in the absence of mediastinal widening.

<u>Mediastinal Stripe</u>

The mediastinal stripe represents the medial surface of the left lung.

It has a wide range in sizes. It is normally *not* visualized above the aortic arch (T_4-T_5).

Apical Cap

The apical cap represents extension of a mediastinal hematoma over the apex of the lung, and is seen as a direct upward continuation of the mediastinal stripe above the aortic arch. This finding may also be associated with inlet rib fractures.

Right Paratracheal Fat Stripe

The right paratracheal fat stripe is composed of the tracheal wall and parietal pleura. It is usually less than 5 mm in diameter. Widening may indicate a mediastinal hematoma.

Deviation Of The Trachea/NGT

Right-ward deviation of the trachea and/or NGT can be indirect signs of TAD. Remember that the position of the trachea and NGT can be affected by patient rotation, and may remain at the midline with balanced bilateral hematomas.

Normal CXR

Can a negative chest coexist with aortic injury? Yes! The range of reported aortic disruptions varies widely, with an average between 3% and 7%.

While the literature is mixed, here is an example of how these finding play out:

Fabian TC, et al. Prospective study of blunt aortic injury: Multicenter trial of the American Association for the Surgery of Trauma. *J Trauma* 1997; 42:374-383.

This is one of the largest series to date, with 274 cases of TAD:

•Wide mediastinum	221(85%)
•Indistinct knob	63 (24%)
•Left effusion	49 (19%)
•Apical cap	49 (19%)
•Tracheal deviation	32 (12%)
•NGT deviation	29 (11%)
•Bronchus deviation	12 (5%)
•Normal CXR	19 (7%)

CT Scanning

A growing number of case series have examined the role of chest CT scanning in the diagnosis of traumatic aortic disruption. Most of these studies have several short-comings:

- •Inclusion/exclusion criteria are variable
- •There are a small number of true-positives in each study
- •Helical technology was not available
- •Not all patients had angiographic verification of TAD

More recent studies using helical-CT technology have very high sensitivities and specificities for mediastinal hematomas and direct signs of aortic injury. Here are summaries of the most recent literature:

Dyer DS, et al. Thoracic Aortic Injury: How Predictive Is Mechanism and Is Chest Computed Tomography a Reliable Screen Tool? A Prospective Study of 1,561 Patients. *J Trauma* 2000; 48(4):673-682.

Treating physicians made an initial risk-assessment based MOI criteria (1=low risk, 5=high risk) and subjective interpretation of the initial CXR (1=not worrisome for TAI, 5=very worrisome for TAI). The decision to perform CCT vs aortography was based a combination of these scores. Patients for whom there was a high suspicion (eg: MOI score =5 and CXR score = 4,5) underwent aortography. High suspicion patients in need of other studies, and those with moderate/low suspicion underwent CCT. Criteria for “positive” findings on CCT included mediastinal hemorrhage, periaortic hematoma, change in caliber or contour of the aorta and the presence of an intimal flap. 1,561 patients were evaluated. Of the patients with MOI characteristic often associated with TAI, only high speed and ISS were found to be significant. No significant association was found between frontal and side impacts, ejection, associated fatalities, sudden deceleration, auto damage, and TAI. Aortography was performed in 223 (14%) patients with a high suspicion for TAI. CCT was the initial study in 1,338 patients, and 486 of these had follow-up aortography. A total of 30 (1.9%) aortic injuries were identified. CCT had a sensitivity of 100%, NPV of 100% and PPV of 39%.

Fabian T, et al. Prospective study of blunt aortic injury: CT is diagnostic and antihypertensive therapy reduces rupture. *J Trauma* 1998; 227:666.

Prospective study of 494 patients (TAD in 71). Helical CT was obtained in all patients with a suspicious CXR. A standardized non-randomized protocol of β-blockade sodium nitroprusside was used.

- Sensitivity: HCTT 100% / Angiography 92%
- Specificity: HCTT 83% / Angiography 98%
- No cases of rupture
- Angiography was not obtained in all patients

Mirvis SE, et al. Use of spiral CT for the assessment of blunt trauma patients with potential aortic injury. *J Trauma* 1998; 45:922-930.

Prospective evaluation of helical chest CT (HCCT) in patients with suspected TAD. All patients with a suspicious CXR underwent helical chest HCCT. The presence and location of mediastinal blood and any direct signs of aortic injury were noted. 1,014 patients were enrolled. Mediastinal hemorrhage was detected in 118 (10.7%) patients. Direct evidence of aortic injury was detected in 24 (20.3%) patients. HCCT was 100% sensitive and 99.7% (20.3%) specific, with a negative predictive value of 100%.

A few questions you need to asking before using this option are:

- Is it always available?
- What is the experience of your radiology staff?
- Will your consultant ask for an angiogram even if the CT is positive?

Transesophageal Echocardiography

A large number of case reports have examined the role of transesophageal echocardiography in traumatic aortic disruption. The advantages and disadvantages of TEE are discussed below.

Advantages
- Portability (ED, OR, ICU...)
- Can be performed during resuscitation/other studies
- Detects myocardial/valvular injury, tamponade
- Can be performed rapidly
- Does not require contrast
- Can be repeated frequently

Disadvantages
- Operator-dependent
- Contraindications: unprotected airway, esophageal disease
- Suboptimal imaging quality for:
  - -Aortic arch branch vessels, ascending aorta/arch
  - -Artheromatous disease, pneumomediastinum

The true sensitivity and specificity of TEE is difficult to assess, given the relatively small number of reported patient series. A review of ten studies (n=381) showed an overall sensitivity of 85.7% and specificity of 92%.[1] In a patient with the most rapidly lethal injury in trauma, the examination of choice must establish the diagnosis rapidly and without reasonable doubt and, therefore, should not require confirmation by an additional examination.

[1]Ben-Menachem Y. *J Trauma* 1997; 42:969-972.

TEE vs. CT… What Does The Latest Literature Tell Us?

Vignon P. Comparison of multiplane tranesophageal echocardiography and contrast-enhanced helical CT in the diagnosis of blunt traumatic cardiovascular injuries. *Anesthesiology* 2001; 94:615-622.

The authors prospectively compared the accuracy of TEE and contrast-enhanced helical CT in 110 consecutive patients with severe blunt chest trauma (ISS 34 +/- 14). High-risk patients were defined by the presence of at least one of the following: (1) history of deceleration, (2) ejection or associated fatality, (3) pedestrian stuck, (4) external signs of major chest injury, (5) chest trauma requiring mechanical ventilation, (6) unexplained shock, (7) wide mediastinum on admission CXR. Studies were obtained in random order and results were interpreted independently. Standard definitions of aortic and cardiac injury were employed. Seventeen patients (15.5%) had vascular injury and 11(10%) had cardiac lesions. TEE and CT identified all aortic injuries necessitating surgical repair. One innominate artery missed by TEE was detected by CT. TEE detected 4 lesions of the aortic intima or media alone missed by CT; these were all managed non-operatively. Cardiac lesion was diagnosed in all but 2 cases by TEE alone.

For TEE: sensitivity = 93%, NPV = 99%, specificity 100%, PPV = 100%. For CT: sensitivity 73%, NPV = 95%, specificity 100%, PPV =100%.

Comments: During the last 3 years several authors have documented the high accuracy of helical CT in the diagnosis of blunt aortic injury. This is the first study to prospectively compare CT to TEE. A few points worth mentioning: [1] CT imaging detected all aortic injuries requiring surgery. The clinical significance of a small intimal injury is unclear. [2] CT imaging detected the only great vessel injury and this was missed by TEE. A well-described limitation of echocardiography is the inability to reliably image branch vessels. [3] The ability of TEE to pick up associated discrete cardiac lesions and myocardial dysfunction is a significant advantage of the technology. TEE should be considered when this is suspected clinically. [4] A major advantage of TEE is the ability to perform the test in the unstable patient, in the ED, ICU, or OR. [5] TEE is very operator-dependent. The investigators in this study had “significant experience” that may not be the case in every hospital. Each test has important advantages and limitation. Good clinical judgement and sound management protocols will help us choose the right test.

Abdominal Injury

Peitzman AB, et al. Blunt Splenic Injury in Adults: Multi-Institutional Study of the Eastern Association for the Surgery of Trauma. *J Trauma* 2000; 49(2):177-187.

This retrospective multicenter trial reviewed the management of 1,488 adults (>15 years) with blunt splenic injury at 27 trauma centers. The objective was to determine if a combination of hemodynamic parameters and CT findings could be used to predict successful nonoperative management. Age, ISS, MOI, GCS, lowest BP and highest HR in the ED, hematocrit and base deficit, and results of diagnostic studies (DPL, CT, US) were recorded. The management plan, time and indications for laparotomy and ultimate outcome were reviewed. Patients were divided into three groups: those who went directly to the OR (CT scan may have been obtained en route) (group I, n = 575), patients successfully observed (group II, n = 816), and patients who failed nonoperative management (group III, n =97). Mechanism of injury did not differ between groups.

38.5% of patients went directly to the OR (group I). This group presented with a significantly lower BP, GCS and hematocrit and a higher HR, ISS and base deficit than patients successfully observed. Of the patients in this group who had a CT scan performed, there was a significant correlation between the decision to operate and the AAST grades of splenic injury: I (23..9%), II (22.4%), III (38.1%), IV (73.7%), V (94.9%), ($p < 0.05$).

61.5% were admitted with planned nonoperative management. 10.8% of these failed and required laparotomy. Of patients initially managed nonoperatively, the failure rate increased significantly by AAST grade: I (4.8%), II (9.5%), III (19.6%), IV (33.3%), and V (75%) ($p < 0.05$). 60.9% of failures occurred within 24 hours.

Comment: Nonoperative management of splenic injury has become routine in children, with success rates between 75% and 90% . The indications and risks of selection for observation of blunt splenic trauma in adults are less clear. While some authors base patient selection on CT scan findings[1], others have found these criteria to be less useful and rely instead on clinical markers.[2]

While this study is retrospective and has several important weaknesses, it suggests successful nonoperative management of splenic injury in adults may be predictable at the time of presentation, based on hemodynamic parameters and CT findings.

There was no strict study protocol, and decision making may have been influences by many factors. It is virtual impossible to make this determination using retrospective methodology. A large prospective study (even if observational) would add credence to the author's conclusions.

[1]Powell M. *Surgery* 1997; 122:654-660.
[2]Alonso M. *J Trauma In press.*

Velmahos GC, et al. Selective Nonoperative Management of 1,856 Patients With Abdominal Gunshot Wounds: Should Routine Laparotomy Still Be the Standard of Care? *Ann Surg* 2001; 234;396-

The authors performed a retrospective review of 1,856 patients with abdominal GSW (1,405 anterior, 451 posterior) admitted during an 8-year period at LA County Medical Center. According to a previously developed protocol, these patients were underwent either laparotomy or selective nonoperative management (SNOM). Patients who did not have peritonitis, were hemodynamically stable, and had a reliable clinical examination (absence of head injury, intoxication, spinal cord injury) were observed. Patients in the SNOM group underwent CT scanning to define bullet trajectory and organ injury. Frequent serial examinations were performed for a 24 hour period. Patients who experienced a change in their clinical status underwent delayed laparotomy.

Initially 792 (42%) patients (34% of patients with anterior and 68% of patients with posterior abdominal gunshot wounds) were selected for nonoperative management. During observation 80 patients (4% of total; 10% of SNOM group) developed symptoms and required a laparotomy, which revealed organ injury in 57. The majority of delayed laparotomies occurred within 8 hours of presentation. Five patients (0.3% of total; 0.6% of SNOM group) suffered complications potentially related to delays. 4/5 of these were intraabdominal abscess; all were managed successfully. 712 patients (38%) were managed successfully without operation. The rate of non-therapeutic laparotomy rate was 14%. Compared with patients with unnecessary laparotomy, patients managed without surgery had significantly shorter hospital stays and lower hospital charges.

Comment: Classic mantra underscores the importance of immediate laparatomy in all patients with abdominal gunshot wounds. This assertion is based on the long-held belief that the rate of intraabdominal organ injury in this population approaches 90%. While

this may be true for military wounds, more recent data suggests that abdominal gunshot wounds from civilian violence are associated with a much lower incidence of clinically significant intraabdominal injuries; ranging from 30% to 74%.

This study confirms the results of two prospective studies by the same authors demonstrating that roughly one-third of anterior[1] and two-thirds of posterior gunshot wounds[2] can be managed without surgery. This approach will undoubtedly become more popular at trauma centers with experienced surgeons and dedicated resources. It is unlikely to become reality at most small centers. While this study has several important weaknesses (most importantly a lack of precise definitions for the indications for surgery) it represents an important paradigm shift that challenges traditional surgical dogma.

[1]Demetriades D. *Archives of Surgery* 1997; 132:178-83.
[2]Velmhos GC. *American Journal of Surgery* 1997; 174:342-6.

Ultrasound

Holmes JF, et al. Emergency department ultrasonography in the evaluation of hypotensive and normotensive children with blunt abdominal trauma. *J Ped Surg* 2001; 36:968-73.

Prospective observational study of children (<16 years old) with blunt trauma. FAST performed by ultrasonographers, and interpreted solely for the presence or absence of intraperitoneal fluid. Hypotension was defined as > or = 1standard deviation below the age-adjusted mean. A total of 224 patients were enrolled. Thirty six patients had intraabdominal injury (IAI), and the ultrasound was positive in 27 [sensitivity 82% (95% CI 65% to 93%); specificity 95% (95% CI 91% to 97%); PPV 73% (95% CI 56% to 8^%); NPV 97% (95% CI 93% to 99%)]. In the 13 patients who were hypotensive, US correctly identified hemoperitoneum in all patients with IAI (sensitivity 100%), and the US was negative in all 7 patients without hemoperitoneum.

Comment: The accuracy of ultrasound in pediatric blunt trauma patients is modest. The test has the best test performance in those children who are hypotensive and should be obtained early in the ED evaluation of these patients.

Ma OJ. Operative versus nonoperative management of blunt abdominal trauma: Role of ultrasound-measured intraperitoneal fluid levels. *Am J Emerg Med* 2001; 19:284-6.

The objective of these study was to determine if the quantity of intraperitoneal fluid on ultrasonography, alone or in combination with unstable vital signs is predictive of the need for laparotomy. Anechoic fluid levels were graded as “small” (< 1 cm), “moderate” (1-3 cm), or “large” (> 3 cm). Unstable vital signs were defined as a pulse > 100 bpm or systolic blood pressure < 90 mmHg. Exploratory laparatomy or CT confirmed hemoperitoneum. Of 270 patients studied, US detected free fluid in 33. Of the 18 patients with large fluid accumulations, 16 underwent exploratory laparotomy (89% sensitivitiy), and all with unstable vital signs went to surgery (100% sensitivity). Of the 10 patients with moderate fluid on US, 6 underwent laparotomy (60% sensitivity), and 4 of 6 with unstable vital signs went to surgery (67% sensitivity).

Comment: A large volume of intraperitoneal fluid accumulation on US in combination with hemodynamic instability is a sensitive

predictor for the need for exploratory laparotomy.

Dolich MO. 2,576 ultrasounds for blunt abdominal trauma. *J Trauma* 2001; 50:108-12.

Retrospective review of US database over a 30-month period. Intraabdominal injury was confirmed by CT, DPL, or exploratory laparotomy. During the study period US was performed in 2,576 (31%) of 8,197 patients. 311 (12%) US exams were considered positive. 43 (1.7%) had a false-negative study; of this group 10 (33%) required exploratory laparotomy. US had a sensitivity of 86%, a specificity of 98%.

Comment: Studies of US at high volume trauma centers have been impressive. It is unclear is these numbers will hold true for every practice setting.

Rozycki GS. The role of ultrasound in patients with possible penetrating cardiac wounds: A prospective multicenter study. *J Trauma* 1999; 46:543-51.

The purpose of this study was to evaluate the accuracy of emergency ultrasound at 5 Level I Trauma Centers. US was performed by surgeons or cardiologists (four centers) and technicians (one center) on patients with penetrating truncal wounds. Pericardial US was performed in 261 patients. There 225 (86.2%) true negatives, 29 (11.1%) true positive, 0 false negative, and 7 (2.7%) false-positive examinations; sensitivity = 100%, specificity = 96.9%.

Comment: Bedside US should be the initial modality for the evaluation of patients with penetrating precordial wounds.

Dulchavsky SA. Prospective evaluation of thoracic ultrasound in the detection of pneumothorax. *J Trauma* 2001; 50:201-5.

Prospective evaluation of thoracic ultrasound detection of pneumothorax in high-risk patients. Ultrasound examinations were performed before standard radiography. 382 patients were enrolled; the cause of injury was blunt (281/382), gunshot wound (22/382), stab wound (61/382), and spontaneous (18/382). Pneumothorax was demonstrated on chest radiography in 39 patients and confirmed on US in 37/39 patients (95% sensitivity). In the 2 patients missed by US, subcutaneous emphysema made the examination unreliable.

Comments: The authors suggest that thoracic US is highly reliable, and should be incorporated into the FAST exam. While US is unlikely the replace chest radiography in the injured patient, it may prove to be a valuable tool for the immediate detection of a tension pneumothorax in the unstable patient.