Medical University of South Carolina
Division of General Surgery

Adult Trauma Manual

This manual is written to provide suggested guidelines for physicians working within a Level I Trauma System. Additional procedures have been added to incorporate pediatric trauma patients. The procedures and protocols herein do not construe hospital policy that mandates compliance. The procedures and policies provided may be modified by the individual trauma surgeon according to the clinical situation, and what the surgeon feels is in the best interest of the patient.

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# Trauma Administration

**MUSC Operational Process Performance Committee**

The purpose of the Multidisciplinary Operational Process Performance Committee is to establish a forum for interdisciplinary communication, problem solving, and the exchange of ideas. This working committee shall address, assess and correct global trauma program and systems issues, in accordance with CD 5-23 of Resources for Care of the Optimally Injured Patient, 2006\(^2\).

Members include:

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<td>Director of Adult Trauma</td>
<td>Bruce Crookes, MD</td>
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<tr>
<td>Pediatric Trauma</td>
<td>Christian Streck, MD</td>
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<tr>
<td>Director of Surgical Critical Care</td>
<td>Stuart Leon, MD FACS</td>
</tr>
<tr>
<td>Trauma Program Director</td>
<td>Terrie Stewart, MS MSN RN</td>
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<tr>
<td>ED Physician Representative</td>
<td>Greg Hall, MD</td>
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<tr>
<td>ED EMS Liaison</td>
<td>David French, MD</td>
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<td>Neurosurgery Representative</td>
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<td>Orthopaedic Representative</td>
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<td>Anesthesia Representative</td>
<td>Ryan Gunselman, MD</td>
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<tr>
<td>Radiology Physician Representative</td>
<td>James Ravenel, MD</td>
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<tr>
<td>Trauma PI Coordinator</td>
<td>Jessica Brown, MSN RN</td>
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<tr>
<td>Nursing Representative, ED</td>
<td>Brian Cox, RN</td>
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<tr>
<td>Nurse Manager, STICU</td>
<td>Cindy Little, RN</td>
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<tr>
<td>Trauma Registrar</td>
<td>Quantella Rivers-Bradley, BS MBA</td>
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<tr>
<td>Critical Care Pharmacy</td>
<td>Brian McKenzie, PharmD</td>
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<tr>
<td>Injury Prevention Coordinator</td>
<td>Regina Creech</td>
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\(^2\)“Resources for Optimal Care of the Injured Patient” 2006, Committee on Trauma, American College of Surgeons, Chicago, Il, p. 35
MUSC Trauma Peer Review Committee

The purpose of the Multidisciplinary Peer Review Committee is to improve trauma care by reviewing selected deaths, complications, and sentinel events, with the objective of identifying issues, and designing appropriate responses (CD 5-18). Members must attend at least 50% of these meetings. The core general surgeons in the call schedule must attend, at minimum, 50% of the meetings, or risk dismissal from the trauma service. The decision for dismissal rests solely with the Trauma Director.

Members include:

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3 “Resources for Optimal Care of the Injured Patient” 2006, Committee on Trauma, American College of Surgeons, Chicago, Il, p. 34
Trauma Service

Members of the Trauma Service

*Members of the Trauma “Blue” Service*
- Dr. Bruce Crookes, Trauma Director
- Dr. Samir Fakhry, SACC Service Line Director
- Dr. Stephen Fann
- Dr. Joseph Sakran
- Dr. Alicia Privette

*Members of the Trauma “Red” Service*
- Dr. Evert Eriksson
- Dr. Stuart Leon
- Dr. Stephanie Montgomery
- Dr. Douglas Norcross

The above individuals are available to cover any and all injured patients twenty four hours per day, seven days per week. Patients will be admitted to the service (i.e. General Surgery Red, General Surgery Blue) of the relevant attending physician.

Backup Call Schedules

Trauma: A back up pager is carried by one of the trauma attending surgeons at all times. The operators can page that pager to contact the back up attending.

Neurosurgery: The back up neurosurgeon is the neurosurgeon who was on-call the previous night. In addition, the chief neurosurgery resident on call can function as the back up attending until the primary on-call attending or back up attending is available.

Orthopedics: The back up orthopedic surgeon will be the orthopedic surgeon on call for spine. If that orthopedic surgeon is the same as the on call surgeon for orthopedic trauma, the pediatric orthopedic surgeon on call will serve as back up attending. In addition, the chief orthopedic surgery resident on call can function as the back up attending until the primary on-call attending or back up attending is available.

*General Surgery Clinic*

General Surgery Clinic is held from 1:00 - 5:00 PM on Monday, Tuesday, and Thursday on the 7th floor of Rutledge Tower. Residents of the service which is not covering consults are expected to attend clinic every Monday. Residents are invited to attend any that they desire.

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4 06/04/10
Trauma Conferences\textsuperscript{5}

- **“Morning Report:”** Monday through Friday, 08:00 AM, Saturday and Sunday 08:30 AM CSB 419J. This conference is designed to insure continuity of care, and involves all of the trauma residents, trauma attendings, case managers, nurse managers, PT and OT, charge nurses, anesthesia, orthopedics, Trauma PI coordinator, Trauma Nurse Manager, and General Surgery Advanced Practitioners. Each patient on the service will be presented by the most senior resident present for the treating team, and pertinent care issues will be discussed. Teaching should, and will occur, at this conference.

- **“General Surgery Performance Improvement:”** every Wednesday, 09:00 - 10:00 AM, 419 J conference room. Presentation of PI cases and case discussion

- **“Joint Trauma ED Conference:”** every third Thursday of the month, 07:00 AM, 419 J conference room. Two cases are presented, one by an ED resident and one by a trauma resident, and discussed in a Socratic Fashion.

- **“Neurotrauma Conference:”** every second Thursday of the month. Case discussion, protocol development, and performance improvement relative to neurotrauma patients is discussed in a multi-disciplinary format

- **“Trauma Radiology Conference:”** fourth Thursday of the month, 12:00 - 1:00PM, 270 Main Hospital Radiology Conference Room. Trauma Case discussion with a focused review of pertinent imaging studies.

Adult Trauma Service Admission Criteria

The Trauma Service will be the clearinghouse for all trauma admissions that are admitted through the E.D.

Resource for Optimal Care of the Injured Patient, 2006\textsuperscript{6} states that the volume of trauma admissions is a very important and necessary requirement to maintain Level I verification by the ACS:

“A Level I trauma center must admit at least 1,200 trauma patients yearly or have 240 admissions with an Injury Severity Score (ISS) of more than 15 or and average of 35 patients with and ISS of more than 15 for the trauma panel surgeons (general surgeons who take trauma call). Each individual surgeon is not required to have 35 patients with an ISS of more than 15 as long as the average for all trauma panel surgeons is 35 cases. (ACS, Resources for Optimal Care of the Injured Patient, CD 2-3, 2006)”

We must ensure that all patients with traumatic injuries are filtered through the Trauma Service. Patients who are found to have isolated neurosurgical or orthopedic injuries may occasionally be admitted directly to the appropriate service, with the agreement of the attending trauma surgeon and with the caveat that a trauma consult be obtained. If a patient has a concomitant minor injury (AIS 1 or 2), they may still be admitted to neurosurgery or orthopedics for the primary severe injury (AIS 3 or greater).

\textsuperscript{5} 10/14/14

\textsuperscript{6} “Resources for Optimal Care of the Injured Patient” 2006, Committee on Trauma, American College of Surgeons, Chicago, Il
Multi-system injured trauma patients will be admitted to the General Surgery Red or Blue Service.
Trauma Alert and Trauma Consult Protocols

Transfers

All incoming trauma calls from referring physicians will go through the Admit Transfer Center and be referred to the on-call attending trauma surgeon. The on call trauma attending should request that all lab work, radiographic imaging studies, and pertinent documentation be sent with the patient. Patients who are transferred from another emergency room will be seen in the Emergency Department, and inpatient transfers will be admitted to the appropriate bed assignment. It is the responsibility of the trauma attending to notify the OR if it is anticipated that the patient will require emergent OR services.

Attending physicians from neurosurgery, orthopedics, ENT, plastics, and urology should be notified of any impending transfer which has an injury to any organ system relevant to their specialty.

If it appears that a patient will require transfer to MUSC, the attending surgeon accepting the patient will call the chief resident in order to make preparations to deal with any other possible associated injuries. It will be the responsibility of the trauma chief resident to notify any subspecialty residents about a transfer. If it is anticipated that there will be a strong need for a sub-specialist, the trauma chief resident will notify the pertinent subspecialty resident, who in turn will contact his/her covering attending.

The Emergency Department should be notified of all pending trauma transfers.

If the ATC operator is unable to reach the trauma attending who is on call in a timely fashion (i.e. 5 - 10 minutes), the call will be referred to the E.D. Attending in the Emergency Department, so that s/he will effect the transfer.

Ensuring the safe transport of a patient to MUSC is the responsibility of the referring provider. MUSC surgeons may advise the referring physician about transport decisions, but it will remain the referring physician’s responsibility to contact and arrange the transport. The emergency number for Meducare is (843) 792-33-11.

Level A Alert Protocol

In an effort to involve the trauma attendings early on in the resuscitation of the injured patient, a protocol has been devised through which a seriously injured patient is identified in the field and the attending physician notified prior to the patient's transport to MUSC. This protocol allows the trauma attending to be in the trauma bay within 15 minutes of patients arrival.

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7 05/18/10
8 10/12/11
Patients will be identified for early attending notification if they present with any one of the following criteria in the field:

<table>
<thead>
<tr>
<th>Level A Scene Transport</th>
<th>Physiologic Criteria</th>
<th>Anatomic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GCS ≤ 9 at time of EMS report</td>
<td>Penetrating injury to the head, neck, torso</td>
</tr>
<tr>
<td></td>
<td>Hypotension (SBP &lt; 90 mmHg) with suspicion of shock</td>
<td>Penetrating Injury proximal to the elbow or thigh with ongoing bleeding, expanding hematoma, and/or loss of peripheral pulses</td>
</tr>
<tr>
<td></td>
<td>Airway Difficulty secondary to trauma, respiratory Compromise (10 &lt; RR &gt; 29 bpm) with suspicion of respiratory compromise</td>
<td>Flail Chest</td>
</tr>
<tr>
<td></td>
<td>2 or more long bone fractures proximal to the wrist or ankle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crushed, degloved, or mangled extremity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amputation proximal to wrist or ankle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paralysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suspected pelvic fracture with hemodynamic instability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open or depressed skull fracture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd or 3rd degree burns &gt; 40% or with suspicion of smoke inhalation or hemodynamic compromise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emergency physician’s discretion</td>
<td></td>
</tr>
</tbody>
</table>
Any patient who is identified by the pre-hospital provider, by medical information (i.e. EnCode), the attending trauma surgeon, or the ED attending, as fulfilling one of these criteria requires activation of the Level A Trauma alert system. The necessity of an alert should be conveyed by the identifying individual directly to the individual in medical information, who will contact the attending physician directly. No details of the patient's injuries or hemodynamic status will be provided to the Trauma Attendings, in order to avoid any potential delays while information is transferred (or debated). The trauma attending will then proceed directly to trauma bay, with an anticipated arrival and sign-in within 15 minutes of the patient’s arrival within the Emergency Department.

Trauma attending response times, appropriateness of trauma alerts, and provider-related morbidity are monitored and presented at the bimonthly meetings of the Trauma Peer Review Committee and Trauma Operations Performance Committee. Persistent violation of the trauma attending response time criteria (i.e. sign-in within 15 minutes of patient arrival), is grounds for suspension from the trauma call roster. Suspension is at the discretion of the Trauma Director.

Level A Trauma Alert Personnel

The trauma team is comprised of the following personnel:
- Surgery PGY 4 or 5
- Surgery PGY 1 or 2
- ED Attending
- ED Resident
- Respiratory Therapy
- Blood Bank, Radiology
- ED Nurses
- STICU Nurse
- Trauma Attending

Note that the ED attending is responsible for the care of the patient until the Trauma Attending arrives within the trauma bay. The ED attending and the trauma chief
resident should work together to care for the patient. Any discrepancies or conflicts in the immediate management of the patient should be referred to the on call trauma attending, who should direct the care of the patient.

**Level B Trauma Alert Protocol**

The following criteria automatically activate the Level B Trauma Alert System:

<table>
<thead>
<tr>
<th>Level B Scene Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic Criteria</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>GCS &gt; 9 and &lt; 14 at time of EMS report</td>
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<tr>
<td>Burns &gt; 20% TBSA, or burns involving the airway</td>
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</tbody>
</table>

*Emergency physician’s discretion*

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9 10/12/11
Any patient who is identified by the pre-hospital provider, by medical information (i.e. the EnCode), the attending trauma surgeon, or the ED attending, as fulfilling one of these criteria requires activation of the Level B Trauma alert system. The necessity of an alert should be conveyed by the identifying individual directly to the individual in medical information, who will send out a text page identifying an incoming Level B Trauma patient.

Trauma attending response times, appropriateness of trauma alerts, and provider-related morbidity are monitored and presented at the bimonthly meetings of the Trauma Peer Review Committee and Trauma Operations Performance Committee.

**Level B Trauma Alert Personnel**

The trauma team is comprised of the following personnel:

- Surgery PGY 4 or 5
- Surgery PGY 1 or 2
- ED Attending
- ED Resident
- Respiratory Therapy
- Blood Bank, Radiology
- ED Nurses
- Trauma Attending

Note that the ED attending is responsible for the care of the patient until the arrival of the Trauma Attending. The ED attending and the trauma chief resident should work together to care for the patient. Any discrepancies or conflicts in the immediate management of the patient should be referred to the trauma attending, who should direct the care of the patient. If the trauma attending is not immediately present, the trauma chief resident must call the trauma attending once his/her evaluation is complete. Trauma attendings must be present in the trauma bay within 30 minutes of the arrival of a Level B alert patient.

If a Level B patient’s condition deteriorates before or after a patient’s arrival, an upgrade from Level B to Level A should be initiated. This will be paged as an upgrade.
Trauma Consultation Protocol

The following patients require Trauma Service consultation for their injuries while in the E.D.:

### Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma consults are encouraged, and should be requested at the discretion of the ED attending or by the admitting service</td>
</tr>
</tbody>
</table>

Note that mechanism alone does not warrant trauma consultation. It has been shown by Jones and Champion\(^{10}\) that impact velocities under 20 m.p.h. generally produce minor injuries whereas those greater than 25 m.p.h. (without a seat belt) and 35 m.p.h. (with a seat belt) can produce severe or lethal injuries.

**Trauma Consultation Personnel**

When a trauma consultation is requested, the patient may be seen by either the surgical resident, the trauma advanced practitioner, or by the trauma attending.

Note that the ED attending is responsible for the care of the patient. The ED attending and the trauma team should work **together** to care for the patient. Any discrepancies or conflicts in the immediate management of the patient should be referred to the on call attending, who should direct the care of the patient.

**Emergency Bypass for Trauma Care\(^{11}\)**

MUSC does not go on diversion for incoming trauma patients due to lack of bed availability. Bypass will occur only due to loss of a critical component of the trauma system.

By protocol, EMS agencies will not divert to another facility once a facility is contacted unless that other facility has agreed to accept the diversion. If no such acceptance is obtained, patients will be brought to the facility originally contacted. For this reason it is vital that, in an event that a critical MUSC resource is unavailable arrangements be made with other hospitals to accept MUSC diversion as soon as possible so that incoming EMS units can be rapidly and appropriately diverted.

The purpose of this policy is to ensure that trauma patients who would normally be transported to MUSC will be triaged to the appropriate facility, when MUSC has an internal emergency which restricts the capabilities of the Trauma Services:

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\(^{10}\) Jones IS, Champion HR: Trauma triage: Vehicle damages and estimate of injury severity. J. Trauma 29:646, 1989

\(^{11}\) Revised 06/04/10
• The area hospitals and Emergency Medical Services (EMS) will be notified, via phone by the charge nurse in the Trauma Center, that MUSC cannot handle the patient load due to an in-house emergency (i.e., non-functional operating room).

• The Emergency Service Attending will continue to provide on-line medical control for EMS en route to MUSC. In consultation with the Trauma Service, the Emergency Service Attending will negotiate disposition with other area designated Trauma Centers for those patients which exceed the capabilities of MUSC due to an internal emergency.

• Once the problem is resolved the charge nurse will notify the area hospitals and EMS.
Trauma Resuscitation and the Trauma Bay

Overview

The primary goal of resuscitation of the trauma patient is stabilization according to the ABC's of trauma care and the American College of Surgeons ATLS Guidelines:
- Airway management and cervical spine control.
- Breathing.
- Circulation and control of external bleeding.
- Neurologic assessment.
- Exposure, emotional support, control of the environment.

Resuscitation Team and Roles

The resuscitation team consists of two groups, those who are initially “Inside” the trauma bay, and those who are “Outside the Trauma Bay:
- Inside
  - Trauma Team Leader
  - MD 1
  - Airway
  - Respiratory Tech
  - RN 1
  - STICU RN (Level A Alerts Only)
  - ED Tech
  - Radiology Tech
  - Students (+/1)
- Outside
  - MD 2
  - RN 2
  - Pharmacy
  - Chaplain
  - Security
  - Charge RN
  - Hospital Supervisor
  - Respiratory Supervisor
  - Students (+/-)

The role of each member of the resuscitation team is outlined below.
- Team Leader: Chief Resident, Fellow, Trauma Attending or designee of the Trauma Service.
  - Assigns roles
  - Obtains MIVT reports
  - Stands at the head of the bed
  - Coordinates and communicates plan

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12 Trauma Bay Committee 07/01/14
• Is not actively involved in the resuscitation, but functions to direct the resuscitation.
• Directs all aspects of patient care
• Leads family discussions
• Communication with operating room and/or ICU.
• MD #1: usually PGY-2 or more senior surgical resident or EM resident
  • behind the red line unless needed
  • EPIC H and P, lab orders, radiology orders, blood orders
  • performs adjunct procedures under direction of the team leader
  • assist MD 1 as needed
• MD #2: Usually a PGY-1 or more senior surgical resident or EM resident
  • behind red line unless needed
  • EPIC H and P, lab orders, radiology orders, blood orders
  • perform adjunct procedure under direction of team leader
  • Assist MD #1 as needed
• Airway Team: EM attending and EM or senior surgery resident
  • performs airway assessment and management
• RN #1:
  • obtains peripheral IV access
  • administers IVFs and medications
  • Draws blood work (during secondary surgery)
  • ensures clear communication with RN 2
  • performs adjunct procedures (EKG, foley, NGT placement)
• RN #2:
  • recorder and admits patient into EPIC PTA
  • starts clock
  • completes trauma resuscitation documentation in EPIC
  • requests ancillary services (MTP, pharmacy, STICU RN)
  • maintains a clear line of communication with trauma team leader
• ED Technician
  • assures that all equipment and supplies for patient care are available, complete, and ready for use
  • attach patient to the monitor
  • armband placement
  • assist RN #1 with adjunct procedures (specimens to lab, collects patient valuables)
  • assist with patient transport
• Respiratory Therapist
  • assures pulse oximetry reading done
  • administers oxygen
  • airway maintenance as needed and under direction of the team leader
  • obtain ABG in all Level A trauma alert patients, and when requested by the team leader
  • assist with intubation (secure ETT, set up ventilator, and attach end-tidal CO₂)
• Radiology Technician
• Assures X-ray equipment available and ready
• ensures radiation protection for trauma team members prior to imaging
• takes and processes film at direction of trauma team leader
• must wear full BSI precautions

• Charge Nurse
  • Removes patients and/or family members from Rooms 2, 2a and 3 whenever possible to more private areas to avoid unnecessary exposure to the chaos of the trauma resuscitation.
  • Assists RN 1 and/or RN II if necessary. Note: Charge nurse should not remain in trauma resuscitation area if not directly involved in patient care

• Chaplain
  • Obtain patient identification and assist with notifying family members and relays information to RN 1 or RN 2.
  • Facilitates communication between family, patient, and staff.
  • Support families during visitation with patient.
  • Provide religious and spiritual support to patients, families and staff.
  • Provide grief support.
  • Collaborate with hospital supervisor, Security, and Guest Relations, to provide information for families and assists with directing them to appropriate areas within the hospital.
  • Remains in trauma admitting area only for as long as necessary to complete roles.

The positions and roles of each of the aforementioned personnel is diagrammed on the following page.
Diagram of Personnel Positions During Resuscitation

**AIRWAY #1**
- Airway Management
- C-spine Control
- Monitor Breath Sounds
- Check Pupillary reaction
- NG Tube Insertion

**MD #1**
- Primary Assessment
- Secondary Assessment

**STICU RN**

**RN #1 (RIGHT)**
- Monitor BP
- Rt. Arm IV insertion
- EKG Monitor Insert Foley

**TRAUMA CAPTAIN**
- Direct Assessment & Resuscitation
- Review Labs/X-rays
- Communicates with Consultants
- ED Thoracotomy

**RN #1 (LEFT)**
- Draw Labs
- Lt. Arm IV insertion
- Cut clothes

**X-ray Tech**
- Chest AP
- Pelvis AP

**MD #2**
- H and P
- Documentation in EPIC
- Orders Labs, Rads, Blood

**RN #2**
- Nursing Documentation in EPIC
- Stat Med Orders
- Obtain Supplies

**OB, OTHER**
- Moves to MD#2 or ED Tech as needed

**AUXILIARY PERSONNEL:**
- Rad Tech
- Pharmacy
- EMS
- Chaplain

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**Trauma Captain Designation**

A specific physician will have ultimate authority in directing the patient’s care. During the initial resuscitation phase of trauma victims, this physician will be designated as Trauma Captain. The physician designated the Trauma Captain may change during the care of the patient in the resuscitation phase. The basic principle governing this designation is that he/she will be the most experienced and skilled physician physically present in the Emergency Department who is rendering care to the trauma victim. It is recognized that the surgical attending staff would be so considered, and that the in-house trauma surgeon or senior surgical resident in-house is considered an attending physician by the Department of Surgery while tending to the needs of the trauma patient. This includes the granting of appropriate clinical and operative privileges. Based upon these tenets, the Trauma Captain shall be:

- Until the attending trauma surgeon is physically present in the Emergency Department, the Emergency Department attending physician is the Trauma Captain.
- Upon arrival of the in-house trauma surgeon or senior surgical resident, this surgeon assumes the responsibility of Trauma Captain.
- Upon arrival of the attending trauma surgeon, this surgeon assumes the responsibility of Trauma Captain.
- All orders of any kind during a resuscitation should be given by the Trauma Captain.

**Role of Neurosurgery and Orthopedics During Acute Resuscitation**

The Neurosurgical and Orthopedic residents will only be called to the Trauma Resuscitation area when specifically required by the Trauma Captain or Attending Trauma Surgeon.

**Dress Code for Trauma Resuscitations**

Personnel involved in the care of trauma patients will be expected to wear the following for:

- Level A Alerts
  - Non-sterile gloves
  - Clean cover gown
  - Glasses or other protective eyewear
  - Surgical hat or bouffant cap
  - Lead apron (depending on expected exposure to X-rays)

- Level B Alerts
  - Clean cover gown
  - Non-sterile gloves
  - Lead apron (depending on expected exposure

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14 Created 03/07/2012
Pre-arrival Preparations

Upon notification that a critically injured patient is to be brought to the Emergency Department, the following preparations will immediately take place. The Trauma Service Alert Page will activate all trauma pages if the criteria for a Red Trauma alert are met:

• An intubation tray and cricothyroidotomy tray (unopened) will be placed at the head of the stretcher.
• Oxygen and suction will be checked to ensure immediate readiness.
• Two liters of lactated Ringer's solution will be made ready for use and positioned at the foot of the stretcher.
• A monitor will be prepared for use.
• Level I rapid infuser will be checked and made ready.
• IV poles with blood pumps should be immediately available.
• A thoracotomy tray, chest tube tray, chest tube drainage equipment, cut-down tray and a pericardiocentesis needle should all be in the immediate vicinity of the patient. These trays should not be opened until the need is ascertained from the patient's clinical exam.
• Resuscitation room should be actively warmed in anticipation of the patient.
• As various members of the trauma team arrive, they should be prepared to perform their functions as directed by the Trauma Captain.

Ideal Time Course for a Resuscitation and ED Length of Stay Guidelines

Specific ED length of stay guidelines have been developed for the three major classifications of admitted trauma patients:

• **Trauma Patients being admitted to an ICU**: these patients should be moved as expeditiously as possible to the ICU due to their physiology, optimally from the CT scan gurney directly to the ICU. All consulting services will endeavor to do all of their care in the ICU: x-rays, surgical procedures, and consultant examinations. All necessary equipment will be provided via a specialized orthopedics "cart" and laceration tray that will be housed in the STICU. Radiology will provide tech support if required.

• **Trauma Patients Going to the OR**: If a trauma patient is going to the operating room that cannot be fully evaluated in the ED, the consulting services should be called on the way to the operating room, so that the consultants may have the opportunity to develop a plan of care, plan for films, and/or intervene while the patient is adequately sedated. This is, of course, dependent upon the patient's physiology at the conclusion of the primary operation. Questions as to whether or not a patient is a suitable candidate for this approach should be directed to the trauma attending.

15 03/22/12
Trauma Patients being admitted to the Floor: These patients must remain in the ED and have intervention’s requiring sedation prior to transfer to the floor. Outside of the OR and the ICUs, the ED is the only hospital location which provides adequate equipment, radiology support, and the ability to provide adequate sedation and analgesia.

The goal of the Trauma service is as follows:
- Two Hours: Patients needing surgery to control hemorrhage or evacuate intracranial hematomas should be in the OR within two hours
- Four Hours: Completely evaluate patients and obtain needed x-rays and diagnostic studies within four hours of admission
- Six Hours: Patients with an ischemic limb should be in the OR within six hours.
  Open fractures should be managed within six hours.

These goals are not difficult to achieve if the protocol is utilized and the team leader is efficient and keeps these times in mind.

Airway Management in the Trauma Bay

Assessment of Airway Patency

The assessment of airway patency is the first step in managing the trauma patient. If the airway is patent, no further intervention is necessary. Breathing is then assessed. If the airway is obstructed, manual techniques as listed below should be performed to attempt to open the airway.
- Chin lift
- Jaw thrust
- Remove foreign bodies and blood with large plastic-tipped suction and finger.
- No movement of the cervical spine is allowed during these maneuvers.

If these manual techniques result in a patent airway, it is maintained with one of the following:
- Oropharyngeal airway in the unconscious patient.
- Nasopharyngeal airway in the conscious patient
- Breathing is assessed next

Endotracheal Intubation

If these manual techniques fail to open the airway, the trachea must be intubated
- If the patient is apneic, direct laryngoscopy oral endotracheal intubation is performed, preceded by bag mask ventilation with 100% O2.
  - In-line cervical immobilization is maintained by an assistant to keep cervical movement to a minimum.
  - Vocal cords are visualized directly and an appropriate sized endotracheal tube is passed
  - Bilateral breath sounds are auscultated prior to fixing the tube in place. Patient is connected to the CO2 monitor.
Indications for Intubation
- GCS<=8
- Expanding Neck Hematoma
- Grade III/IV Hypovolemic Shock
- Respiratory Distress not Correctable with Tube Thoracostomy
- Apnea
- Traumatic Arrest per Guideline
- Hypoxia on FIO2>50%(SaO2<90)
- Patient requiring restraint (threat to himself/others)
- Airway obst. not relieved by suction or oral/nasal airway

Airway Evaluation

Easy

Trauma Airway/Highly Suspected C-spine Injury

Yes

Rapid Sequence intubation with in-line cervical stabilization and cricoid pressure

No

Difficult

Consult anesthesia

Intubate orally with cricoid pressure

- If the physician intubating the patient is unable to successfully pass the endotracheal tube after 30-45 seconds, the patient is oxygenated with a bag/mask apparatus and 100% oxygen and a second attempt at intubation is made.
- If two attempts to intubate by a physician experienced in airway management are unsuccessful, a cricothyroidotomy is performed.
- Tube is secured at 21-cm in a female and 23-cm in a male at the teeth.
- Successful placement of the ET tube is confirmed by color change on the ETCO2 monitor attached to the ET tube.
- If the patient requiring intubation is breathing, the preferred method of establishing a definitive airway is rapid sequence intubation (RSI). This
procedure should always be performed under the direct supervision of an attending physician with experience in airway management.

- The patient should be pre-oxygenated with 100% oxygen by NRB for 5 minutes or instructed to take 5 vital capacity breaths prior to medication. Patients undergoing RSI should not be bagged with positive pressure unless absolutely necessary.
- During this time, the physician performing RSI shall assemble and prepare all equipment deemed necessary for intubation. Any physician performing RSI must anticipate and prepare for the possibility of failed intubation in the paralyzed patient.
- Throughout the performance of RSI, an assistant shall be responsible for maintaining in-line stabilization of the patient's cervical spine. This assistant shall assume no other duties during this time.
- In head-injured patients with clinical evidence of elevated ICP, pretreatment with Lidocaine 1-1.5 mg/kg I.V. bolus may be given minutes prior to intubation to minimize further ICP rise during intubation.
- A defasiculating dose of Vecuronium (1 mg I.V.) may be given 3-5 minutes prior to intubation at the discretion of the attending directing the procedure.
- Short-acting sedation shall be administered 2-3 minutes prior to intubation.
  - The sedative of choice for most trauma patients is etomidate 0.3 mg/kg, as this has minimal adverse hemodynamic effect
  - Other choices for sedation include thiopental 2-4 mg/kg or midazolam 0.1-0.2 mg/kg and may be used at the discretion of the attending directing the procedure.
- At one minute prior to intubation, succinylcholine 1.5 mg/kg shall be administered. When neuromuscular blockade has been achieved (45-60 seconds), orotracheal intubation shall be performed via direct laryngoscopy as outlined in the above section.

*Nasotracheal Intubation*

In the awake, cooperative patient with spontaneous respiration's, blind nasotracheal intubation may be considered as an alternative to RSI.

- As the patient is pre-oxygenated with 100% oxygen by NRB, equipment should be prepared and tested.
- As with RSI, an assistant shall be devoted to maintaining in-line stabilization of the cervical spine throughout the procedure.
- The nose should be pretreated with cophenylcaine. The endotracheal tube (7 mm in females and 7-8 mm in males) should be lubricated with Surgi-lube or 2% lidocaine jelly.
- The tube is passed along the floor of the nasal passage until the tip lies immediately above the glottis, as evidenced by airflow through the tube. As the patient inspires, gentle pressure should be applied to the cricothyroid cartilage and the ETT should be advanced into the trachea to a level of 27 cm in females and 28 cm in males.
• Tracheal placement should be confirmed by continued airflow through the ETT, then the balloon should be inflated and placement checked by end tidal CO2 detector, auscultation, and CXR.
• The physician who places the ETT is responsible for maintaining tube position until the ETT has been taped securely in place.
• If two attempts at nasotracheal intubation by an experienced operator are unsuccessful, then an alternate method of airway management will be employed.
• Nasotracheal intubation is contraindicated in the presence of maxillofacial trauma, apnea, bleeding disorders, and in children. Relative contraindications include poor patient cooperation and symptomatic closed head injury.

Cricothyroidotomy

If either orotracheal or nasotracheal intubation has failed or if the patient has sustained significant maxillofacial trauma, cricothyroidotomy will be the procedure of choice for obtaining definitive airway control:
• Sterile technique will be utilized.
• The cervical spine will be maintained, immobilized in a neutral position.
• A transverse or vertical incision directly over the cricothyroid membrane is performed after appropriate local anesthesia has been obtained if the patient is conscious.
• A transverse incision is then made in the cricothyroid membrane without damaging either the cricoid or thyroid cartilage.
• The incision is spread using either a tracheostomy spreader or a hemostat.
• An appropriate size tracheostomy tube, (#4 Shiley) or endotracheal tube (#6 cuffed) is then inserted via the cricothyroidotomy.
• The tracheostomy tube is then fixed to the skin using sutures

Contraindications to cricothyroidotomy include:
• Direct laryngeal trauma - a formal tracheostomy will be performed (consider ENT consult)
• Patients less than twelve years of age - needle jet insufflation (needle cricothyroidotomy) will be performed in these patients.

Needle Jet Insufflation with Manual Jet Ventilator

Available in the ED, this technique should be used only rarely:
• Sterile technique will be used
• A 14 gauge angiocath will be used
• The cricothyroid membrane is punctured by directing the needle at a 45 degree angle to the skin and downward toward the feet.
• Once the airway is entered, the catheter is threaded into the airway and the needle is removed.
• A Lauer-lock connector from the jet insufflator is attached to the end of the 14 gauge catheter. This must be manually held in place.
• Adjust pressure manifold attached to O2 outlet in wall to 15 psi initially.
• Squeeze handle of jet insufflator to control inspiratory.
• Observe chest for adequate movement - if inadequate increase manifold pressure.
• The needle cricothyroidotomy will be revised to a tracheostomy once the patient’s condition is stabilized.
• This mode of airway control is contraindicated in patient with signs and symptoms of upper airway obstruction.

Post intubation, oxygenation should be maintained with is 100% $O_2$. Muscle relaxants may be required in order to control ventilation:
• Vecuronium 0.1 - 0.2 mg/kg (recommended)
• Succynlicholine 1-1.5 mg/kg: Contraindicated in burns and massive soft tissue trauma because of the risks of hyperkalemia.
• Lidocaine 1 mg/kg IVP may be given to head-injured patients during intubation to minimize changes in ICP.)
• Etomidate .2-.3 mg/kg IV: has the least hemodynamic depressant effects. Lasts 5-8 min.

Cervical Spine Management in the Trauma Bay

The cervical spine will be immobilized on the following trauma patients:
• Unconscious trauma patient.
• Any patient with trauma above the clavicles.
• Any patient who has sustained a significant deceleration injury.
• Any patient with neck pain.
• Any patient with physical findings suggesting cervical spine injury (tenderness, muscle spasm over neck, neurologic findings in extremities).

The cervical spine will be maintained immobilized until "cleared" by c-spine clearance algorithm (see C, T/L/S Spine Clearance, p. 140-143 ). Any cervical spine injury is an indication for a Spine Service Consultation.

Cervical spine movement after a normal lateral film will be kept to a minimum until an anteroposterior cervical spine film and an open mouth view of the C1 and C2 are obtained and are normal. Flexion/extension films should be done to completely rule out c-spine injury in any patient with an abnormal physical exam.

Procedure for immobilizing cervical spine:
• The patient will be placed on a long backboard.
• A blanket or towel roll will be placed about the head.
• Alternatively, IV fluid bags may be used on either side of the head or "ferno immobilization bolsters."
• A cervical collar (appropriate size for the patient) will be positioned around the neck.
• Tape will be used across the forehead to fix the head to the backboard.
• A strap will be used to fix the upper torso to the backboard.

If the patient has been immobilized during the pre-hospital care, the immobilization must be maintained until radiographic clearance is obtained. The anterior portion of the
cervical collar may be temporarily removed at any time for access to the neck for examinations or procedures. It should be replaced when access is no longer needed.

**Vascular Access in the Trauma Bay**

All trauma patients must have at least two intravenous lines inserted on presentation. The intravenous lines should be at least 16 gauge caliber, with extension tubes placed on all IVs. These lines may be inserted percutaneously or via cut-downs in one of two locations:

- Saphenous vein at the level of the ankle
- Median antecubital vein in the antecubital fossa.

The following patients should also have a central venous line inserted for central venous pressure monitoring. This step may be omitted at the discretion of the Trauma Team Leader:

- Any patient who has sustained significant blunt thoracic trauma.
- Any patient who has been resuscitated from a traumatic cardiopulmonary arrest.
- Any patient with pre-existing cardiac, pulmonary, or renal disease.
- Any patient with penetrating thoracic trauma.
- Any patient with a greater than 40-50% TBSA burn.

The location of any intravenous lines should be determined by the pattern of injuries:

- Any patient with hypotension associated with thoracic trauma must have at least one intravenous line established in a lower extremity.
- Any patient with hypotension associated with abdominal trauma must have at least one intravenous line established in an upper extremity.

**Saphenous Vein Cut-down**

Technique:

- Sterile technique will be used.
- A transverse 2-3 cm incision is made one finger-breadth superior and one finger-breadth anterior to the medial malleolus.
- The vein is isolated using blunt dissection.
- The saphenous vein is encircled twice with 3-0 suture and the distal vein is ligated.
- A transverse venotomy is performed and a large bore catheter is threaded proximally.
- The proximal 3-0 suture is tied about the vein and catheter to prevent back-bleeding.
- The wound is then closed about the catheter.

Saphenous vein catheters should be removed as soon as the patient has been completely resuscitated because of the propensity for infection and phlebitis. This should be done within 24 hours of the patient being stabilized following his resuscitation.

**Central Venous Lines**
The preferred central venous access in the trauma patient consists of a cordis introducer, placed in a femoral vein, although lines may be placed in multiple sites:

- Subclavian vein
- Internal jugular vein
- A long (24") line passed via the basilic or cephalic vein

A central line should not be placed through a vein that is potentially injured (i.e., a right subclavian line should not be placed in a patient with a potential right subclavian venous injury). Note that these lines are not to be used as one of the two resuscitation lines, as fluid rates are not great enough through these longer intravenous lines. If a subclavian line is to be placed, it should be inserted on the site of a pre-existing chest tube, unless there is suspicion of a major vascular injury on that side. A chest film must be obtained after placement of a central venous pressure line to ascertain its position for monitoring. Central venous lines placed in E.D. should be removed or changed in 48-72 hours.

*Intraosseous Needle Placement*\(^{16}\)

The most common site recommended for intraosseous (IO) insertion is the proximal tibia because it provides a flat surface with a thin layer of overlying tissue and ease of identifying landmarks. Also, it is distant from the airway and chest, where resuscitation attempts are in progress. The procedure for IO insertion in the proximal tibia is as follows:

- Identify the tibial tuberosity, just below the knee, by palpation.
- Locate a consistent flat area of bone 2 cm distal and slightly medial to the tibial tuberosity. (Identifying these landmarks helps avoid hitting the growth plate.)
- Support the flexed knee by placing a towel under the calf.
- If time permits, cleanse the area with an iodine solution and drape it. Perform insertion using sterile gloves and technique.
- Inject local anesthetic (1% lidocaine) into the skin, into the subcutaneous tissue, and over the periosteum, especially if the patient is awake.
- Insert the IO needle through the skin and subcutaneous tissue; this should occur easily. Upon reaching the bone, hold the needle with the index finger and thumb as close to the entry point as possible and, with constant pressure on the needle with the palm of the same hand, use a twisting motion to advance the needle through the cortex until reaching the marrow. A 10-15° caudal angulation may be used to further decrease the risk of hitting the growth plate, but direct entry parallel to the bone is acceptable.
- Advance the needle from the cortex into the marrow space, at which point a popping sensation or lack of resistance is felt. Do not advance the needle any farther.

\(^{16}\) 10/13/14 Crookes
• The first indication of proper placement occurs when the needle stands up on its own. At this point, remove the inner trocar, attach a syringe to the needle, and aspirate bone marrow. Obtaining marrow confirms placement.

• If marrow is not aspirated, push a 5-mL to 10-mL bolus of isotonic sodium chloride solution through the syringe. Resistance to flow should be minimal, and extravasation should not be evident. Observing the calf area is important.

• If flow is good and extravasation is not evident, connect the intravenous (IV) line with a 3-way stopcock at the needle, and secure the needle with gauze pads and tape.

Although fluid may run from the IV line by gravity, the rate is too slow for resuscitation. Faster rates of infusion occur by drawing up 30-mL to 60-mL aliquots from the intravenous bag and administering manual fluid boluses via the stopcock. Administering medications this way is much easier, as well, and it provides more accurate administration of fluid to small infants. As an alternative for larger boluses, an intravenous pump or pressure bag can be used to increase flow.

The procedure for IO insertion in the proximal humerus is as follows:

• Position the patient so the shoulder is adducted and the greater tuberosity is most prominent by lying the patient supine, arm at his or her side, with the palm overlying his or her umbilicus.

• Palpate the proximal humerus, and identify the greater tuberosity.

• Insert the needle at a 90-degree angle directly into the greater tuberosity.

• Follow technique as detailed above

Algorithm for Fluid Resuscitation in the Trauma Bay

Crystalloid Resuscitation

All trauma patients will receive lactated Ringer's Solution as the initial resuscitation fluid. In children under 16 years of age, first bolus will be with D5RL. All fluids should be warmed if possible. The rate of fluid administration should be determined by the hemodynamic stability of the patient:

• Hemodynamically Stable: lactated Ringer's will be infused at a measured rate determined by the Trauma Team.
• Hemodynamically Unstable: If the patient has a systolic blood pressure of 90 mmHg or less, he/she will receive 2,000 cc of lactated Ringer's as rapidly as it can be administered.

If the patient remains hypotensive after this infusion, immediate surgical intervention will be undertaken.

If after 2,000 cc of lactated Ringer's Solution, the patient has become normotensive, the IV infusion will be slowed to 500 cc/hour.
• At this point, if the patient relapses into shock, the IV infusion will be increased and immediate surgical intervention will be undertaken (“Elevator Test”).
• If the patient remains normotensive after slowing the infusion, the rate will be adjusted according to the clinical status and appropriate diagnostic tests will be obtained.

An overview of fluid resuscitation can be found in the diagram on the following page.
Algorithm for Fluid Resuscitation in the Trauma Bay

1. Systolic Blood Pressure < 90 mmHg
   - Rapid Infusion of 2000 cc Lactated ringer's Solution
     - Systolic Blood Pressure < 90 mmHg?
       - Yes: Begin Transfusion O-neg or Type-specific
       - No: Slow Infusion Rate to 500 cc/hr
         - Systolic Blood Pressure < 90 mmHg?
           - Yes: Adjust infusion rate per clinical status, Obtain appropriate diagnostic tests
           - No: Immediate Surgery Begin Transfusion O-neg or Type-specific
Resuscitation with Blood Products and the Adult Major Transfusion Protocol

All Level A trauma patients will have a specimen drawn for the blood bank to perform a type and screen for at least 2 units PRBC's. A Jewett Blood Bank refrigerator is maintained in the Emergency Department and is stocked with six units of O negative blood and 6 units of O positive blood\textsuperscript{17}.

- If the trauma patient remains hypotensive after 2,000 cc of lactated Ringer's solution has been infused, transfusion of RBC's will be begun (O-negative or type specified blood, depending on availability). An ABC score should then be determined for the patient, to assess for need for the initiation of the Massive Transfusion Protocol.
- If the trauma patient relapses into shock after the crystalloid infusion has been slowed, transfusion of RBC's will be begun (O-negative, type specific or cross-matched blood), depending on availability. An ABC score should then be determined for the patient, to assess for need for the initiation of the Massive Transfusion Protocol.

The ABC score is positive if the patient scores $\geq 2$ after a 2 L bolus and:

- there is a penetrating mechanism ($0 = \text{no}, 1 = \text{yes}$)
- SBP of 90 mmHg or less ($0 = \text{no}, 1 = \text{yes}$)
- HR of 120 bpm or greater ($0 = \text{no}, 1 = \text{yes}$)
- Positive FASR ($0 = \text{no}, 1 = \text{yes}$)

The MTP may also be activated at Trauma Attending discretion.

\textsuperscript{17} 06/04/10
Adult Major Bleed Protocol

Patient scores ≥ 2 on ABC score after 2L fluid bolus
Penetrating Mechanism (o=no, 1=yes)
SBP of 90 mm Hg or less (0=no, 1=yes)
HR of 120 bpm or greater (0=no, 1=yes)
Positive Fast (0=no, 1=yes)
OR
Trauma Attending Discretion

Attending surgeon notifies the charge nurse/designee to activate major bleed protocol
Blood Bank notified as follows:
This is ______, we are initiating the Adult Major Bleed Protocol for TV ______
MRN ______ age ______ sex ______ When the stat pack is ready call ______
If patient changes location
To OR: stat pack will be delivered to OR lab and Blood Bank will call OR charge nurse (6-6306) to obtain OR room phone number
To STICU: Blood Bank will call STICU Charge Nurse phone number (6-6037)

If initiated in ED send Trauma A profile draw and send to lab with crossmatch
If initiated in OR/ICU send Blood gas long panel/PO2,PCO2,ph,HCO3,TCO2,02 Sat,BE,Na,K,C,Ion Ca,Glu,HGB,HCT) and PT, PTT and ensure cross match previously sent
Correct hypothermia (warm blankets,Bair hugger,warm fluids)
Consider O neg blood until stat pack arrives (Available in ED/OR)

First Stat Pack
PRBC 8
FFP 8
Draw lab after each stat pack
ABG long panel / PT/PTT

HD Unstable
Start TXA: loading dose 1 gram over 10 minutes and then start infusion of 1 gram over 8 hours

Second Stat Pack
PRBC 8
FFP 8
Platelets 1

HD Unstable

Third Stat Pack
PRBC 8
FFP 8
Platelets 1

HD Unstable

>3 Stat Packs
Attending physician to determine ratio of blood products for further stat packs guided by
ROTEM when available

Consider
Calcium Replacement
Factor VII (if ongoing hemorrhage despite intervention)
Draw CBC/ Fibrinogen / D-dimer
If patient has pH<7.25/temperature>33/platelets < 50,000
Call Pharmacy per MUSC Factor VII Guideline

ROTEM guided resuscitation
ACT>110 include FFP
Angle> 60 include OXY
MA<50 include Platelet
EPL>15% consider additional dose of TXA

Discontinuing MBP
MBP will continue in ED, OR and ICU until bleeding is controlled, efforts deemed futile, or correction of lab values in normothermic patient. Final decision made by trauma attending surgeon.
All blood should be warmed during administration.

Fresh frozen plasma (FFP) will be administered for the following indications:
- Evidence during or after surgery of the development of a consumptive coagulopathy as determined by the trauma surgeon
- Prothrombin time at greater than 1 1/2 times control

Platelets will be administered for the following indications:
- Evidence during surgery of the development of a consumptive coagulopathy as determined by the attending surgeon
- Platelet count < 30,000
- Platelet count < 50,000 with evidence of ongoing hemorrhage

Albumin should never be used in the resuscitation of trauma patients, as it has been shown to increase mortality\(^\text{19}\), especially in the setting of head injury\(^\text{20}\).


Algorithms for the reversal of “second generation” anticoagulants are below. In any patient who is on Rivaroxaban, Apixaban, or Dabigatran, early reversal is paramount. In addition, strong consideration should be given to aggressive imaging (i.e. “pan scan”) in these patients.

**RIVAROXABAN or APIXABAN PROTOCOL**

1. **Bleeding Suspected**
   - Obtain baseline CBC, aPTT, PT, platelets, and fibrinogen

2. Patient taking APIXABAN AND aPTT ≥ 36 sec
   - Mild bleeding:
     - A drop in Hgb of < 2 gm/dL, OR
     - A decrease in HCT of < 10%
     - Administer blood products as needed; repeat CBC

3. Patient taking RIVAROXABAN AND PT ≥ 16 sec
   - Moderate-to-Severe bleeding:
     - A drop in Hgb of 2 – < 5 gm/dL, OR
     - A decrease in HCT of 10-15%
     - Administer blood products as needed, (additional supportive care with fluids if needed)

4. Life-threatening bleeding:
   - A drop in Hgb of ≥ 5 gm/dL, OR
   - A decrease in HCT of >15%
   - Urgent surgical intervention required, OR
   - Bleeding at a critical site*
   - Administer blood products as needed
   - Administer Factor IX Concentrate (Profilnine® SD)
   - Administer Anti-Inhibitor Coagulant (FEIBA® NF) 50 units/kg

5. Did patient respond?
   - Yes
     - Continue to monitor
   - No
     - Administer additional blood products as needed, consider
       - Factor IX Concentrate (Profilnine® SD)
       - Anti-Inhibitor Coagulant (FEIBA® NF) 25 units/kg

6. Repeat doses require hematology consult

* Note: Bleeding at a critical site: intracranial, intraspinal, intraocular, retroperitoneal, intra-articular, or pericardial, or intra-muscular with compartment syndrome

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**DABIGATRAN REVERSAL PROTOCOL**

**Bleeding Suspected**
Obtain baseline CBC, aPTT, TT, platelets, and fibrinogen

- **Mild bleeding:**
  - A drop in Hgb of < 2 gm/dL, OR
  - A decrease in HCT of < 10%
  - Administer blood products as needed; repeat CBC

- **Moderate-to-Severe bleeding:**
  - A drop in Hgb of 2 - < 5 gm/dL, OR
  - A decrease in HCT of 10 - 15%
  - aPTT < 36 sec and TT < 20 sec
  - Administer additional blood products as needed, **consider**
    - Factor IX Concentrate (Profilnine® SD)
    - OR
    - Anti-Inhibitor Coagulant Complex (FEIBA® NF)
    - 25 units/kg

- **Life-threatening bleeding:**
  - aPTT ≥ 45 sec or TT ≥ 40 sec, plus
  - a drop in Hgb of ≥ 5 gm/dL, OR
  - a decrease in HCT of > 15%, OR
  - Urgent surgical intervention required, OR
  - Bleeding at a critical site*
  - aPTT > 45 sec or TT > 40 sec
  - Factor IX Concentrate (Profilnine® SD)
  - OR
  - Anti-Inhibitor Coagulant Complex (FEIBA® NF)
  - 50 units/kg

**Did patient respond?**
- Yes
  - Continue to monitor
- No
  - Administer additional blood products as needed, **consider**
    - Factor IX Concentrate (Profilnine® SD)
    - OR
    - Anti-Inhibitor Coagulant Complex (FEIBA® NF)
    - 25 units/kg
  - aPTT 36 – 45 sec and TT > 20 sec
  - Factor IX Concentrate (Profilnine® SD)
  - OR
  - Anti-Inhibitor Coagulant Complex (FEIBA® NF)
  - 25 units/kg

**Repeat doses require hematology consult**

*Note: Bleeding at a critical site: intracranial, intraspinal, intraocular, retroperitoneal, intra-articular, or pericardial, or intra-muscular with compartment syndrome*
Rapid Initial Neurologic Exam for the Trauma Bay

This is an initial emergency assessment/screening to be used in the trauma bay during a level A patient assessment when time is of the essence. This should not be used in level B alert patients, or elective settings because some sublet injuries may be missed.

MD #1 should examine:

- Pupil response, position
- Face symmetry
- Upper extremities: can patient lift arms off bed (antigravity or not) squeeze hands (strong, weak, absent)
- Lower extremities: can patient lift leg off bed (straight leg raise), if not can they bend knees up off bed. Also check ankle plantar flexion/dorsiflexion
- Can patient feel pain in arms and legs? (pinch them)

This exam should take 20 seconds, and will diagnose approximately 90% of traumatic injuries. If the patient cooperates and follow commands, higher cortical functions are working, including language. This also assesses:

- Cranial nerves 3, 4, 6, 7 (midbrain, pons)
- upper and lower C-spine and lumbar spine
- spinothalamic tracts
- corticospinal tracts.

If a positive finding, do a more detailed focused exam quickly (should take another 30 seconds. Once stabilized, patient still needs a detailed neurological exam, but this quick initial exam will cover major injury complexes.

Nasogastric/Orogastric Tubes in the Trauma Bay

Indications:
- Any trauma patient who has sustained abdominal trauma.
- Any trauma patient who is unconscious.
- Any trauma patient with clinical signs of a paralytic ileus or acute gastric distention.
- Mechanically ventilated patients.
- Patients undergoing peritoneal lavage.

Contraindications:
- Any trauma patient with massive maxillofacial trauma.

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23 Crookes, Turner 08/15/11
• Any trauma patient with a suspected cribriform plate fracture.
• Infant less than 30 days of age.

In the intubated patient, orogastric tubes are preferred over nasogastric tubes.

**Foley Catheters in the Trauma Bay**

**Indications:**
• Any trauma patient requiring fluid resuscitation.
• Any trauma patient undergoing a diagnostic peritoneal lavage.

**Contraindications**
• Any trauma patient with clinical evidence of a possible urethral injury.
  • Meatal blood
  • Perineal or scrotal hematoma
  • High-riding prostate
• Patient less than 2 years of age
• Any trauma patient with a pelvic fracture in whom difficulty in passing the Foley catheter is encountered.
• Any patient who does not meet the indications for insertion, above. **When in doubt, leave the foley out!**

In patients with any of the contraindications above, a retrograde urethrogram will be obtained.

If a Foley catheter is indicated in a trauma patient who’s clinical status appears stable, a freely voided urine specimen should be obtained prior to placing the catheter.

**Tube Thoracostomy in the Trauma Bay**

The need to place a chest tube, may be determined based upon clinical indications. In the setting of these indications, radiographic imaging is contraindicated:
• Any trauma patient with evidence of a tension pneumothorax.
• Any trauma patient with an open pneumothorax.
• Any trauma patient who is hypotensive and has absent breath sounds over one side.
• Any patient who has sustained penetrating trauma above the costal margin and will be placed on positive pressure ventilation in the operating room.

When the patient's clinical status permits, a chest radiograph will be obtained prior to insertion of a tube thoracostomy. Radiographic indicators include:
• Any pneumothorax or hemothorax resulting from penetrating trauma.
• Any pneumothorax in a patient who has sustained blunt trauma.
• Any hemothorax which has resulted from blunt chest trauma.

**Technique of Insertion**

Sterile technique is to be used throughout the procedure.
• The patient is positioned with the ipsilateral arm held above the head.
• Local anesthesia is used to anesthetize skin and subcutaneous tissue.
• Insertion site for most trauma tube thoracostomies will be in the midaxillary line in the 4th or 5th intercostal space.
• A 3 cm incision is made at the inferior border of the rib below the desired intercostal space (e.g. inferior border of the 6th rib to place a tube in the 5th intercostal space).
• Once the rib is reached, a second dose of local anesthetic is used to anesthetize the intercostal muscle and pleura.
• Using blunt dissection, a tunnel is created over the superior border of the rib and into the pleural space.
• This opening is enlarged to admit an appropriate size tube (28-36 French).
• The tube is directed through the opening and posteriorly toward the apex of the pleural space.
• The tube is positioned so that the last hole is within the pleural cavity.
• Sutures are used to fix the tube in place.
• The tube is connected to a water seal system with 15-20 cm water (H2O) suction applied.
• An occlusive dressing is applied about the tube to prevent air leaking back into the pleural space.
• A chest radiograph will be obtained to confirm the position of the tube and the presence of a fully expanded lung.

Cefazolin 1 gram IV should be given prior to chest tube placement in non-emergent situations. Chest tubes placed emergently should be followed by cefazolin 1 gram IV q 8 hours for 24 hours.24

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration</th>
<th>Cost / Therapy</th>
</tr>
</thead>
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<tr>
<td>Cefazolin</td>
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<tr>
<td></td>
<td>1 gram</td>
<td>Q8H X 24 hours post chest tube placement</td>
<td>$ 12.42</td>
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<td>IF PENICILLIN-ALLERGIC:</td>
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<td>Prior to chest tube placement. OR</td>
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<tr>
<td>Clindamycin</td>
<td>600 mg</td>
<td>Q8H X 24 hours post chest tube placement</td>
<td>$ 35.34</td>
</tr>
</tbody>
</table>

24 EAST Trauma Practice Guidelines; Parameters for Prophylactic Antibiotics in Tube Thoracostomy for Traumatic Hemopneumothroax, Copyright EAST 1998. EAST Trauma Practice Guidelines; www.EAST.org

25 06/07/10
Blunt and Penetrating Traumatic Arrest Resuscitation

In general, the Trauma service follows the algorithm published by the Western Trauma Association for resuscitation following blunt and penetrating traumatic arrest. Significant individual practice variation may occur, however, and all resuscitations in these circumstances are run by the trauma attending who is present for the arrest. Any traumatic arrest will undergo a mandatory review within the context of the Trauma Performance Improvement Process, and will be reviewed individually by the Trauma Medical Director. Algorithms for the management of these entities are found on the ensuing two pages:
Blunt Trauma Resuscitation Algorithm

Bruce Crookes, MD FACS
06/19/2014

Adopted from:
Penetrating Trauma
CPR < 15 min
Penetrating trauma to the neck or extremities with > 5 min of CPR heralds non-salvagability

Yes

Patient Undergoing CPR with no signs of life
no respiratory or motor effort, electrical activity (HR < 40 bpm), or pupillary activity

No

Profound Refractory Shock:
CPR with signs of life or systolic BP < 60 mmHg

Resuscitative Thoracotomy

Cardiac Activity?

Yes

Cardiac Injury?

Yes

Repair Heart

No

Tamponade?

Yes

No

Thoracic Hemorrhage?

Yes

Control

No

Air Embolism?

Yes

Hilar Cross Clamp

No

Extrathoracic Hemorrhage?

Assess Viability

OR

SBP < 70 mmHg
Apply aortic cross clamp

Bruce Crookes, MD FACS
06/19/2014
Adapted from: "WTA Critical Decisions in Trauma: Resuscitative Thoracotomy" J of T 2012 (73(6): 1359-63
Emergency Department Thoracotomy

Indications for an ED thoracotomy:

Any trauma patient who arrives in the Emergency Department with signs of life (pupillary reaction, respiratory effort, cardiac rhythm) but unconscious with no obtainable blood pressure after establishment of airway access, ventilation and appropriate venous access

Any trauma patient who has sustained penetrating trauma, has signs of life at the scene and arrives in the Emergency Department without signs of life

Airway access, ventilation and appropriate venous access will be established prior to thoracotomy

Assumes a transport time of 10 minutes or less

Any trauma patient who arrives in the Emergency Department with an obtainable blood pressure and pulse and loses these vital signs in the Emergency Department

Contraindications to ED thoracotomy:

Note that these contraindications may be superseded at the discretion of the Trauma Captain present in the Emergency Department room.

Any trauma victim who had no signs of life at the scene, and despite EMS resuscitation efforts, has no signs of life upon arrival in the Emergency Department will be pronounced dead on arrival.

Any blunt trauma victim who arrives in the Emergency Department without signs of life

Technique of ED thoracotomy:

Clean technique will be used

A left fifth interspace anterolateral thoracotomy incision is utilized

The incision can be extended into the right chest if there appears to be a major source of hemorrhage in the right chest.

The pericardium is opened anteriorly in the vertical direction and any tamponade that is present will be evacuated. Watch for phrenic nerve, which courses along the lateral aspect of pericardium.

Two-handed cardiac massage is performed anterior and posterior to heart.

Digital pressure is used to control any source of major hemorrhage.

The descending aorta is occluded at the diaphragm either by direct compression against the vertebral column or by placement of a non-crushing vascular clamp.
Standard medications are used for cardiac resuscitation. Internal defibrillation can be performed using 10 - 40 joules energy.

**Terminating resuscitation:**

If there is no cardiac activity and no pericardial tamponade, resuscitation will continue for a maximum of 20 minutes to attempt to bring arterial pH and temperature to within a normal range.

If a cardiac tamponade is evacuated, resuscitation will be continued until systolic blood pressure is greater than 60 mmHg. At this point, the patient will be transferred to the operating room.

If a cardiac tamponade is evacuated, but a systolic blood pressure of 60 mmHg cannot be achieved, resuscitation efforts will be terminated after a maximum of 30 minutes.

**Tetanus Prophylaxis**

In general, tetanus prophylaxis should be addressed in the trauma bay:

- For children younger than seven years old: DTP (DT, if pertussis vaccine is contraindicated) is preferred to tetanus toxoid alone. For persons seven years old and older, Td is preferred to tetanus toxoid alone.
- If only three doses of fluid toxoid have been received, a fourth dose of toxoid, preferably an adsorbed toxoid, should be given.
- Prophylaxis should be given if it has been more than 10 years since last dose.
- Prophylaxis should be given if it has been more than five years since last dose. (More frequent boosters are not needed and can accentuate side effects)

**Wound Classification**

<table>
<thead>
<tr>
<th>Clinical Features</th>
<th>Non tetanus-prone Wounds</th>
<th>Tetanus-Prone Wounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of wound</td>
<td>&lt; 6 hours</td>
<td>&gt; 6 hours</td>
</tr>
<tr>
<td>Configuration</td>
<td>Linear wound , abrasion</td>
<td>Stellate wound, avulsion</td>
</tr>
<tr>
<td>Depth</td>
<td>&lt; 1 cm</td>
<td>&gt; 1 cm</td>
</tr>
<tr>
<td>Mechanism of injury</td>
<td>Sharp surface (e.g. glass, knife)</td>
<td>Missile, crush, burn, frostbite</td>
</tr>
<tr>
<td>Signs of infection</td>
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<td>Present</td>
</tr>
<tr>
<td>Devitalized tissue</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Contaminants (dirt, feces, soil, saliva,etc)</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Denervated, and/or ischemic tissue</td>
<td>Absent</td>
<td>Present</td>
</tr>
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</table>
Summary of Tetanus Prophylaxis for the Injured Patient

<table>
<thead>
<tr>
<th>History of Adsorbed Tetanus Toxoid (doses)</th>
<th>Non tetanus-Prone Wounds</th>
<th>Tetanus-Prone Wounds</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Unknown or &lt; 3</td>
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<tr>
<td>&gt; 3 2</td>
<td>No3</td>
<td>No</td>
</tr>
</tbody>
</table>
Management of Trauma In the Pregnant Patient

Decision for alert activation

If a pregnant patient is injured, and the fetus is \( \geq 24 \) weeks gestation, then:

- if the patient meets level A criteria, and an **OB trauma alert Level A** should be paged
- if the patient meets level B criteria **OB trauma alert Level B** should be paged
- if the patient meets neither level A or B trauma alert criterion, **OB Injury Alert** should be paged.

*Caveats in the management of the traumatized pregnant patient*

Generally, maternal condition takes precedence over that of the fetus. There are obstetrical complications in pregnancy that jeopardize maternal health and warrant immediate treatment:

- Maternal blood loss is often underestimated. Blood pressure typically will not decrease until at least 1500 mL of blood loss has occurred.
- Retroperitoneal hemorrhage occurs more frequently with gestational trauma than in the presence of a non-gravid uterus.
- Bowel injuries are less frequent in gestational trauma because of the protective effect of the gravid uterus.
- Splenic rupture is the most common cause of intraperitoneal hemorrhage found in gestational trauma. Liver and spleen trauma occur in up to 25% of severe MVA's. Rib fractures are associated with splenic and hepatic injuries.
- Minor injuries including minor MVC can lead to placental abruption, fetal maternal hemorrhage, and premature birth. Uterine irritability, tenderness, uterine tetany, maternal bleeding, and fetal tachycardia may be signs of those complications.
- Vaginal bleeding, abdominal pain and uterine contractions are the cardinal warning signs of a placental abruption. However, 20% of placental abruptions may occur without external bleeding.
- Pelvic fractures correlate with an increase frequency of placental abruption, retroperitoneal hemorrhage, urinary tract injuries, uterine rupture, and fetal head position.

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29 04/15/10
• Abdominal complaints and abnormal findings may not be present initially and diagnostic tests are not as definitive as in the non pregnant patient.

• Tocolytic therapy must be used with discretion and sensitivity for side effects as well as potential hazards.

• Pregnancy should not be the rationale for compromise or modification of the evaluation and treatment plan for the gravid trauma patient.

• Diagnostic tests (radiography) and therapy should be directed primarily at the care of the mother and should not be delayed or compromised because of the pregnancy.

• Tetanus toxoid can and should be given if otherwise indicated.

• Magnetic resonance imaging is not recommended in the first trimester secondary to a lack of safety information

• When multiple diagnostic X-rays are performed consider consultation with Radiation Safety to determine fetal dose

• Consider keeping the pregnant patient, 20 weeks gestation, tilted left side down 15 degrees to keep the pregnant uterus off the vena cava and prevent supine hypotension syndrome.

• The mother is the initial priority and fetal/placental disorders can cause significant maternal morbidity and mortality. It is for this reason, even more then fetal salvage, that continuous fetal heart rate monitoring and tocometry is essential during the trauma work up.

The greater the severity of the maternal trauma, the more likely a significant fetal insult will occur.

Algorithms for the management in trauma in pregnancy and the management of of neonatal resuscitation of a delivery as a result of trauma are on the following pages.
Clinical Guideline for the Management of Trauma In Pregnancy

Clinical Guideline for the Management of Trauma in Pregnancy

Does patient meet Trauma Level A or B Activation Criteria and is pregnant with gestation age > 24 weeks

Yes

Page “OB Trauma Alert Level A or B”
This team consist of trauma team, OB attending, OB chief, OB charge nurse, and Neonatal Stabilization Nurse

1. All OB trauma team members will respond to ED. Neonatal Stabilization RN will notify Neonatal Stabilization Team if birth is expected in the ED or OR. Neonatal Stabilization Team will notify Pediatric Surgery as necessary.
2. Send type and screen
3. Determine gestational age by fundal height, history or ultrasound
4. Shield Abdomen

No

Did patient experience any traumatic injury and gestational age is >24 weeks

Yes

Page “OB Injury Alert”
This team consist of OB attending, OB chief resident, and OB charge nurse

Follow usual ER guidelines
Consult Obstetrical Service after stabilization

Is patient stable

Yes

Clinical evaluation and continuous fetal monitoring by OB chief resident and/or OB nurse in consultation with OB attending

If not already done activate “OB Trauma Alert Level A or B”
Resuscitate per ATLS protocols
Obtain 0 Negative PRBC for fetus

No

Further work up and imaging studies to be determined by trauma team in consultation with OB team

Is patient stable

Yes

immediate delivery necessary

No

To OR

Yes

Suspicion of other Abdominal Injuries?

Yes

Midline vertical abdominal incision for entry

Incision of Choice in consult with Trauma Attending

if mother’s condition does not allow for admission to L&D the OB service will determine the plan for FHR monitoring prior to mother leaving the ED

No

Other injuries identified

Yes

Admit L & D

No

During initial evaluation if patient > 24 weeks gestation and requires procedures or X-rays FHR will be continuously monitored by the OB nurse or physician
If continuous FHR monitoring is discontinued for any reason the OB attending must be notified immediately

No

Yes

If patient requires OR

1. Chief OB resident will notify stab team and assure availability of equipment in MAIN OR
2. Trauma team to reserve one unit non crossmatched O negative PRBC’s for neonatal use

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30 08/01/11
Neonatal Resuscitation of a Delivery as a Result of Trauma

Guideline for Neonatal Resuscitation of a Delivery as a Result of Trauma

1. Decision made to deliver fetus?
   - No: Chief OB resident will notify Neonatal Stabilization Nurse and L&D nurse re decision to admit for observation
   - Yes: Neonatal Stabilization Nurse will page Neonatal Stabilization Team and confirm O-negative PRBC availability from blood bank or ED supply

2. NRP Resuscitation
   - Is patient responding to resuscitation?
     - No: Bolus PRBC’s or Normal Saline 10-20 cc/kg Repeat once if required
     - Yes: Admit to Level II or III nursery per clinical condition

3. Response to Bolus?
   - No: Transfuse with 10-20cc/kg of blood
   - Yes: Obtain Hct on admission, repeat in 2 hours

4. Response to Treatment?
   - No: Continue resuscitation per NRP guidelines
     - Repeat transfusions / NS bolus
     - Obtain Hct, coagulation studies including platelets
     - STAT surgical evaluation
     - Transfuse platelets and FFP for evidence of continued bleeding or in response to abnormalities in lab profiles
   - Yes: Check Hct

5. Hct Results Received
   - <30: Transfuse with 20 cc/kg PRBC’s check coagulation profile and platelets as indicated
   - >30: Recheck every 2 hours until stable and when stable transfer to Level One Nursery

Notes:
1. Volume depletion secondary to blood loss might present with signs of shock but a relatively normal hematocrit. Transfusion should be considered regardless of hematocrit in any infant with suspected blood loss who does not respond to interventions.
2. In atraumatic abruptio placentae, fetal blood loss is not a common problem and it is not necessary to have O negative blood available in these circumstances.
3. In all forms of trauma, with or without direct injury to the utero-placental-fetal unit, there is a significant risk of hypoxic-ischemic injury to the fetus.
Trauma Diagnostics and the Evaluation of Specific Injury Complexes

Monitoring

During the performance of all diagnostic tests, the patient must be monitored with:

- Blood pressure measurements
  - every 5 - 15 minutes for the first hour, depending on the patient’s overall condition
  - Vital signs at least hourly thereafter.
- Continuous cardiac monitor.
- Neurologic checks at least every hour for patients with head injury or spinal cord injury.
  - Glasgow Coma Score
  - Pupils
  - Extremity movement.

Ongoing monitoring during diagnostic tests will be provided by the Emergency Department nurse and trauma surgeon, depending on patient’s overall condition

Blood Panels

Three types of blood panels are available for assessment of the trauma patient:

- **Level A Trauma Alerts**: performed on all Level A trauma alert patients, or with a physician’s order
  - Trauma A Profile: PT, PTT, Urinalysis, BMP, CBC, Ethanol
  - Trauma A Profile for Females of Childbearing Age: PT, PTT, Urinalysis, BMP, CBC, HCG, Ethanol
  - Trauma A Profile for Pregnant patients: PT, PTT, Urinalysis, BMP, CBC, HCG, Ethanol, Fetal Hgb, Fib
- **Level B Trauma Alerts**: done on minimally injured trauma patients per MD request
  - Trauma B Profile for female childbearing age: HCG
  - Trauma B Profile for pregnant patients: PT, PTT, CBC, HCG, Fetal Hgb, Fib
- **Type and Screen**: Physician or RN may draw blood for T & S in an emergency.

Electrocardiology

Electrocardiography shall be performed on the following patients:

- Trauma patients who have sustained a significant anterior chest wall trauma
- Trauma patients who have sustained a significant deceleration injury (30 m.p.h. motor vehicle accident, three story fall)
- Trauma patients who have sustained electrical injuries

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32 Revised 10/1/09, Reviewed 03/18/10
Standard Radiographic Studies

Studies Available within the trauma bay include:

- AP chest radiograph: obtained on all patients
- Pelvis x-ray (AP)
  - All patients involved in deceleration accidents (motor vehicle accidents, falls) shall have a pelvic film performed.
  - All patients suspected of having sustained a cervical spine injury shall be entered into the C-spine Protocol, and require c-spine imaging
    - Unconscious trauma patients
    - Patients who have sustained significant blunt or penetrating trauma above the clavicle
    - Patients involved in significant deceleration injuries
    - Physical signs or symptoms suggesting a cervical spine injury
- T/L/S spine imaging
  - All patients who are unable to have a reliable exam shall have complete thoracic and lumbar spine films.
- Other films will be obtained as clinically indicated.

Ultrasound Studies (FAST Examination)

A FAST (Focused Abdominal Sonogram in Trauma) is indicated in any patient who has sustained significant blunt abdominal trauma and the potential for an intra-abdominal injury is present.

- Only physicians credentialed by the Division of General Surgery in the FAST program will be doing the ultrasound.
- The performance of the ultrasound will in no way interfere with the normal diagnostic and therapeutic procedures to be performed on the trauma patient.
- Sonograms will be performed during the primary survey in the ED resuscitation phase

The standard protocol for performing the exam is as follows:

- The transducer will be placed in the subxiphoid area and the heart identified. Adjustment of acoustic power, depth, and gain will be made and defined at this time using the density of blood as a standard; further adjustments will be made for each patient based on body habitus. The subxiphoid approach through the longitudinal axis (sagittal section) of the heart will be used to examine for blood in the pericardium.
- The transducer is then placed in the right mid-axillary line region between the eleventh and twelfth ribs to identify the liver, kidney, and diaphragm, and to examine for blood in the tissue planes between the liver and kidney, i.e. the hepatorenal recess, or Morison's pouch.
- Next, the transducer is positioned on the left posterior axillary line between the tenth and eleventh ribs to visualize the spleen and kidney and to seek blood in the space between these organs and posterior to the spleen.
- The transducer is oriented for coronal sections and placed midline approximately 4 cm superior to the symphysis pubis. Gain and power are adjusted downward...
to approximately 80% for adequate visualization. The bladder is identified as an anechoic structure and the pouch of Douglas examined for blood.

A negative sonogram along with a U/A that has no blood will obviate the need for abdominal CT in the low risk patient at discretion of the Attending Trauma Surgeon.

If the patient is hemodynamically stable, a positive or equivocal FAST for fluid in hemodynamically stable patients will have a CT of the abdomen and pelvis. Positive FAST in a hemodynamically unstable patient will mandate OR exploration.

A positive FAST examination can be defined by the “McKenney Score,” which is determined by measuring the depth of the largest fluid collection to the nearest tenth of a centimeter, adding one point for each additional area in which fluid is identified:

- McKenney Score ≥ 3: 87% chance of a therapeutic laparotomy
- McKenney Score < 3: no need for an operation (85% of patients)

**Pericardial Window**

All patients that are admitted with penetrating chest injuries (especially those with parasternal injuries between the nipples) should be suspected of having pericardial tamponade.

All patients with penetrating chest injuries and stable vital signs will have an Echocardiogram performed.

- If there is no pericardial effusion or evidence of cardiac injury, the patient may be admitted to a telemetry bed.
- If there is evidence of a pericardial effusion, the patient should be taken to the OR for a subxiphoid window
  - If blood is found in the pericardial sac, a sternotomy will be performed at that time

If the patient has no obtainable blood pressure and is suspected of pericardial tamponade, an emergency thoracotomy should be performed.

**Computerized Tomography (CT Scans)**

**Overview**

CT Scans are a primary diagnostic tool in the evaluation of the blunt trauma patient. Note, however, that they are to be used only in patients that are hemodynamically stable.

**CT Scan of the Brain**

The indications for a brain CT Scan will be determined by the Neurosurgical Service or by the trauma surgeon when appropriate consultations have been obtained. In CT

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Scans of the head, non-enhanced CT's are used, 2.5 mm images and 5 mm images. The Neurosurgical Service will determine if the neurologic condition of the patient is too unstable to warrant diagnostic tests. The Trauma Attending will determine when the cardiovascular condition is too unstable to warrant diagnostic tests.

**CT Scan of the Spine**

CT Scans of the cervical, thoracic, and lumbar spine should be obtained in accordance with the BST/Orthospine algorithms for spine clearance. Please see pages 140-143 for a detailed explanation of the algorithm.

**CT Angiogram (CTA) of the Neck**

Computed Tomography Angiogram (CTA) may be utilized to screen for blunt or penetrating traumatic injury of the carotid and vertebral arteries of the neck. MR angiogram may be substituted at the discretion of the Trauma, Neurosurgical or Orthospine Services.

The following patients would be considered for CTA or MRA:
- Closed head injury and mandibular fracture
- Basilar skull fracture
- Patient with focal neurologic deficits which could not be explained by CT findings
- Patient with closed head injury and seizures
- Patient with an ischemic locus on CT following trauma
- Horner’s Syndrome
- Neck hematoma
- Penetrating injuries to the neck in the absence airway compromise, expanding hematoma, or hemodynamic instability (98% sensitive, 98% specific)
- “clothesline” injuries to the neck

All positive CTAs mandate a vascular or a neurosurgical consultation (discretion of the trauma attending). Equivocal studies mandate carotid and vertebral angiogram. The decision with regard to surgical vs. non-operative management (i.e. anticoagulation) will be based on evaluation by the appropriate consultants.

**CT Scan of the Abdomen and Pelvis**

Peritoneal lavage may be substituted for CT Scan of the abdomen at the discretion of the attending trauma surgeon. The indications for CT Scan of the abdomen are the same as for peritoneal lavage in blunt abdominal trauma, but are limited to the following patients.
- Patients 17 years of age or less who have sustained abdominal trauma
- Patients who have sustained abdominal trauma more than 24 hours prior to presentation

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• Patients suspected of having sustained a retroperitoneal injury on the basis of clinical signs, symptoms or lab results
• Patients suspected of having sustained an intraparenchymal or subcapsular hematoma of the liver or spleen on the basis of clinical signs, symptoms or lab results who are candidates for conservative management of their injuries (see splenic/liver injuries).
• Postoperative patients suspected of having developed an intra-abdominal abscess on clinical grounds.
• CT Scans are preferable to IVP for the evaluation of renal and ureteral injuries

Contraindications to obtaining a CT Scan of the abdomen and pelvis include:
• Indication for surgical intervention (e.g., shock, peritonitis, etc.)
• Patients whose condition is too unstable to warrant diagnostic tests

The technique for a CT Scan of the abdomen and pelvis is as follows:
• CT scan of the abdomen will be performed in all instances using contrast medium. Both IV and oral contrast (either p.o. or via NG) will be given prior to the study. It is only necessary to give approximately 200 cc of oral contrast approximately 20 minutes prior to procedure - it is not necessary to wait 1-2 hours after giving p.o. contrast as in elective CT scan of abdomen. The main advantage of the p.o. contrast is to outline the bowel
• IV contrast is required to evaluate for the presence of liver, splenic, ureteral, and bladder injuries
  • Five minute delays are required
  • Bladder delay films are required
• For penetrating flank wounds, rectal contrast may be used.

The CT Scan of the abdomen will be performed under the auspices of the Radiology Department. The patient will be accompanied by a physician member of the BST Team who will remain with that patient and monitor his clinical status throughout the course of the CT Scan.

**CT Scan of the Chest**

Any patient who demonstrates signs on a chest radiograph indicating a potential aortic transection must have their aortic arch imaged unless contraindicated. Radiographic signs identified on routine AP CXR include:
• Superior mediastinal widening equal to or greater than 8 cm on a standard 100 cm AP projection
• Shift of the trachea to the right of midline
• Loss of the sharp contour of the aortic knob
• Obliteration of the medial aspect of the left upper lobe
• Opacification of the clear space between the aorta and pulmonary artery
• Depression of the left main stem bronchus
• Fractures of 1st or 2nd ribs
• Apical capping on x-ray
• Displacement of NG tube to the right
Any patient who has sustained a significant deceleration (defined below) injury will undergo an arch aortogram for diagnosis

- Head-on motor vehicle accident at 30 m.p.h. or greater
- Evidence from either the vehicle or the physical examination of a significant deceleration injury (i.e., bent or broken steering wheel, star-burst windshield, steering wheel imprint, sternal fracture)
- Falls from 30 feet or higher

A dynamic CT of the chest may be substituted for angiography as a screening technique for mediastinal blood. Those patients who screen positive for mediastinal blood must undergo an arch angiogram to rule out aortic transection. All chest CTs must be read by an Attending radiologist who is familiar with the findings of the chest.

Patients whose condition too unstable to warrant diagnostic tests should not undergo imaging of the thoracic aorta.

**Peripheral Arteriograms**

Indications for obtaining an arteriogram in the trauma patient are as follows:

- Penetrating trauma
  - Any penetrating injury with associated findings indicating a possible vascular injury will undergo an arteriogram (CT or peripheral) for diagnosis unless contraindicated.
  - Patients whose only indication for arteriogram is proximity of the missile to a major artery do not need to undergo arteriography unless there are physical findings or an abnormal extremity/brachial index in the extremity suggesting an arterial injury (<0.9: systolic blood pressure in the affected extremity/systolic blood pressure in an uninjured extremity – preferably an uninjured upper extremity).

- Blunt trauma
  - Any blunt injury with associated physical finding or an abnormal extremity/brachial index in the extremity indicating a possible vascular injury will undergo an arteriogram (CT or peripheral) for diagnosis unless contraindicated.
  - Non-visualization of one kidney on an IVP or CT.

Contraindications to peripheral arteriograms include:

- Patient's condition too unstable to warrant diagnostic tests.
- Evidence of compartmental hypertension.
- Limb-threatening ischemia.
- Obvious arterial injury that warrants exploration.

Arteriograms will be performed in the Radiology Department by a staff angiographer if at all possible. During the angiogram, the patient will be accompanied by a physician member of the BST Team who will remain with that patient and monitor his clinical status throughout the course of the angiogram. The arteriogram will be interpreted by the staff radiologist.
After the completion of the arteriogram, the catheter will be removed and compression will be maintained at the puncture site for at least 5 minutes. The Trauma Service and the Vascular Service will determine the need for surgical intervention.

The Trauma or Vascular Surgery Service may perform a peripheral arteriogram in the Operating Room or the Emergency Department if the patient's condition warrants emergency surgical intervention.

Arch Aortogram

Any patient who demonstrates signs on a chest radiograph indicating a potential aortic transection must have their aortic arch imaged unless contraindicated. Radiographic signs identified on routine AP CXR include:

- Superior mediastinal widening equal to or greater than 8 cm on a standard 100 cm AP projection
- Shift of the trachea to the right of midline
- Loss of the sharp contour of the aortic knob
- Obliteration of the medial aspect of the left upper lobe
- Opacification of the clear space between the aorta and pulmonary artery
- Depression of the left mainstem bronchus
- Fractures of 1st or 2nd ribs
- Apical capping on x-ray
- Displacement of NG tube to the right

Any patient who has sustained a significant deceleration (defined below) injury will undergo an arch aortogram for diagnosis

- Head-on motor vehicle accident at 30 m.p.h. or greater
- Evidence from either the vehicle or the physical examination of a significant deceleration injury (i.e., bent or broken steering wheel, star-burst windshield, steering wheel imprint, sternal fracture)
- Falls from 30 feet or higher

A dynamic CT of the chest may be used as a screening technique for mediastinal blood. Those patients who screen positive for mediastinal blood must undergo an angiogram to rule out aortic transection. All chest CTs must be read by an Attending radiologist who is familiar with the findings of the chest.

Patients whose condition too unstable to warrant diagnostic tests should not undergo imaging of the thoracic aorta.

All CT angiograms which are performed to evaluate for the presence of an aortic injury will have carotid and vertebral runoff to look for blunt cervical arterial injuries.

Cystogram/Urethrogram

Indications for a cystogram or urethrogram are as follows:

- Penetrating pelvic trauma that potentially crosses the midline.
- Patients suspected of having a bladder injury on clinical grounds.
Any pelvic fracture where suspicion of bladder or urethral injury is present.

Contraindications include:
- Patients suspected of having a urethral injury on clinical grounds as outlined below (must be preceded by a retrograde urethrogram).
- Patients whose clinical condition is too unstable to warrant diagnostic tests.

The technique for obtaining a cystogram or urethrogram is as follows:
- **Urethrogram.**
  - The penile meatus is cleansed and red rubber catheter attached to a 50 cc syringe (Toomey) is introduced into the meatus.
  - The penis is held obliquely and the x-ray beam is directed perpendicularly to the penis.
  - About 20 cc of contrast material is introduced and the film is obtained as another 10 cc of contrast is introduced.
- **Cystogram -** (Note: CT cystogram may instead be obtained if bladder injury suspected prior to CT scan)
  - If urethrogram is normal Foley inserted into bladder.
  - Renograffin infused by gravity through Foley until patient complains of urge to void (approximately 250 cc needed).
  - Foley clamped, A.P., lateral and oblique films taken of pelvis with contrast in bladder.
  - Foley unclamped, contrast allowed to drain and a post-evacuation film taken to assess for any residual contrast in the pelvis.

Results:
- All retrograde urethrograms and cystograms will be reviewed by the trauma service and radiology service.
- The need for surgical intervention will be determined by the trauma surgeon.

**Proctoscopy**

Indications for rigid proctoscopy are as follows:
- Gross blood on rectal examination.
- Penetrating pelvic trauma that potentially crosses the midline.
- Retained foreign body.

The contraindications to proctoscopy is hemodynamic instability

Technique:
- Adequate suction with a long metal suction tip and normal saline irrigation will be available.
- The patient will be placed in a Syme's position for the test.
- The rectal mucosa will be viewed as the scope is advanced to at least 15 cm.

Results:
- The Trauma Service will perform the diagnostic test.
Any area of rectal mucosa that is suspicious for injury will be treated as an injury and thus constitute an indication for surgical intervention.

**Diagnostic Peritoneal Lavage**

**Indications:**
- Blunt abdominal trauma:
  - CT showing free fluid with solid organ injury **and** equivocal physical exam.
  (used rarely)
- Penetrating trauma:
  - Lower thoracic penetrating injuries (between 4th intercostal space and costal margin)
  - Penetrating flank or back trauma (posterior to mid-axillary line, between costal margins and iliac crest)
  - Tangential abdominal gunshot wounds

**Contraindications** include any indication for surgery (i.e. peritonitis, hemodynamic instability)

**Technique:**
- A closed, percutaneous technique is to be used except in the special circumstances outlined below.
- The bladder and stomach must be decompressed prior to performance of peritoneal lavage by placing a Foley catheter and a nasogastric tube.
- Sterile technique will be used.
- A needle is inserted (two finger-breadths below the umbilicus in the midline) into the peritoneal cavity and guide-wire is introduced through the needle.
- The needle is withdrawn and the peritoneal lavage catheter is introduced over the guide-wire, aiming toward the pelvis.
- The guide-wire is withdrawn and the catheter is aspirated with a syringe. If gross blood or more is aspirated, the diagnostic test is terminated.
- If no blood is aspirated through the catheter, one liter (or 15 cc/kg if a child) of lactated Ringer's Solution is introduced through the catheter.
- Fluid is then siphoned from the peritoneal cavity per gravity.
- At the completion of the test, the catheter is removed.
- The fluid returned from the peritoneal cavity will be sent for the following tests:
  - RBC Count
  - WBC Count
  - Dipstick for bile
  - Gram stain for bacteria, vegetable matter
  - Amylase level

**Special cases:**
- Pelvic fractures
  - The peritoneal lavage will be performed utilizing an open technique (see below).
  - The peritoneal lavage will be performed in a supra-umbilical location.
• Pregnancy
  • The peritoneal lavage will be performed using an open technique (see below).
  • The peritoneal lavage will be performed above the level of the fundus of the uterus as determined by palpation.
• Previous midline incisions
  • The peritoneal lavage will be performed utilizing an open technique (see below).
  • The peritoneal lavage will be performed in an avascular line (i.e., midline or lateral border of the rectus sheath) away from the previous incision.

Open technique for peritoneal lavage:
  • Sterile technique will be used.
  • Local anesthetic is infiltrated in the area of the incision.
  • The vertical incision is made and carried to the level of the fascia, which is also incised vertically.
  • Careful hemostasis is obtained in the incision.
  • The peritoneum is identified and grasped with two forceps.
  • A small opening is made in the peritoneal cavity under direct vision.
  • The fascial incision is closed using non-absorbable sutures.
  • The skin incision is then closed.
  • The remainder of the procedure is the same as in the closed technique.

Positive results:
  • Blunt abdominal trauma.
    • \( \geq 100,000 \text{ RBC's/mm}^3 \)
    • \( \geq 500 \text{ WBC's/mm}^3 \)
    • Presence of bile, bacteria or vegetable matter
  • Penetrating abdominal trauma
    • \( \geq 1,000 \text{ RBC's/mm}^3 \)
    • \( \geq 500 \text{ WBC's/mm}^3 \)
    • Presence of bile, bacteria or vegetable matter

A positive peritoneal lavage result constitutes an indication for surgical exploration.

**Evaluation and Diagnosis of Specific Traumatic Injuries:**

The following pages delineate specific care algorithms for the evaluation of specific injury complexes.
Algorithm for the Evaluation of Penetrating Abdominal Trauma

Evaluation of Penetrating Abdominal Trauma

1. Penetrating Trauma True Abdomen
   - CXR
     - Chest tube if appropriate

2. Stab Wound
   - Peritoneal Signs
     - Hemodynamic Instability
     - Evisceration
       - NO
         - Posterior or flank wound
           - Yes
             - Triple contrast CT
               - Negative
                 - No
                 - Evaluate for possible discharge
               - Positive
                 - Yes
                   - Attending Consultation Regarding Laparotomy
                     - Laparoscopy
                     - Admission for serial exams
                     - DPL
                   - No
                     - Contact attending possible admit for observation OR, DPL

3. GSW
   - Peritoneal signs/
     - Hemodynamic Instability
     - present
       - Yes
         - OR
       - No
         - Tangential Wound
           - No peritoneal signs
             - Yes
               - Injury confined to RUQ (suspect isolated liver injury)
                 - OR
                 - No
                   - Abdominal CT/
                     - Discuss finding with Attending
                   - No
                     - Attending Consultation Regarding Laparotomy
                       - Laparoscopy
                       - Triple Contrast CT
                       - Admission for serial exams

4. Do not probe wounds
   - Do not explore wounds involving the rib cage
Algorithm for the Evaluation of Blunt Abdominal Trauma

Evaluation For Blunt Abdominal Trauma

Serial Physical Exams

- Normal
  - Observe
  - Hemo-dynamically Unstable
    - Ultrasound
      - Positive
        - Negative for Intraperitoneal fluid
          - Observe
        - Positive for Intraperitoneal fluid
          - Discuss with Trauma Attending
      - Hemo-dynamically Stable
        - Ultrasound
          - Abdominal/ Pelvic CT Scan
            - Discuss with attending
    - Hemo-dynamically Stable
      - Abdominal/ Pelvic CT Scan
      - Observe
- Abnormal
  - Exploratory Celiotomy
  - Blunt Abdominal Trauma
    - Hemodynamically Unstable
      - Abdominal/ Pelvic CT Scan
      - No Visceral Injury
      - Hemo-dynamically stable but intoxicated or has altered mental status or distracting injuries or need for general anesthesia
      - Discuss with Trauma Attending

Algorithm for the Evaluation of Cervical Spine Injuries\textsuperscript{37}

1. These guidelines apply to all patients presenting to the trauma center with cervical collars in place. Any patients meeting the guidelines for suspicion of cervical spine injury should be placed in a semi-rigid collar immediately upon recognition that the patient falls into these guidelines.

2. For the purpose of this guideline, a radiographic study is considered normal when interpreted as such by an attending radiologist. If the attending radiologist is not available and immediate interpretation is necessary for the ongoing care or patient discharge, the senior radiology resident will read the films.

3. Responsibility for removal of the cervical collar rests with the trauma service, and in particular with the trauma attending. The advice of radiologists and the various consultants involved in any single patient’s care will be taken into consideration. But, for patients remaining on the trauma service, the order to remove the cervical collar will be the responsibility of the trauma service.

\textsuperscript{37} 03/16/10
Cervical Spine Evaluation

Cervical Spine Evaluation

Cervical Clearance Screen
- Posterior midline cervical tenderness?
- Focal neurological deficit?
- Acute mental status change?
- Suspected intoxication/drug use?
- Pain that may distract from cervical pain?

Yes → Cervical CT scan with reconstructions

If no neurological deficit consult Spine Service (with deficit consult Neurosurgery)

Negative

Intubated or distracted patients
- (mental status change/intoxication/pain)

Yes → Place in long term collar

No → D/C collar

Patient Symptomatic?
- (tenderness without deficit)

If patient has any neurological deficit consult Neurosurgery

Yes → Mental Status improves

MRI within 72 hours if patient’s condition allows. If patient to unstable for MRI leave in collar

No → MRI positive

MRI negative

Consult Spine Service

Consult Trauma Attending

Study positive

Study negative

Consult Spine Service

Remove collar

An order must be written to remove c collar
Removal of c collar must be discussed and approved by attending
Use caution, no method of c spine clearance is 100% reliable

38 Reviewed 01/14/14
Algorithm for the Evaluation of Thoracic and Lumbar Spine Injuries

Guidelines for the Evaluation of Thoracic and Lumbar Spine Injuries

Patients with appropriate mechanism should be placed or remain on a backboard unless GCS=15 and patient has no neurological deficit or complaints of back pain.

Complains of back pain/Neurological deficit

- NO
- Yes

Log roll patient examine for tenderness/deformity

- NO
- Yes

Remove Backboard

- Consult Neurosurgery
- Any spinal fracture requires work up of entire spine

Altered Mental Status TBI, suspected drug/alcohol intoxication

- Yes
- NO

Obtain appropriate CT scans for level of symptoms

- CT scan Positive
- CT scan Negative

Consult Spine Service or Neurosurgery

- Remove from backboard maintaining spinal precautions (Keep flat in bed)
- Re exam when normal mental status and re initiate guideline

Appropriate CT scans with entire spine reconstructions

- CT scan Positive
- CT scan Negative

Any spinal fracture requires work up of entire spine

- 03/16/2010
Algorithm for the Evaluation of Blunt Myocardial Injury

Guidelines for Evaluation of Blunt Myocardial Injury

**Significant Blunt Chest Trauma**

**Cardiogenic Shock Suspected**

- **Normal**
  - Yes: Admit to ICU
  - No: Follow normal flowchart

- **Abnormal**
  - Yes: Swan Ganz Catheter to confirm cardiac origin of shock
  - No: New murmur or rub?

**New murmur or rub?**

- **Yes**
  - Echocardiogram within 24 hours
  - Normal: Admit for 24 hours of cardiac monitoring
  - Abnormal: Cardiology Consult

- **No**
  - Significant Arrhythmias present
    - **Yes**
      - Cardiology Consult
    - **No**
      - Discontinue monitoring unless otherwise indicated

**Cardiac Enzyme testing is of no clinical value**

1. Cardiac Enzyme testing is of no clinical value
2. Patients with Blunt myocardial injury can be safely operated upon with appropriate monitoring

Rev. 03/16/10
Algorithm for the Evaluation for Urological Injury in Patients with Suspicion of Blunt Abdominal Trauma

Urological Evaluation of Patient with Suspicion of Abdominal Trauma

- Will patient need foley catheter
  - Yes: High Riding Prostate Blood at Urethral Meatus Scrotal Hematoma
  - No: Obtain Clean Catch specimen at first opportunity

  - No: Place Foley / Obtain Urine Specimen
    - No: Gross Hematuria
      - Yes: Perform CT with IV Contrast
        - > 50 RBC's per HPF
          - Yes: Injury Detected
            - No: No further Evaluation
          - No: Perform CT with IV Contrast
        - No: No further Evaluation
    - Yes: Retrograde Urethrogram
      - No: Normal
        - Yes: Abnormal
          - Yes: Consult Urology for Suprapubic Catheter
          - No: Patient Hemodynamically / Neurological Stable
            - Yes: Does patient need Abdominal / Pelvic CT
              - No: No further Evaluation
              - Yes: Send Specimen to Lab
                - > 50 RBC's per HPF
                  - Yes: Injury Detected
                    - No: No further Evaluation
                  - No: Perform CT with IV Contrast
                - No: No further Evaluation
            - No: Obtain 2 shot Cystogram and IVP in ED or as appropriate
              - No: Injuries Detected
                - Yes: Discuss with trauma attending
                - No: No further Evaluation
            - Yes: Normal
              - Yes: Patient Hemodynamically / Neurological Stable
                - Yes: Does patient need Abdominal / Pelvic CT
                  - No: No further Evaluation
                  - Yes: Send Specimen to Lab
                    - > 50 RBC's per HPF
                      - Yes: Injury Detected
                        - No: No further Evaluation
                      - No: Perform CT with IV Contrast
                    - No: No further Evaluation
                - No: Obtain 2 shot Cystogram and IVP in ED or as appropriate
                  - No: Injuries Detected
                    - Yes: Discuss with trauma attending
                    - No: No further Evaluation
              - No: Injuries Detected
                - Yes: Discuss with trauma attending
                - No: No further Evaluation

Rev. 03/16/10
Algorithm for the Evaluation of Penetrating Neck Injuries

Penetrating Neck Injuries

Wound penetrates platysma

Yes

To OR STAT

Exsanguinating Hemorrhage/ Hemodynamic Instability

No

Close Wound as Appropriate

Determine Zone of Injury

Multiple Zones

Zone I
Below Cricoid Cartilage/Above Clavicle

Follow algorithm for Zone 1 and /or 2 Consult with Attending Surgeon

Zone II
Above Cricoid Cartilage/Below Angle of Mandible

S/S of Major Injury (hematoma, SQ emphysema, hemoptysis, hoarseness, hematemesis)

Yes

CT Angio/Angio Bronchoscopy Esophagoscopy Contrast Swallow

No

Injury Detected on testing or in OR

Yes

Injury Detected

CT Angio/Angio Laryngoscopy Pharyngoscopy Contract Swallow

Discuss with Attending

Injury Detected

Discuss with Attending

Injury Detected on testing or in OR

Yes

Treat as Appropriate

Patients with evidence of SCI
Radiological evaluation of the Spine should be performed as soon as patients condition allows

No

Discharge Home

Treat as Appropriate

Admit for observation / CXR in 3 hours from injury

CT Angio/Angio

Laryngoscopy

Pharyngoscopy

Contrast Swallow

OR

Possible OR (Discuss with attending)

Treat as Appropriate

Rev. 05/18/10

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Algorithm for the Evaluation of Penetrating Extremity Injuries

OR STAT

Yes

Exsanguination

No

Obtain AP/Lat X-rays

Hard Signs of Vascular Injury?

Yes

Shotgun Wound

Active Bleeding

Yes

OR

No

Angio

Discuss results with Trauma Attending

No

No

Yes

ABI < 0.90

CT Angio

Discuss finding with trauma attending

Contact attending trauma for possible admission

No

Hard Signs of Vascular Injury
1. Distal Ischemia (pain / pallor / pulselessness / paralysis / parathesia)
2. Audible Bruit and/or palpable Thrill
3. Large Expanding or Pulsatile Hematoma
4. Active bleeding

Rev. 03/16/10

43 03/16/10
Management of Neurologic Injuries

Initial Management of Traumatic Brain Injuries

Indications for a Head CT:
- All adult patients who sustain a head injury with loss of consciousness.
- Children with a loss of consciousness may not require a head CT - a decision not to have one will be made by the Neurosurgery Attending.
- Any patient who presents with a head injury and either lateralizing neurologic signs and/or dilated nonreactive pupil will have a STAT CT of the head.
  - As a temporizing measure mannitol (1 gm/kg loading dose) IV/rapidly may be given if the clinical condition warrants
    - patient not hypotensive
    - signs of transtentorial herniation
    - progressive neurologic deterioration not attributable to systemic pathology
    - A Foley catheter is mandatory if mannitol is given.

Algorithm for Head CT Triage

An algorithm for the triage of head injury patients can be found on the following page.

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44 In this situation CT of the head takes priority over all diagnostic procedures except those during the `ABCs' part of the resuscitation. If the patient is in shock and cannot be resuscitated the patient will forgo CT and proceed to the OR where blind burr holes or placement of an ICP monitor are to be done at the direction of the Neurosurgery service.

45 Reviewed 05/18/10
Algorithm for Head Injury Triage Guidelines

**HEAD CT/HEAD INJURY TRIAGE**

Head CT / Head Injury Triage Guideline

Loss of Consciousness or Altered Level of Consciousness

- **Notify Neurosurgery**
  - Positive
  - **CT head**

- **Negative**
  - Normal Neuro Exam, GCS=15, no alcohol or drug use suspected
  - **NO**
  - Abnormal neurological symptoms i.e. headache, nausea, vomiting, diplopia and/or altered consciousness from suspected alcohol or drug use.
  - **YES**
  - Reliable person available to continue neuro checks at home
    - **Yes**
      - Home with head injury instructions given to individual responsible for observation
    - **No**
      - Admit for observation
  - Admit for observation

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46 Approved 05/18/10
Indications for Neurosurgical consultation:

- All patients who sustain a head injury with loss of consciousness and an abnormal CT of the head and/or a sustained GCS of less than 13
- At the discretion of the Trauma attending.
- All patients with a depressed skull fracture and clinical evidence of a basilar skull fracture

Phenytoin (Dilantin) Seizure Prophylaxis in Head Trauma

Initiating therapy:

Phenytoin (Dilantin®) therapy should be initiated within 24 hours of injury. Initiate therapy with a loading dose of 15-20 mg/kg IV, followed by a maintenance dose of 5 mg/kg/day IV given in 2-3 divided doses.

Monitoring therapy:

Check a Dilantin® free level 24 hours after the initial loading dose. A free drug level is preferred to a total drug level because Dilantin® is highly protein bound. A total drug level cannot be accurately interpreted without considering the patient's serum albumin level (i.e., a serum albumin level must also be drawn). The 24 hour post-loading dose level is obtained to ensure that the loading dose has achieved a serum concentration in the therapeutic range (1-2 micrograms/mL). Be sure this level is drawn prior to the next scheduled dose (i.e., drawn as a trough level). If Dilantin® is dosed appropriately upfront and the initial 24 hour post-loading dose level is therapeutic it is not necessary to obtain further drug levels. If the patient experiences a seizure on Dilantin® therapy, check a Dilantin® free level and adjust the regimen if needed. Consult Brian McKinzie, PharmD (pager 13540) for assistance with drug dosing.

If the initial 24 hour post-loading dose level is sub-therapeutic, administer another loading dose. Use the following calculation to determine the follow-up loading dose:

Follow-up loading dose = (desired free concentration – actual free concentration) (10) (0.7) (weight in Kg)

Check a Dilantin® free level 24 hours after this loading dose as described above. If sub-therapeutic, repeat a loading dose (calculation described above) and follow-up 24 hour post-dose free level until the patient's drug level is therapeutic.

If the initial 24 hour post-loading dose level is supra-therapeutic (> 2 micrograms/mL), consult Brian McKinzie, PharmD (pager 13540).

Duration of therapy:

If the patient is seizure-free, Dilantin® may be discontinued after 7 days of therapy. If the patient has a seizure during the initial week post-injury, Dilantin® should continue for

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90 days and therapy reevaluated at that time. Serum concentrations should be monitored weekly in patients continuing Dilantin® therapy beyond 7 days. Consult Brian McKinzie, PharmD (pager 13540) for further drug regimen adjustments.48

Mannitol, Hypertonic Saline, and Albumin

Mannitol and Hypertonic Saline, which are utilized to treat head trauma victims with possible increases in intracranial pressure, will only be administered after appropriate consultation with a neurosurgeon or the SICU attending.

Albumin should never be used in resuscitation of the patient with TBI, as it has been associated with an increase in mortality when compared to resuscitation with normal saline.49

Indications for Intubation in the TBI patient:

- All patients with a head injury and a Glasgow Coma Score (GCS) of ≤ 8 will be intubated.
  - It is always preferable to have a neurological evaluation and GCS done before intubation if the situation allows.
  - During intubation lidocaine 1 mg/kg may be given to decrease coughing with resultant increase in intracranial pressure (ICP)
- Patients with GCS between 9-15 will be intubated if their clinical condition warrants intubation and both Neurosurgical and Trauma service concur.

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Suggested Algorithm for Initial Management of the TBI Patient
Clinical Guidelines for the Management of Severe Traumatic Brain Injury (TBI) in Adults

This algorithm is designed for the treatment of patients with TBI and/or intracranial hypertension and/or herniation. It is designed for the following target population:

- Adults (age ≥ 16) with GCS < 9 or intubated (< 8T)
- with and abnormal CT Scan (i.e. contusion, clot, DAI, or SAH)

The goals of therapy are to:

- Maintain euvoolemia
- Maintain ICP < 20 mmHg or CPP = 60 - 70 mmHg if ICP ≥ 20 mmHg
- Maintain Hg > 7
- Normalize electrolytes
- Maintain Temperature < 38°C and > 35°C
- Maintain SaO₂ > 95%

Initial Evaluation and Monitoring of Patients with TBI

Initial evaluation and monitoring of patients with TBI shall proceed in the following, step-wise, algorithm:

1. Insert ICP MONITOR or Ventriculostomy (preferred)
2. Insert CVC or PA catheter (as indicated)
3. Insert Arterial line
4. IVs: normal saline (Avoid dextrose)
5. Ventilator: Set for PCO₂ = 35-40 torr
6. Load and daily dilantin for seven days
7. Correct hypovolemia, hypoxemia and inadequate cardiac output.
8. Sedation first 48 hours: propofol/fentanyl
9. Sedation >48 hours: morphine/ativan
10. Monitor temp (centigrade)
11. Head of bed > 30° or reverse Trendelenberg at 30°
12. Normalize Coags INR <= 1.4, Plts >100,000 for monitor placement, or plts >50,000 and concurrent platelet transfusion. INR<=1.5, plts >50,000 for maintenance
13. Consider: Licox Brain Monitor (PbtO₂)
14. Foley Catheter
15. Maintain quiet room and limit visitors
16. OG tube
Treatment of Intracranial Hypertension: If ICP >20 for > 5 min THEN apply the following in a stepwise manner until resolved:

1. Drain CSF if feasible
2. Increase sedation and/or analgesia
3. Assess temp and treat to maintain temp < 38°C
4. Assess CPP. If CPP <60:
   1. Initiate fluid resuscitation: CVP > 12 to 15 or PCWP 15 to 20 or SVV < 15 or EDVI >100
   2. Initiate or increase neosynephrine to CPP > 60 or max dose 200 mcg/min
   3. Contact critical care physician.

Consider Repeat Head CT Scan

**Note:** Orders will be written by primary service caring for pt unless unavailable to come to bedside. Primary service will be notified of all orders written by other services.

Critical Care Resident and/or Attending: Assess for other causes of hypotension or elevated ICP (abdominal compartment syndrome, tension pneumothorax, tamponade, etc).

Initiate hyperosmolar therapy and notify on-call Neurosurgery resident:

1. Hypertonic Saline if serum NA < 160 and serum osmo < 320
2. Mannitol if serum NA serum NA > 160 and serum osmo < 320
3. Consider mild hyperventilation to PaCO2 32-35

If CPP < 60 mmHg for > 30 minutes despite medical therapy, notify neurosurgery and:

1. Consider pentobarbital coma
2. Consider craniectomy

Repeat Head CT Scan if not Done above

Criteria for discontinuing Major TBI Protocol

1. Sedation is minimal (RASS -2 to -3), paralytics off, temperature control is no longer a problem
2. Recent CT scan shows stability or improvement
3. ICP < 20 mmHg for ≥ 24 hrs and neurosurgery discontinues monitor

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50Date of Original TBI Clinical Guideline: 3/13/11
Approved by All of Trauma Section 3/13/11
Approved by Neurosurgery liaison 3/16/11
Management of TBI in the setting of Orthopedic injuries

CT scan shows intracranial bleed, contusion, or infarction
OR
Patient's GCS < 13

Yes No

Open fracture?

Yes No

Wash out at bedside and place in splint / traction and repeat CT scan in 24 hours.

Splint or place in traction and repeat CT scan in 24 hours

Neurological status stable and CT better or unchanged

Daily bedside washout until neurologically stable

Patient may require invasive intracranial monitoring for orthopedic procedure. Discuss with neurosurgeons before proceeding to OR

Maintain in traction / splint
Management of Spinal Cord Injury

Goals of Therapy

In patients with a suspected, or diagnosed, spinal cord injury, the goals of management are:

1. Maintain euvolemia
2. Maintain MAP 60 - 70 mmHg
3. Maintain Hg > 7
4. Normalize electrolytes
5. Maintain SaO₂ > 95%

Initial Evaluation and Monitoring of Adult Patients with SCI:

Inclusion Criteria:

- Spinal Fractures with or without neurologic findings
- Steroids should not be given for penetrating or blunt spinal cord injury
- Insert CVC or PA catheter (as indicated)
- Insert A-line if concern for spinal cord compromise or evidence of spinal cord injury
- IVs: isotonic fluid administration
- Correct hypovolemia, hypoxemia and inadequate cardiac output
- Maintain MAP 60 - 70 mmHg
- Reverse Trendelenberg at 30°
- Strict Log Roll
- Normalize Coags INR ≤ 1.5, plts > 50,000 for maintenance

MAP < 60 mmHg?

1. Contact critical care physician
2. Critical care resident and/or attending: assess for other causes of hypotension or elevated ICP (abdominal compartment syndrome, tension pneumothorax, tamponade, etc.)
3. Evaluated neurologic function - if change in physical exam, notify neurosurgery service
4. Initiate fluid resuscitation: CVP > 12 to 15 or PCWP 15 -20 or SVV < 15 or EDVI > 100
5. Initiate or increase neosynephrine to MAP

Criteria for Discontinuing Spinal Cord Injury Protocol:

1. Spinal fractures stabilized by neurosurgery
2. Discharge from the ICU

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51 Date of original SCI clinical guidelines: 07/07/11 (Eriksson, Turner)
Approved by all of Trauma Section and Neurosurgery 07/18/11
Antibiotic Management in Patients with CSF Leak

Consensus Statement

For any adult patient (age ≥ 16 yrs) with a CSF leak, the routine use of prophylactic antibiotics is not indicated.\textsuperscript{52}

\textsuperscript{52} Authors: Ralph Barker MD, Evert Eriksson MD, Raymond Turner, MD
Date of Original SCI Clinical Guideline: 07/07/11
Approved by Trauma Section and Neurosurgical Liaison 07/18/2011
Management of Penetrating Neck Injuries

Indications for Surgery in Penetrating Neck Trauma

Indications for operative intervention vary by the zone of injury:

**Zone I**

Zone I is defined as the region inferior to the clavicular heads:
- Any patient with systolic hypotension that cannot be resuscitated
  - Any patient with exsanguinating hemorrhage
  - All stable patients will undergo the following work-up and any evidence of injury will constitute an indication for surgery
    - Arteriography
    - Gastrograffin swallow if superior mediastinum is crossed
    - Bronchoscopy if superior mediastinum is crossed

**Zone II**

Zone II is defined as the region between the clavicular heads and the angles of the mandible, anterior to a perpendicular line drawn from the insertion of the sternocleidomastoid
- A wound that penetrates the platysma may be explored at the discretion of the attending vascular surgeon or trauma surgeon upon his examination of the patient.

**Zone III**

Zone III is defined as the region superior to the angle of the mandible:
- Any patient with exsanguinating hemorrhage
- All patients will undergo arteriography and a positive finding will indicate surgery or endovascular management.

Conduct of Neck Exploration

Neck explorations, similar to laparotomies, should proceed in an orderly and systematic fashion:
- **Incision:**
  - The cervical incision should be along the anterior border of the sternocleidomastoid on the appropriate side.
  - If bilateral neck explorations are required, this may be performed through two separate incisions or via a collar incision at the discretion of the operating surgeon.
- **Exploration and Identification of Injuries:**
  - All hematomas within the neck will be thoroughly explored.
  - The tract of a penetrating injury in the neck will be completely defined during the exploration.
• Proximal and distal control of the carotid artery and internal jugular vein will be obtained prior to approaching a hematoma overlying these structures.

• Closure:
  • The incision will be closed in layers and the skin and subcutaneous tissues will be closed primarily.

**Carotid Artery Injuries**

Any carotid artery injury will be repaired under the direction and supervision of the vascular surgery attending, utilizing the guidelines outlined below; these may be modified at the discretion of the vascular surgery attending.

**Identification of Injury:**
- Carotid artery injuries will be identified by either
  - preoperative arteriography
  - appropriate surgical exploration

**Operative Management:**
- All carotid artery injuries will be repaired via appropriate techniques except those injuries that are associated with a complete neurologic deficit that is at least 1 hour in duration. In these cases, the repair will be discretionary based on the clinical situation.
- Intra-operative shunts may or may not be used at the time of carotid artery repair at the discretion of the operating surgeon.
- Prosthetic material will be employed in carotid artery repairs only as a last resort and when no suitable autogenous substitute is available.

**Jugular Venous Injuries**

**Identification of Injury:**
- Jugular venous injuries will be identified at the time of appropriate surgical exploration.

**Operative Management:**
- Indications for ligation of jugular venous injuries
  - Unstable patient
  - Injuries that involve a loss of 2 cm or more of the internal jugular vein after debridement
  - All other jugular venous injuries will undergo repair either by primary venorrhaphy or vein patch repair

**Esophageal Injuries**

**Identification of Injury:**
- Esophageal injuries will be detected by complete exploration of the tract of a penetrating neck injury.

**Operative Management:**
• Esophageal injuries will be managed by debridement and repair in two layers of non-absorbable suture material.
• All esophageal injuries will be drained externally for at least seven days.
• Indications for cervical esophagostomy
  • Injuries that involve extensive devitalization of the esophagus (either thoracic or cervical)
  • Neglected esophageal injuries that are associated with extensive contamination (either thoracic or cervical)

Postoperative Care:
• Patients with esophageal injuries will be maintained NPO until a contrast swallow has been obtained at seven days and does not demonstrate a lead at the site of repair.

Laryngeal Injuries

Laryngeal injuries will be managed at the direction of the ENT attending physician. The guidelines below may be modified at the discretion of the ENT attending physician.

Identification of Injury:
• Laryngeal injuries will be identified during thorough surgical exploration.

Operative Management:
• Principles of management for laryngeal injuries
  • Mucosal debridement and closure with absorbable sutures
  • External support for upper airway either with existing cartilage or a flap of strap muscle
  • External drainage for three to five days
  • Tracheostomy below the site of injury, depending on severity of injury

Post-operative Care:
• Tracheostomy shall remain in place for at least ten days
• A direct laryngoscopy will be performed prior to removal of the tracheostomy to assess the degree of damage and stricture formation in the upper airway.

Tracheal Injuries

Tracheal injuries will be managed at the direction of the ENT attending physician. The guidelines below may be modified at the discretion of the ENT attending physician.

Identification of Injury:
• Tracheal injuries will be identified at the time of thorough surgical exploration.

Operative Repair:
• < 50% circumference:
  • If the tracheal injury involves less than 50% of the circumference of the trachea after debridement, it will be managed by primary repair with single layer of absorbable sutures.
• > 50% circumference:
• If the tracheal injury involves greater than 50% of the circumference of the trachea, it will be managed by adequate tracheal mobilization, resection and end-to-end anastomosis with absorbable sutures.
  • If significant amounts of cartilage are lost because of the injury, a flap of strap muscle will be used to provide airway support.
  • All tracheal injuries will be externally drained for three to five days.
  • All tracheal injuries will be stented internally with an endotracheal tube or tracheostomy tube, dependent on the level of the injury.
  • Care will be taken so that the cuff of the tracheal tube will be inflated below the injury.

Post-operative Care:
  • The internal stent will be maintained for 10 to 14 days prior to removal
  • An effort will be made to assess the repair and the potential for stricture prior to removal of the stent.
Thoracic Injury Management

Indications for Emergency Thoracic Surgical Intervention

Indications for the operative treatment of thoracic injuries include:

- Initial tube thoracostomy output > 1,500 cc (20 cc/kg child) of blood (assuming the tube is placed within two hours of the trauma incident)
- Ongoing tube thoracostomy output of at least 250 cc blood per hour (100 cc/hr child) for four hours
- Total tube thoracostomy output of 2,000 cc of blood over the first eight hours (50% total blood volume child)
- Presence of confirmed pericardial tamponade
  - Positive pericardiocentesis
  - Positive echocardiogram demonstrating blood in the pericardium
- Demonstration of blood in the pericardium on a subxiphoid pericardial window
- Demonstration of a major vascular injury by arteriogram
- Demonstration of an esophageal injury by either esophagoscopy or contrast study

Conduct of Exploratory Thoracotomy

Indications for the operative treatment of thoracic injuries include:

- Initial tube thoracostomy output > 1,500 cc (20 cc/kg child) of blood (assuming the tube is placed within two hours of the trauma incident)
- Ongoing tube thoracostomy output of at least 250 cc blood per hour (100 cc/hr child) for four hours
- Total tube thoracostomy output of 2,000 cc of blood over the first eight hours (50% total blood volume child)
- Presence of confirmed pericardial tamponade
  - Positive pericardiocentesis
  - Positive echocardiogram demonstrating blood in the pericardium
- Demonstration of blood in the pericardium on a subxiphoid pericardial window
- Demonstration of a major vascular injury by arteriogram
- Demonstration of an esophageal injury by either esophagoscopy or contrast study

Appropriate thoracic surgical consultation will be obtained prior to the performance of a trauma thoracotomy.

Incision:

- The choice and location of the incision will be based on the location of the injury and any preoperative diagnostic studies that have been performed.
- When the patient's condition mitigates against preoperative studies, a fifth interspace posterolateral thoracotomy on the side of the major hemorrhage will be used.

Technique:

- All blood clot is evacuated and hemorrhage is controlled with direct pressure and treatment appropriate to its source.
• Intercostal vascular bundles that are injured will be suture ligated.
• Hemorrhage from pulmonary parenchymal injuries will be controlled with sutures or stapling devices.
• Internal mammary vessel injuries will be controlled via suture ligatures.
• Management of hemorrhage from mediastinal structures will be dependent on the structure involved.
  • All trauma thoracotomies will be drained with both an anterior and a posterior tube thoracotomy.
  • All trauma thoracotomy incisions will be closed in a standard layered fashion.

**Cardiac Injuries**

**Identification and Exposure:**
  • Cardiac injuries will be approached via a:
    • median sternotomy or
    • left thoracotomy
    • The choice of approach is at the discretion of the operating surgeon.
  • The pericardium will be opened in a longitudinal fashion and the heart will be brought out of the pericardial sac.

**Operative Management:**
  • Digital pressure will be used to control hemorrhage.
  • Repair of cardiac injuries will be accomplished with non-absorbable sutures over Teflon pledgets.
  • Injuries near coronary arteries:
    • repair with horizontal mattress sutures so as to avoid occluding the coronary artery.
  • Injuries involving a coronary artery:
    • necessitate a cardiac surgery consult
  • Any injury requiring the use of a bypass pump will necessitate a cardiac surgery consult.
  • The pericardium will be left open at the completion of the procedure.
  • The mediastinum will be drained by means of a #36 chest tube brought externally in a subxiphoid position.

**Aortic Injuries**

Aortic injuries will be managed under the direction of thoracic surgery. The guidelines outlined below may be modified at the discretion of the thoracic surgical attending.

**Non-operative Management:**
  • Prompt repair of blunt aortic injury is preferred
  • Indications for non-operative management:
    • If the patient has more immediate life-threatening injuries that require emergent intervention (i.e. laparotomy or crainotomy)
    • the patient is a poor operative candidate because of age or co-morbidities
  • Management:
• Medical control of blood pressure is advised until surgical repair can be accomplished.
• It is preferable to keep the blood pressure under 120 TORR (systolic) with beta-blockers (decreases dp/dt).\textsuperscript{53}
• Esmolol, due to its short half-life, is the preferred beta-blocker in trauma patients

**Aortic Stent Grafting:**\textsuperscript{54}

**Background:** Aortic transection due to trauma is an uncommon, but potentially rapidly lethal injury. As such, timely surgical treatment should be performed as soon as a patient is stable and other immediately life threatening problems have been stabilized.

Currently, aortic stent grafting has become the procedure of choice in many, if not most, patients with this injury. However, in the event that this procedure fails or if there is a technical complication with deployment of the graft, immediate thoracotomy is generally required. Also, in many patients, other operative procedures may be required immediately before or immediately after aortic stent graft placement.

**Purpose:** To develop procedures to allow application of aortic stent grafting in appropriate patients while having immediately available the resources necessary to convert to an open thoracotomy procedure in the event that this becomes necessary and to provide the resources required to perform other related and unrelated operative procedures in conjunction with placement of an aortic stent graft.

**Policy:**

1. If an aortic stent graft is to be placed, the CT surgery attending or fellow will simultaneously notify both the interventional radiology suite and the operating room of the intent to perform this procedure. The normal procedure for posting cases will be followed. Level 1 cases will require direct contact between the CT surgery attending or fellow and the OR charge nurse or anesthesia attending physician on call.

2. Based on the needs of the patient, the trauma attending physician and physicians from other surgery teams involved in the case will determine whether the aortic stent graft will be performed alone or in conjunction with other necessary procedures.

3. Operating room nursing staff will provide a scrub nurse in the angiography suite to provide the nursing support for the procedure. The angiography staff will serve as circulating nurse. Should equipment from the main operating room be needed, operating room staff will assure delivery of that equipment to the angiography suite.

4. CT anesthesia will be notified by the anesthesia attending of the day or the on call anesthesiologist as appropriate that an aortic stent graft is being placed.

\textsuperscript{53} Guidelines for the Diagnosis and Management of Blunt Aortic Injury; Copyright East Association for the Surgery of Trauma, 1998.

\textsuperscript{54} 07/29/10
performed. CT anesthesia will provide anesthesia support for the procedure in the angiography suite as well as in the OR should a need arise to move the patient to the operating room.

5. A “back up room” in the main OR will be set up and staffed with CT service OR nursing personnel while the patient is in the angiography suite. The room must be ready for surgery immediately. Therefore, all instrument sets and other necessary equipment must be in the room and available for immediate use so that no delay occurs once the decision is made to transport the patient to the main OR as a result of a problem with deployment of the stent graft. Instrument sets will not be opened, however, until it is clear that the patient is to be moved to the main operating room.

6. A pump team will be available in the selected back up room. A bypass machine will be available and in the operating room but will not be set up until it is determined that operative intervention will be necessary. (Assuming the set up can be accomplished within a time frame that allows its use when needed.) The CT surgery team will be responsible for assuring that the pump team has been called in.

7. In the event that other procedures will be performed prior to aortic stent graft placement, upon completion of those procedures, the patient will be transported from the operating room to the angiography suite after first assuring that the angiography team is present and prepared to initiate the procedures as well as assuring that the OR nurses who will be performing the procedure are present and the instrumentation ready for use. The patient will be accompanied to the angiography suite by anesthesia personnel for ongoing monitoring and anesthesia care during the subsequent stent grafting procedure.

8. In the event that other procedures will be performed after the stent grafting procedure, an operating room will be prepared for that subsequent procedure so that the patient can be brought from the angiography suite back to the operating room immediately upon completion of the aortic stent graft placement procedure. During transportation of the patient back to the operating room, anesthesia personnel will accompany the patient for ongoing monitoring and anesthesia care during the subsequent procedures.

Thoracic Tracheal and Esophageal Injuries

Thoracic tracheal and esophageal injuries will be repaired in the same fashion as described for cervical tracheal and esophageal injuries.

Pulmonary Injuries

Indications for repair:
- The need for surgical intervention in pulmonary injuries will be based on amount and rate of blood loss:
  - Initial tube thoracostomy output > 1,500 cc (20 cc/kg child) of blood (assuming the tube is placed within two hours of the trauma incident)
• Ongoing tube thoracostomy output of at least 250 cc blood per hour (100 cc/hr child) for four hours
• Total tube thoracostomy output of 2,000 cc of blood over the first eight hours (50% total blood volume child)
• Bronchoscopic identification of injury.

Operative Management:
• Peripheral injuries of pulmonary parenchyma will be either stapling devices or absorbable sutures.
• Injuries involving pulmonary hilar structures will mandate a thoracic surgical consultation. These injuries will be treated either:
  • by resection of appropriate lobe(s)
  • repair of the injury directly.
• Following treatment of pulmonary injuries, the pleural cavity will be drained using two chest tubes as previously outlined.

Rib Fractures

Management:

In patients with multiple rib fractures and severe pain, strong consideration should be given to a thoracic epidural for pain relief. The pain service (Department of Anesthesia) will administer the epidural.

Algorithm for Management of Rib Fractures

MUSC’s algorithm for rib fracture management can be found on the following page56e:
Any patient who has PFT's checked should have F/U PFTs 3 months after date of injury. This should be ordered on discharge.

** Titrate based on renal function

### Titrate based on liver function

&& If planning anesthesia consult for Epidural, Place patient on Heparin 5000IU SQ Q8h. Hold dose until Anesthesia Evaluates patient. Consult Anesthesia upon admission and have epidural placed ASAP. If no epidural, Lovenox OK for all patients unless other contraindication exists.

Revision_1_3/1/2013
Traumatic Hemothorax

Traumatic hemothoracies are common injuries which should be managed per the following protocol:\textsuperscript{56}:

\begin{itemize}
\item Traumatic Hemothorax Protocol
\item 05/13/14
\item Alicia Privette, MD
\item Stephanie Montgomery, MD
\item Peri-Procedural Cefazolin or Vancomycin
\item Placement of 32 to 36 Fr Chest Tube
\item Repeat AP and Lat CXR in 48 hrs
\item CT Scan of Chest
\item Retained Hemothorax
\item > 300 cc (moderate to large)
\item Yes
\item VATS
\item No
\item Hemothorax Suspected?
\item Yes
\item No
\item Remove Chest Tube when Drainage is < 150 cc/24 hrs.
\\end{itemize}

\textsuperscript{56} Montgomery and Privette 05/13/14

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Abdominal Trauma Management

Indications for Exploratory Laparotomy

Abdominal Gunshot Wounds

Indications for surgical exploration:
- Evidence from physical examination or radiographic studies that the missile has penetrated the peritoneal cavity.
- Positive peritoneal lavage indicating penetration by meeting one of the following criteria:
  - RBC count 1,000 cells/mm³
  - WBC count 500 cells/mm³
  - Presence of bile
  - Presence of bacteria (multiple strains)
  - Presence of feces or vegetable matter
- Systemic hypotension secondary to intraperitoneal hemorrhage.

Abdominal Stab Wounds

Indications for exploration:
- Systemic hypotension secondary to intraperitoneal hemorrhage.
- Peritonitis.
- Pneumoperitoneum on a chest radiography.
- Evisceration of intraperitoneal contents.
- Retained stabbing implement.
- Abnormal diagnostic study (CT or UGI gastrograffin swallow).
- Presence of gross blood per nasogastric tube, vaginal examination, or rectal examination.
- Increasing abdominal tenderness, distention during observation period.
- Fall in hematocrit 10% with no other plausible explanation during observation period.

Abdominal Shotgun Wounds

Indications for exploration:
- All close-range (entrance wound that can be covered by one hand) shotgun wounds.
- Any intermediate-range (entrance wound that encompasses less than one body cavity) shotgun wounds that are associated with evidence on physical examination of radiographic studies of peritoneal penetration.
- Any long-range (entrance wounds encompassing more than one body cavity) shotgun wounds that have associated signs of visceral injury.
- Systemic hypotension secondary to intraperitoneal hemorrhage
- Peritonitis
- Pneumoperitoneum
- Abnormal diagnostic study
• Increasing abdominal tenderness, distention during observation period

**Blunt Abdominal Trauma in Adults (16 years or older)**

Indications for exploration:
• Systemic hypotension secondary to intraperitoneal hemorrhage
• Peritonitis
• Pneumoperitoneum
• Retroperitoneal air
• Positive peritoneal lavage for visceral injury by meeting one of the following criteria:
  • RBC count > 100,000 cells/mm³
  • WBC count > 500 cells/mm³
  • Presence of bile
  • Presence of bacteria (multiple strains)
• Presence of feces or vegetable matter
• Abnormal diagnostic study
• Development of increasing abdominal tenderness or distention during observation period

**Penetrating Lower Thoracic Trauma**

“Lower Thoracic” is defined as any injury below the nipples anteriorly, below the tips of the scapulae posteriorly, and above the costal margin.

Indications for exploration:
• Evidence on physical examination or radiographic studies of abdominal penetration
• Positive peritoneal lavage for penetration by meeting criteria as previously defined under abdominal gunshot wounds
• Presence of lavage fluid in tube thoracostomy drainage (if tube thoracostomy is present)
• Development of pneumothorax after induction of a pneumoperitoneum

**Penetrating Flank Trauma**

“Flank” is defined anatomically as posterior to the mid-axillary lines, between the costal margins superiorly, and between the iliac crests inferiorly.

Indications for exploration:
• Evidence on physical examination or radiographic studies of peritoneal penetration
• Positive peritoneal lavage for penetration by meeting criteria as previously defined under abdominal gunshot wounds

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57 There is now accumulated evidence that non-operative management of selected liver and spleen injuries documented on CT scan may be appropriate. See section on liver and spleen injuries for selection of patients and criteria.
• Retroperitoneal air
• Systemic hypotension with no other plausible cause

**Penetrating Pelvic Trauma**

Indications for exploration

- Evidence on physical examination or radiographic studies of peritoneal penetration
- Positive peritoneal lavage for penetration by meeting criteria as previously defined under abdominal gunshot wounds
- Evidence of rectal injury on proctoscopic examination
- Evidence of urinary bladder injury on cystogram
- Evidence of vaginal or uterine injury on vaginal speculum examination
- Evidence of major vascular injury on an arteriogram

**Conduct of Exploratory Laparotomy**

All patients undergoing a trauma laparotomy will be explored via a midline incision. (For pediatric patients, the incision may be modified at the discretion of the attending surgeon.)

The sequence of events is as follows:

- Remove blood and blood clots by using lap sponges
- Control active bleeding
- Separate body cavities (i.e., repair diaphragmatic injuries to separate peritoneal and pleural spaces)
- Temporarily control gastrointestinal contamination
- Thorough exploration of all intraperitoneal contents to locate all injuries
- Thorough exploration of all retroperitoneal hematomas except:
  - Pelvic hematomas associated with pelvic fractures
  - Perinephric hematomas secondary to blunt trauma that are confined to Gerota's fascia and associated with an IVP or CT that demonstrates renal function without gross extravasation
- Definite repair
- Closure of midline wound:
  - either continuous or interrupted sutures.
  - In contaminated cases, the midline closure will be accomplished with monofilament suture material.
  - In cases with gross fecal contamination, the skin and subcutaneous tissues will be closed by secondary intention. This also applies to grossly infected cases, such as neglected small bowel injuries. A secondary closure with steri-strips on the fourth or fifth day may be performed at the discretion of the attending trauma surgeon.
  - Retention sutures will be used at the discretion of the operating surgeon for wounds that are deemed likely to dehisce.
  - Wounds associated with massively edematous bowel that can not be closed can be closed temporarily with skin-placed towel clips (towel clip closure) or a
cassette drape/ioban closure. Re-exploration and formal closure is then performed at 48-72 hours or when edema resolves.

**Observation of Abdominal Trauma**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Type</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular, non-expanding &lt; 10% surface area</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, non-bleeding, &lt;1 cm parenchymal depth</td>
</tr>
</tbody>
</table>
| II    | Hematoma    | • Subcapsular, non-expanding, 10-55% surface area  
|       |             | • Intraparenchymal, non-expanding, <2 cm in diameter  |
|       | Laceration  | Capsular tear, active bleeding; 1-3 cm parenchymal depth, <10 cm in length |
| III   | Hematoma    | • Subcapsular, >50% surface area or expanding; Ruptured subcapsular hematoma with active bleeding  
|       |             | • Intraparenchymal hematoma >2 cm or expanding  |
|       | Laceration  | >3 cm parenchymal depth |
| IV    | Hematoma    | Ruptured intraparenchymal hematoma with active bleeding |
|       | Laceration  | Parenchymal disruption involving 25-50% of hepatic lobe |
| V     | Laceration  | Parenchymal disruption involving >50% of hepatic lobe |
|       | Vascular    | Juxtahepatic venous injuries; i.e., retrohepatic vena cava/major hepatic veins |
| VI    | Vascular    | Hepatic Avulsion |

**Note:** Advance one grade for multiple injuries to the same organ

Any patient with abdominal trauma who does not meet any of the above criteria will undergo a 24 hour period of abdominal observation to include:

- Serial abdominal examination every two to four hours; preferably done by the same physician
  - Serial hematocrit every six hours
  - No oral intake
  - Repeat chest radiograph in eight hours if lower thoracic trauma
- If the patient has developed no new findings in this 24 hour period, he/she will be given regular diet, and if tolerated, will be discharged. Pediatric patients may need to be observed longer at the discretion of the attending surgeon.
Management of Specific Intra-abdominal Injuries

Hepatic Injuries

The AAST Classification Scheme for Hepatic injuries is shown below:

Non-operative Management:

- Requirements:
  - Patient must be hemodynamically stable.
  - All other potential intra-abdominal injuries requiring operative intervention must be excluded.
  - Any severity of hepatic injury (as suggested by CT grade or degree of AST classification) but without active bleeding or expanding hematoma may be considered for non-operative management.

- Protocol:

  - Grade I and II: minimum of 48 hours in hospital
    - Admit to Floor
    - Vital signs every 4 hours for first 24 hours, then as per routine
    - Hemoglobin: every 12 hours for 24 hours until stable, then every 24 hours until stable
    - NPO for first 12 hours after injury, then advance as tolerated
    - Bedrest for 24 hour post-injury, then out of bed with bathroom privileges
    - Once patient has had a “stable” hematocrit and is able to ambulate to the bathroom, patient may be discharged
    - “House arrest” for two weeks from the date of injury
    - No contact sports for 6 weeks post-injury
    - No follow-up imaging is required, but may be ordered at the discretion of the attending surgeon

  - Grade III through V: minimum of 72 hours in the hospital
    - Admit to SICU for observation the first 24 hours post injury
    - Type and Screen is required
    - Two large bore ivs must be placed
    - NPO for the first 24 hours after injury
    - Hemoglobin: every 6 hours for 24 hours until stable, then every 12 hours for 24 hours until stable, then every 24 hours until stable.
    - Transfer to floor when hemoglobin is stable after 24 hours in the ICU
    - Bedrest for 48 hours, then bathroom privileges on post-injury day number 3
    - Once patient has had a “stable” hematocrit and is able to ambulate to the bathroom, patient may be discharged
    - “House Arrest” for two weeks from the date of injury.

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59 “Stable” is defined as as a decline of $\leq 0.5$ g from the previous hemoglobin
• No contact sports for 3 months post-injury. CT Scan prior to return to return to contact sports

Note that the protocol begins from the time of injury, not the time of hospital admission. Episodes of hemorrhage which occur outside of the hospital, however, “reset” the clock. For example, the patient who has been at home for 48 hours post-injury, begins to hemorrhage, and presents to the ED should be treated as if the injury has just occurred.

No follow-up imaging is required.
### Liver and Spleen Non-operative Algorithm Calendar for Clinicians and Patients

#### Grade I to II

<table>
<thead>
<tr>
<th>Inpatient Location</th>
<th>Vital Signs</th>
<th>Hemoglobin</th>
<th>Diet</th>
<th>Activity</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>Q4°</td>
<td>Q12°</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Floor</td>
<td>Q4°</td>
<td>Q12°</td>
<td>advanc as tolerated</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Inpatient Location</td>
<td>Vital Signs</td>
<td>Hemoglobin</td>
<td>Diet</td>
<td>Activity</td>
<td>Discharge</td>
</tr>
<tr>
<td>Floor</td>
<td>as per routine</td>
<td>as per routine</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Floor</td>
<td>Q6°</td>
<td>Q12°</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Floor</td>
<td>as per routine</td>
<td>as per routine</td>
<td>advanc as tolerated</td>
<td>Bedrest</td>
<td>No</td>
</tr>
</tbody>
</table>

#### Grade III to V

<table>
<thead>
<tr>
<th>Inpatient Location</th>
<th>Vital Signs</th>
<th>Hemoglobin</th>
<th>Diet</th>
<th>Activity</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>as per routine</td>
<td>Q6°</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>ICU</td>
<td>as per routine</td>
<td>Q12°</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Floor</td>
<td>as per routine</td>
<td>Q24°</td>
<td>NPO</td>
<td>Bedrest</td>
<td>No</td>
</tr>
<tr>
<td>Floor</td>
<td>as per routine</td>
<td>as per routine</td>
<td>advanc as tolerated</td>
<td>Bedrest</td>
<td>No</td>
</tr>
</tbody>
</table>

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Angiographic Embolization:

Angiographic embolization is an adjunct in the non-operative management of the hemodynamically stable patient with hepatic injuries and evidence of ongoing bleeding.\(^{61}\)

Operative Management:

- Preparation:
  - 2 cordis introducers (at least one above diaphragm)
  - Case will be done with at least two attendings
  - Blood will be in the room at the time of incision
  - Perfusionist, cell saver and veno-veno bypass set up prior to incision
  - Major vascular and thoracotomy tray in room
  - Patient prepped from clavicles to mid thighs
  - Veno-veno bypass:
    - Veno-veno bypass cannulation should be performed prior to abdominal incision if hemodynamic stability permits
    - Right saphenofemoral cut-down; 20F venous catheter (Research Medical Inc., Midvale, Utah)
    - 8F venous catheter in axillary vein
- Operative Approach:
  - The first objective is control of hemorrhage and can be achieved through the following sequence of maneuvers:
    - Direct pressure for 10 minutes continuously (may be aided by use of pedicle of viable omentum placed within the injury)
    - Non-anatomic resection of actively bleeding injuries near the edge of the liver
    - Pringle maneuver fails, a major hepatic venous or retrohepatic caval injury should be suspected. The patient is placed on venous-venous bypass with total vascular isolation of the liver. This is achieved by clamping the IVC just above the renal veins and also the supra-hepatic IVC, and a Pringle maneuver
  - The patient will be packed and towel-clipped closed
- Post-operative Care
  - Bladder pressures will be checked for compartment syndrome every six hours
  - Veno-veno bypass cannulas will be left in place for 2nd look OR procedure.
  - ABGs will be drawn every six hours with measurement of base excess
  - HCT every six hours
  - Planned packing removed at 48-72 hours after the initial exploration
- “Second Look” laparotomy

---

\(^{61}\) Patient Management Guidelines for the Non-Operative Management of Blunt Injury to the Liver and Spleen; copyright EAST, 2003.
• The decision to take patient back to OR will follow non-operative guidelines
• The objective of the second laparotomy is debridement of devitalized hepatic tissue.
• The decision whether or not to drain hepatic injuries will be the attending operating surgeon's.

Biliary Tract Injuries

Biliary tract injuries should be managed in accordance with the guidelines below:
• All gallbladder injuries will prompt a cholecystectomy
• Injuries to extra-hepatic biliary ducts will be diagnosed by direct inspection in the operating room. If doubt exists as to whether or not there is a biliary duct injury, and intra-operative cholangiogram will be performed via the gallbladder.
• Sharp lacerations that involve less than 50% of the circumference of the biliary duct may be primarily repaired over a T-tube stent.
• All other biliary duct injuries will necessitate a biliary-enteric anastomosis with a stent place.
• All biliary duct injuries will be externally drained for five to seven days minimum.
Splenic Injuries

The AAST Classification Scheme for Splenic injuries is shown below:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Type</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular, non-expanding &lt;10% surface area</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, non-bleeding &lt;1 cm parenchymal depth</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>• Subcapsular, non-expanding, 10-50% surface area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intraparenchymal, non-expanding, &lt;2 cm in diameter</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, active bleeding; 1-3 cm parenchymal depth which does not involve a trabecular vessel</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>• Subcapsular, &gt;50% surface area or expanding; Ruptured subcapsular hematoma with active bleeding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intraparenchymal hematoma &gt;2 cm or expanding</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth or involving trabecular vessels</td>
</tr>
<tr>
<td>IV</td>
<td>Hematoma</td>
<td>Ruptured intraparenchymal hematoma with active bleeding</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Laceration involving segmental or hilar vessels producing major devascularization (&gt;25% of spleen)</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Completely shattered spleen</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Hilar vascular injury which devascularizes spleen</td>
</tr>
</tbody>
</table>

**Note:** advance one grade for multiple injuries to the same organ.

Non-operative Management:

Indications for non-operative management:
- Minimal or no abdominal findings.
- Hemodynamic stability.
- Minimal laboratory evidence of blood loss.
- Low-energy trauma.
- No hilar involvement or massive destruction on CT scan.

Non-operative Management:
- Requirements:
  - Patient must be hemodynamically stable.
  - All other potential intra-abdominal injuries requiring operative intervention must be excluded.
• Any severity of hepatic injury (as suggested by CT grade or degree of AST classification) but without active bleeding or expanding hematoma may be considered for non-operative management.

• Protocol:\textsuperscript{62}
  - Grade I and II: minimum of 48 hours in hospital
    - Admit to Floor
    - Vital signs every 4 hours for first 24 hours, then as per routine
    - Hemoglobin: every 12 hours for 24 hours until stable, then every 24 hours until stable\textsuperscript{63}
    - NPO for first 12 hours after injury, then advance as tolerated
    - Bedrest for 24 hour post-injury, then out of bed with bathroom privileges
    - Once patient has had a “stable” hematocrit and is able to ambulate to the bathroom, patient may be discharged
    - “House arrest” for two weeks from the date of injury
    - No contact sports for 6 weeks post-injury
    - No follow-up imaging is required, but may be ordered at the discretion of the attending surgeon
  - Grade III through V: minimum of 72 hours in the hospital
    - Admit to SICU for observation the first 24 hours post injury
    - Type and Screen is required
    - Two large bore ivs must be placed
    - NPO for the first 24 hours after injury
    - Hemoglobin: every 6 hours for 24 hours until stable, then every 12 hours for 24 hours until stable, then every 24 hours until stable.
    - Transfer to floor when hemoglobin is stable after 24 hours in the ICU
    - Bedrest for 48 hours, then bathroom privileges on post-injury day number 3
    - Once patient has had a “stable” hematocrit and is able to ambulate to the bathroom, patient may be discharged
    - “House Arrest” for two weeks from the date of injury.
    - No contact sports for 3 months post-injury. CT Scan prior to return to contact sports

Note that the protocol begins from the time of injury, not the time of hospital admission. Episodes of hemorrhage which occur outside of the hospital, however, “reset” the clock. For example, the patient who has been at home for 48 hours post-injury, begins to hemorrhage, and presents to the ED should be treated as if the injury has just occurred.

No follow-up imaging is required.

\textsuperscript{62} Crookes and Leon 09/23/13

\textsuperscript{63} “Stable” is defined as a decline of $\leq 0.5 \text{ g}$ from the previous hemoglobin
### Liver and Spleen Non-operative Algorithm Calendar for Clinicians and Patients

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
<th>Days 4-14</th>
<th>Days 14 to 42</th>
<th>Day 43 to 90</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade I to II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inpatient Location</td>
<td>Floor</td>
<td>Floor</td>
<td>Floor</td>
<td></td>
</tr>
<tr>
<td>Vital Signs</td>
<td>Q4°</td>
<td>Q4°</td>
<td>as per routine</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>Q12°</td>
<td>Q12°</td>
<td>Q24°</td>
<td></td>
</tr>
<tr>
<td>Diet</td>
<td>NPO</td>
<td>advance as tolerated</td>
<td>advance as tolerated</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Bedrest</td>
<td>Bedrest</td>
<td>Out of Bed with BR Privileges</td>
<td>House Arrest</td>
</tr>
<tr>
<td>Discharge</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Grade III to V

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Floor</th>
<th>Floor</th>
<th>ICU</th>
<th>ICU</th>
<th>Floor</th>
<th>Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital Signs</td>
<td>as per routine</td>
<td>as per routine</td>
<td>as per routine</td>
<td>as per routine</td>
<td>as per routine</td>
<td>as per routine</td>
<td>as per routine</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>Q6°</td>
<td>Q6°</td>
<td>Q12°</td>
<td>Q24°</td>
<td>Q6°</td>
<td>Q6°</td>
<td>Q12°</td>
</tr>
<tr>
<td>Diet</td>
<td>NPO</td>
<td>NPO</td>
<td>advance as tolerated</td>
<td>advance as tolerated</td>
<td>advance as tolerated</td>
<td>advance as tolerated</td>
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</tr>
<tr>
<td>Activity</td>
<td>Bedrest</td>
<td>Bedrest</td>
<td>Bedrest</td>
<td>Out of Bed with BR Privileges</td>
<td>House Arrest</td>
<td>House Arrest</td>
<td>No contact sports</td>
</tr>
<tr>
<td>Discharge</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

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Operative Management:

Indications for splenectomy:
• Type V (AAST Classification) injuries, avulsion of the pedicle or shattered spleens
• Any patient who is unstable and has sustained a splenic injury
• Any patient who has multiple intraperitoneal injuries which will require a prolonged operative period will undergo a splenectomy for treatment of a splenic injury.

Indications for Splenorrhaphy:
• Blood loss <500 cc (1/3 blood volume in child).
• Minimal associated injuries.
• No hilar involvement.
• Minimal/moderate splenic disruption.
• No coagulopathy
• Type I (AAST) injuries, a capsular tear not involving splenic parenchyma will be managed by topical hemostatic application and/or horizontal mattress sutures.
• Type II-III (AAST) injuries, extending into splenic parenchyma but not involving the hilum, will be managed by horizontal mattress sutures with or without a pedicle of omentum.
• Type IV (AAST) injuries, parenchymal injuries extending into the hilum, will be managed by absorbable mesh splenorrhaphy or hemi-splenectomy. A decision for splenectomy may be made at the discretion of the operating surgeon.

Splenectomy Vaccination Guidelines

All patients who are status post splenectomy and any patient with less than 50% of their spleen intact and/or with absence of the major vascular supply shall receive the following vaccinations:65
• Pneumococcal (PPV) vaccine 0.5 mL IM X 1
• Haemophilus influenza vaccine 0.5 mL IM X 1
• Meningococcal vaccine 0.5 mL IM X 1

Vaccinations should be administered within 48 hours of splenectomy or splenic injury, unless the patient is on a vasopressor. (Must be administered prior to discharge)

There is no evidence to support delaying vaccination because of immunosuppression following splenectomy.

Update on adult immunizations: Recommendations of the immunization practices advisory committee (ACIP) MMWR 1991;40:40-44.
All patients should be revaccinated with the pneumococcal vaccine at least every 6 years. There are no recommendations for revaccination for haemophilus or meningococcus.

All patients who undergo splenectomy will receive the following prior to discharge from the hospital:
- Education concerning the signs and symptoms of post splenectomy sepsis.
- Instructions to return to the hospital or to their local MD at the onset of these signs or symptoms

**Intra-abdominal Esophageal Injuries**

Any hematoma over the gastroesophageal junction must be explored to locate the presence of an esophageal injury:
- Injuries involving less than 50% of the circumference of the esophagus will be managed by debridement and primary repair with two layers of non-absorbable sutures.
- Injuries involving greater than 50% of the circumference of the esophagus will be managed by resection and re-implantation into the fundus of the stomach.
- All esophageal repairs will be drained externally using an active drainage system. These drains will remain in place five to seven days, and a contrast swallow will be performed prior to removal. If this study demonstrates an anastomotic leak, the drains will remain in place.

**Gastric Injuries**

Identification of Gastric Injuries:
- Penetrating gastric injuries will be diagnosed by direct visual inspection
- Gastric injuries necessitate evaluation of possible mucosal injuries, not necessarily diagnosed by inspection of the external surface. This will be accomplished in one of two fashions:
  - Forming a gastrotomy by dividing the gastric wall between exit and entrance wounds, assuming they are in close proximity
  - Forming a gastrotomy by extending either the exit or entrance wound if they are not in close proximity

Injury Management:
- Partial thickness mucosal injuries will be managed with a running suture or absorbable material to control potential hemorrhage.
- Full thickness injuries will be managed by debridement and two layer repair except where resection is indicated.
- Gastric Resection:
  - Indications for gastric resection
    - Injuries involving the pylorus
    - Multiple perforations in a small segment of stomach
    - Injuries associated with significant devitalization
Reconstruction after gastric resection that includes the pylorus may be done in either a Bilroth I or Bilroth II fashion, depending on local conditions.

Duodenal Injuries

General management principles:
- Restoration of intestinal continuity:
  - Simple injuries:
    - will be managed by debridement and closure with two layers of sutures.
  - Injuries in the fourth portion of the duodenum not amenable to primary repair:
    - shall be managed by resection and duodenojejunostomy.
  - Injuries in the first portion of the duodenum not amenable to primary repair:
    - shall be managed by resection and either gastroduodenostomy or duodenal closure and gastrojejunostomy.
  - Injuries elsewhere in the duodenum not amenable to primary repair:
    - shall be managed by Roux-en-Y duodenojejunostomy, except in specific circumstances listed below.
  - Duodenal diverticularization:
    - used when the viability and/or lumen size of the duodenum following debridement is in doubt.
  - Pyloric exclusion:
    - used when a Roux-en-Y duodenojejunostomy has been performed to a questionably viable duodenum.
- Internal duodenal decompression
  - All duodenal injuries will be internally decompressed.
    - Decompression will be accomplished with a simple rubber catheter varying in size according to local conditions.
    - Injuries distal to the ampulla of Vater will be decompressed and threaded to, but not past, the repair.
    - Injuries proximal to the ampulla of Vater will be decompressed via a catheter placed through a jejunostomy and threaded retrograde to, but not past, the repair.
    - In cases where duodenal diverticularization has been performed, an end tube duodenostomy will be utilized for internal decompression.
    - At no time will a decompression tube cross a duodenal repair.
- External drainage:
  - External drainage will be accomplished via passive and/or active drains depending on the severity of the injury.
    - All duodenal repairs will be drained externally.
  - Placement of a feeding jejunostomy, if the injury is of such severity that alimentation is unlikely in the first ten days
Pancreatic Injuries

Management of pancreatic injuries is dependent upon the location of the injury:

- All injuries that do not threaten the pancreatic duct:
  - managed by debridement, hemostasis and external drainage, using sump drain and Penrose drains in combination.
- All injuries located left of the mesenteric vessels that threaten the major pancreatic duct:
  - managed by distal pancreatectomy to a level proximal to the injury.
- All injuries that involve the pancreatic duct at the level of the mesenteric vessels:
  - managed by either:
    - Normal patient: distal pancreatectomy
    - Patients with diabetes, a family history of diabetes, or a history of alcoholism: Roux-en-Y drainage of the distal pancreas with oversewing of the proximal stump
- All injuries that may involve the major pancreatic duct in the head of the pancreas:
  - Evaluated by intra-operative pancreatectography
  - Intra-operative cholangiography will also be performed in these injuries to evaluate the common bile duct.
  - Once proven radiographically, injuries that involve the major pancreatic duct in the head will be managed by Roux-en-Y jejunal drainage to the injury with adequate external drainage as previously outlined.
- Indications for Whipple procedure:
  - Extensive devitalization of the duodenum and head of the pancreas
  - Injuries involving the duodenum, major pancreatic duct and common bile duct simultaneously
  - Exposure for repairing retropancreatic portal vein injuries
  - A “trauma Whipple” should never be attempted during a trauma patient’s initial laparotomy! A Damage Control approach should be utilized in any patient with an injury to the pancreatic head.
- External drainage:
  - Should be accomplished using sump drain and Penrose drains in combination.
    - The sump drain will remain in place for three to five days.
    - The Jackson-Pratt drains will remain in place for at least seven days and until the patient is eating a general diet without evidence of a pancreatic fistula.

Small Bowel Injuries

Identification of Injuries:

- In every exploratory laparotomy performed for trauma, the small bowel will be explored in a systematic fashion from the ligament of Treitz to the ileocecal valve.
- The exploration will be done segment by segment and include the mesentery as well as the bowel.
• All mesenteric hematomas will be explored to locate possible sites of bleeding or bowel injuries.

Operative Repair:
• Simple small bowel injuries will be treated by adequate debridement, hemostasis, transverse closure in two layers.
• Indications for small bowel resection
  • Compromised vascular supply
  • Loss of tissue greater than 50% of the circumference of the bowel wall after debridement
  • Multiple small bowel injuries in a short segment of bowel
• No small bowel repairs will be drained.

Colonic Injuries

Identification of Injuries:
• The colon will be explored systematically in every trauma laparotomy from the cecum to the peritoneal reflection at the rectosigmoid junction.
• All hematomas overlying the colon wall will be explored to locate occult colon injuries.

Operative Repair:
• Criteria which must be met to perform primary repair of colon injuries:
  • No period of hypotension (systolic blood pressure 90 mmHg) prior to or during surgery
  • Less than 2,000 cc of blood in the peritoneal cavity on exploration
  • Less than eight hours time elapsed between injury and exploration
  • No gross fecal contamination (fecal spill less than 5 cm from the site of injury)
  • Less than three associated injuries intraperitoneal
  • Tissue loss involving less than 50% of the circumference of the colon wall after debridement
  • Injuries to the colon are confined to one anatomic location
  • No need for prosthetic material to be inserted (i.e., abdominal wall, vascular repair)
• When the above criteria are met, the colon injury may be managed by adequate debridement and primary repair in two layers. A primary colon repair will not be drained externally.
• Colon injuries that cannot be managed by primary repair will be treated with exteriorization and colostomy formation except for special circumstances.
  • Cecal injuries not amenable to primary repair:
    • treated by resection, and ileostomy and mucous fistula.

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66 It is becoming increasingly clear that more and more colonic injuries may be primarily repaired. The below criteria are only suggested guidelines which may be modified at the discretion of the attending trauma surgeon. It is important to note that colostomy is associated with its own discrete complication rate.
• Distal sigmoid or proximal rectal injuries which cannot be exteriorized and are not amenable to primary repair:
  • created by repair of the injury with formation of a proximal completely diverting colostomy as close to the injury as possible.
• Injuries in two separate anatomic areas of the colon:
  • treated by exteriorization and colostomy as close to the injury as possible.
• Injuries that compromise the vascular integrity of a segment of colon:
  • managed by resection of that segment with end colostomy and mucous fistula formation.
• Colostomies will be placed as remote as possible from any drain sites.
• The skin and subcutaneous tissues will not be closed primarily in cases where a colon injury is involved.
• Colostomies will remain in place for at least six weeks prior to closure.

Rectal Injuries

Identification of Injuries:
• Rectal injuries must be diagnosed by appropriately performed proctoscopy
• Classification:
  • low: 0-5 cm from the anal verge
  • middle:6-9 cm from the anal verge
  • high:> 9 cm from the anal verge

Operative Management:
• Proximal diverting colostomy
  • The colostomy will be formed in the sigmoid colon as distal as is anatomically possible.
  • The colostomy must be a completely diverting colostomy (functional double barrel colostomy).
  • The colostomy must be matured at the time of original laparotomy
  • The colostomy will remain in place for at least six weeks following injury.
• Primary repair of the rectal injury
  • Low rectal injury: primary repair will be accomplished trans-anally using an operating proctoscope and a single layer repair.
  • Middle rectal injury: primary repair will be accomplished trans-anally using an operating proctoscope and a single layer repair.
  • High rectal injury: Primary repair will be accomplished by dividing the peritoneal reflection and mobilizing the rectum from the pre-sacral space. These repairs will be performed in two layers if technically feasible.
• Pre-sacral drainage:
  • the utility of pre-sacral drainage has been questioned\textsuperscript{67}, and should be performed at the discretion of the trauma attending

\textsuperscript{67} Gonzalez RP. “The Role of Pre-sacral Drainage in the Management of Penetrating Rectal Injuries,” \textit{Journal of Trauma}, 1998;45:656-661
• Penrose drains will be placed in the pre-sacral space via an incision between the anus and the coccyx.
• High rectal injuries: the pre-sacral space may be dissected from the abdomen to ensure the Jackson-Pratt drains communicate with the area of the injury.
• Pre-sacral drains will remain in place for seven days and until there is no significant drainage.

- Distal washout:
  - Studies, have questioned the need for primary repair of extraperitoneal rectal injuries, as well as the need for distal rectal washout.\(^\text{68}\)
  - This is performed by inserting a #28 chest tube into the distal limb of the colostomy and irrigating with normal saline until all feces have been removed.
  - Utilized only for high velocity injuries or injuries in which the colostomy had to be formed a long distance from the rectal injury.
  - Place patient in stirrups for distal repair and washout.

Major Intra-abdominal Vascular Injuries

General Tenets:
- The following injuries must be managed by some form of repair (primary, vein)
  - Aorta
  - Suprarenal inferior vena cava
  - Superior mesenteric artery
  - Superior mesenteric vein
  - Proper hepatic artery
  - Common iliac artery
  - External iliac artery
- The following injuries will be managed by repair except in cases where the patient is unstable and/or the injury cannot be repaired without prosthetic material:
  - Infrarenal inferior vena cava
  - Celiac axis
  - Renal artery
  - Renal vein
  - Common iliac vein
  - External iliac vein
  - Common hepatic artery
  - Portal vein
- All other intra-abdominal vascular injuries will be managed by ligation with appropriate resection of devitalized end organ.

General principles of vascular repairs
- When a major vascular injury is suspected, proximal and distal control of the affected vessel will be achieved prior to approaching the area of injury.

• If a graft is necessary, autogenous material will be used except when no such material exists. Prosthetic material will only be used as a last resort in dealing with a vascular injury that must be repaired.
• Portal venous injuries treated with ligation demand a "second look" procedure in 12 hours. If intestinal viability is in doubt at this time, a mesocaval shunt will be performed.

Renal Injuries

All renal injuries require a Urology consult and follow-up.

Indications for Operative Exploration:
• Exploring renal injuries only if:
  • expanding/pulsatile hematoma
  • active bleeding outside Gerota’s with hemodynamic instability
  • extravasation not improved with internal stenting

Operative Management:
• Obtain vascular control:
  • Prior to opening Gerota’s fascia to explore the kidney, the renal artery and vein will be identified and encircled to provide vascular control of the kidney
  • Administer mannitol and Lasix, if indicated:
    • Prior to clamping the renal pedicle for repairing renal injuries, 25 gm of mannitol and 20 mg of Furosemide will be infused
    • A period of five minutes will be allowed to pass between this infusion and occlusion of the renal artery.
• Renal injuries:
  • debridement, hemostasis, repair of the collecting system (if injured)
  • Omental buttresses may be used for sutures placed in renal parenchyma
  • External drainage
    • JP for creatinine and imaging (IVP and/or CT) may be warranted
    • Gerota’s fascia will be re-approximated to aid in closing urinary leaks
• Indications for nephrectomy
  • Active bleeding renal injury in an unstable patient on table IVP.
  • Devitalized tissue involving at least 50% of one kidney
  • Renal pedicle injuries that are more than two to four hours old
  • Prior to performing a nephrectomy, confirmation of contra-lateral renal function will be obtained by on table IVP.

Ureteral Injuries

Identification of Injuries:
• Identified by thorough exploration of retroperitoneal hematomas in the area of the ureter and identifying the ureter near the tract of a penetrating abdominal injury.

Operative Management:
• Simple clean lacerations involving less than 50% of the circumference of the ureter:
  • may be managed by primary repair using an absorbable suture material.
• Ureteral transections involving greater than 50% of the circumference of the ureter:
  • will be managed by debridement and completion of the transection and end-to-end re-anastomosis using an absorbable suture material.
  • Care will be taken when mobilizing the ureter that only the area of the anastomosis is cleaned of peri-ureteral connective tissue.
  • The ends of the ureter for anastomosis will be spatulated to provide a wider anastomosis.
• Indwelling urethral stents are advisable where possible.
• All ureteral injuries will be externally drained until there is no drainage IVP should be obtained 2 weeks after stent removal.
• Complex repairs requiring procedures such as ureteral re-implantation of urinary diversion will be performed with urologic consultation.

Urinary Bladder Injuries

Identification of Injuries:
• Injuries to the urinary bladder will be diagnosed by:
  • appropriately performed preoperative cystogram
  • exploration during surgery

Operative Management:
• Urinary bladder injuries will be managed by debridement and two layer repair using absorbable sutures.
• A suprapubic cystostomy may or may not be performed at the discretion of the operating surgeon.
• All urinary bladder injuries will be externally drained for 7-10 days.
• Retroperitoneal bladder rupture as diagnosed by cystogram and with no other further operative intervention may be managed by an indwelling Foley catheter for 7-10 days.
Pelvic Fracture Management

Initial Evaluation

The initial goal in the management of major pelvic fractures is the restoration of hemodynamic stability.

The first step is to assess for sources of controllable bleeding; either intra-abdominal or intra-thoracic. This will be accomplished by:

- Large bore intravenous access
- Chest x-ray with appropriate placement of chest tubes as previously outlined.
- Open, supra-umbilical peritoneal lavage as previously described.
- Management of intra-abdominal and intra-thoracic bleeding will follow previously established guidelines.
- Once the pelvic fracture is established as the source of uncontrolled bleeding, a T-pod will be placed.

Pelvic Binder Management

Pelvic binders should only be used in the setting of hemodynamic instability, and should be managed with the following caveats:

- Pelvic binders should be removed as soon as possible from a stable patient.
- Pelvic binders should not be managed on the floor. The need for a pelvic binder is an indication for ICU admission.
- Pelvic binders are to be adjusted and removed by physicians only, with the exception of minor adjustment for patient comfort.

If a pelvic binder remains in place longer than 24 hours, skin integrity must be checked and evaluated every 12 hours. The trauma service is responsible for examining skin by loosening binder daily on rounds.

Pelvic Arteriogram

If the patient’s blood pressure remains < 100 mmHg with the PASG or T-pod, a pelvic arteriogram will be obtained.

- If the arteriogram is negative, the Orthopedic Department will be called for the placement of an external fixator in appropriate situations.
- If the arteriogram demonstrates bleeding from small branches of the iliac system, transcatheter embolization will be performed by the arteriographer.
- If the arteriogram demonstrates significant bleeding from the common, external or iliac artery proper, consideration for exploration will be undertaken.

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A pelvic external fixator may be utilized either before or after arteriogram to stabilize certain types of pelvic fractures and to control hemorrhage. Consultation with orthopedics is required in these cases.

Once the patient's condition has been stabilized, urologic assessment will be undertaken as previously outlined.

The Orthopedic Department will be responsible for definitive management of the pelvic fracture.

**Open Pelvic Fractures**

Open pelvic fractures shall be managed along the same guidelines with the following additions:

- Actively bleeding perineal wounds will initially be packed with gauze to control hemorrhage.
- The wounds will be debrided and closed (with or without drainage catheters) once the patient's condition has been stabilized.
- A diverting sigmoid colostomy will be performed on all patients with open pelvic fractures once condition has been stabilized.
Pelvic Fracture Management

Pelvic Fracture Treatment Guideline

Pelvic Fracture Identified

Patient Hemodynamically Stable

Yes

Evaluate for and treat other life threatening injuries and consult orthopedic surgery

No

Apply external fixator or pelvic binder

Patient Hemodynamically Stable

Perform DPL or FAST Consult Orthopedics

FAST / Lavage Positive

Patient Hemodynamically Stable

Yes

Exploratory Celiotomy control bleeding source in abdomen

Yes

Close Abdomen and evaluate other injuries

No

Abdominal CT scan/treat other injuries

Contact Attending

FAST / Lavage Negative

Patient Hemodynamically Stable

No

Consider Angiogram for possible angioembolization

* RBC > 100,000, WBC > 500, presence of bacteria, bile or amylase

Rev. 05/18/10
Extremity Injury Management

Closed Fractures

All closed extremity fractures mandate consultation by the orthotrauma service. Antibiotic coverage for the repair of these fractures is the responsibility of the trauma service, and shall be given in accordance with the table below:

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>1 gm</td>
<td>Pre-op, then Q8H x 24 hours</td>
<td>$16.56</td>
</tr>
<tr>
<td>IF PENICILLIN-ALLERGIC:</td>
<td>15 mg/kg</td>
<td>Pre-op, then Q12H x 24 hours</td>
<td>$24.00 (based on 1 gm/dose)</td>
</tr>
<tr>
<td>Vancomycin</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Open Fractures:

For documentation purposes, all open fractures should be classified according to the Gustillo fracture classification system:

**Gustillo Fracture Classification**

<table>
<thead>
<tr>
<th>Gustillo Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Open fracture, clean wound, wound &lt;1 cm in length</td>
</tr>
<tr>
<td>II</td>
<td>Open fracture, wound &gt; 1 cm but &lt; 10 cm in length[4] without extensive soft-tissue damage, flaps, avulsions</td>
</tr>
<tr>
<td>III</td>
<td>Open fracture with extensive soft-tissue laceration (&gt;10 cm[4]), damage, or loss or an open segmental fracture. This type also includes open fractures caused by farm injuries, fractures requiring vascular repair, or fractures that have been open for 8 hr prior to treatment</td>
</tr>
<tr>
<td>IIIA</td>
<td>Type III fracture with adequate periosteal coverage of the fracture bone despite the extensive soft-tissue laceration or damage</td>
</tr>
<tr>
<td>IIIB</td>
<td>Type III fracture with extensive soft-tissue loss and periosteal stripping and bone damage. Usually associated with massive contamination. Will often need further soft-tissue coverage procedure (i.e. free or rotational flap)</td>
</tr>
<tr>
<td>IIIC</td>
<td>Type III fracture associated with an arterial injury requiring repair, irrespective of degree of soft-tissue injury.</td>
</tr>
</tbody>
</table>

Any open fracture mandates that the orthopedic service be consulted, and antibiotics should be administered as soon as possible after the identification of the fracture. Note
that it is the responsibility of the trauma service to order (and manage) any necessary antibiotics. Antibiotic coverage for open fractures should be given per the following guideline:

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration*</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin +/-</td>
<td>1 gm</td>
<td>Upon admission, then Q8H until 24 hours after wound closure If needed, start upon admission then Q8H x 1st 72 hrs#</td>
<td>$12.42/day</td>
</tr>
<tr>
<td>Gentamicin#</td>
<td>1 mg/kg</td>
<td></td>
<td>$1.34/day</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>$13.76/day</td>
</tr>
<tr>
<td>IF PENICILLIN-ALLERGIC:</td>
<td>15 mg/kg</td>
<td>Upon admission, then Q12H until 24 hours after wound closure If needed, start upon admission then Q8H x 1st 72 hours only#</td>
<td>$16.00/day (based on 1 gm / dose) $1.34/day</td>
</tr>
<tr>
<td>Vancomycin +/-</td>
<td>1 mg/kg</td>
<td></td>
<td>$17.34</td>
</tr>
<tr>
<td>Gentamicin#</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Hand Fractures**

*MUSC Hand Surgery Foundations for an Interdisciplinary Program*  

Given that the subspecialty of hand surgery involves the care of multiple tissue types in a concentrated area with a strong focus on functional anatomy and outcomes, it is understandable that the contemporary practice of hand surgery has evolved as a multidisciplinary endeavor. Specifically, each of the boards of orthopaedic surgery, plastic surgery, and general surgery has established pathways to attainment of a Certificate of Added Qualifications (CAQ) in Surgery of the Hand. Accordingly, MUSC is committed to establishing a collaborative interdisciplinary hand surgery program consistent with this philosophy. This document will outline the essential foundations of this collaborative effort.

Emergency On---Call coverage – The orthopaedic and plastic surgery services will each share equally in the responsibility for provision of on---call care of hand emergencies at University Hospital. Effective in September, 2013, each service will cover alternating one week blocks for hand surgery emergencies. Specifically, the purview of hand call will be simply defined as including:

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1. Delineation of injury complexes:
   a) soft tissue injury distal to the elbow, and
   b) skeletal injury distal to the wrist, including intra-—articular fracture of the distal radius. It is important to note that this definition specifically excludes extra-—articular distal radius fractures from the hand surgery domain as being "orthopaedic" injuries, the indications for fixation of which are currently in evolution and best determined in the context of skeletal injury fixation as viewed by a fully trained orthopaedic surgeon.

2. Interdisciplinary Didactic Conferences —A combined interdisciplinary hand surgery conference schedule will include active participation by both orthopaedic and plastic hand surgery faculty members who hold an active CAQ or are "eligible" to sit for the CAQ exam in Surgery of the Hand. This will provide a fertile environment for didactic education with mutual benefit to each respective training program.

3. Interdisciplinary Clinical Rotations —An interdisciplinary rotation for residents and medical students will benefit from the tutelage of both orthopaedic and plastic surgery faculty members holding, or eligible to sit for, a CAQ in hand surgery. In order to appropriately focus the content and clinical material of the rotation, the pre—requisite for participation will be the exclusive practice of the faculty member in hand and upper extremity surgery on either a full time basis or in dedicated blocks of time suitable for a focused educational experience in this discipline.

As these initiatives prove to be successful, opportunities will develop for a combined interdisciplinary clinical service as well as a fellowship program in hand surgery.

Mangled Extremity

Although the definition of “mangled extremity” remains elusive, any extremity sustaining sufficiently severe injury to a combination of vascular, bony, soft tissue and/or nerve structures that results in subsequent concern for viability of the limb should be considered a mangled extremity and evaluated appropriately to optimize the potential for functional outcome. An evidence based algorithm for the management of these injuries is on the following page:
Algorithm for the Management of the Mangled Extremity

1. Restore appropriate anatomic alignment of extremity
2. Vascular evaluation
3. Neurologic evaluation

Classify bony injury?

Evidence for vascular injury?

Yes

CTA to exclude or define vascular injury

No

Operating Room

Comprehensive evaluation for systemic consequences of limb salvage attempt (i.e. life over limb)

Salvage candidate?

Yes

Limb salvage

Indeterminate

Obtain 2nd opinion if stable

Talk to family if available

Consider bringing family to operating room to view extremity if stable

No

Salvage candidate?

Amputation

Criteria for immediate amputation present?

No

Intraluminal shunt as necessary

Classify bony injury and consider prognosis for nerve injury

Yes

To OR for emergent operative exploration and vascular control

Persistent hemorrhage or refractory hemodynamic instability?

To OR for emergent operative exploration and vascular control

Management of the Mangled Extremity

Predictive factors for the need for amputation are within the following table.

<table>
<thead>
<tr>
<th>Predictors Associated with the Need for Amputation of the Mangled Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systemic Factors</strong></td>
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<tr>
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<tr>
<td></td>
</tr>
<tr>
<td><strong>Bony skeletal factors</strong></td>
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<tr>
<td><strong>Soft tissue factors</strong></td>
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<tr>
<td><strong>Neurologic Factors</strong></td>
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<tr>
<td><strong>Vascular Factors</strong></td>
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</tbody>
</table>

Note that the decision to amputate a limb, in the absence of other life-threatening injuries, should be a decision made and document by at least two clinicians. It is preferable if the two clinicians are from different sub-specialties (i.e. trauma, orthopedics, and/or vascular surgery).

**Management of Peripheral Vascular Trauma**

The indications for surgical intervention in peripheral vascular trauma can be broken down into “Hard Signs” and “Soft Signs:”
- **“Hard Signs”**
  - Pulsatile bleeding
  - Expanding hematoma
  - Palpable thrill
  - Audible thrill
  - Evidence of regional ischemia
• Pallor
• Paresthesia
• Paralysis
• Pain
• Pulselessness
• Poikilothermia
• Evidence of limb-threatening ischemia
• “Soft Signs” suggest the need for further evaluation
  • History of moderate hemorrhage
  • Injury (fracture, dislocation, or penetrating wound) in proximity to a major artery
  • Diminished but palpable pulse
  • Peripheral nerve deficit

Additional indications for exploration include:
• Demonstration of a major vascular injury by arteriogram (or duplex ultrasound)
• Evidence of compartmental hypertension
  • Tense compartments to palpation
  • Neurologic, venous or arterial signs of compartmental hypertension
  • Elevated compartmental pressure (>30 mmHg)
• Demonstration of a major vascular injury at surgery
Adult Burns

Criteria for Adult Burn Transfer

The American Burn Association has identified the following types of burn injuries that typically require referral to a burn center:

- Partial-thickness and full-thickness burns on greater than 10% of the BSA in patients over 50 years of age
- Partial-thickness and full-thickness burns on greater than 20% of the BSA in adults
- Partial-thickness and full-thickness burns involving the face, eyes, ears, hands, feet, genitalia, and perineum, as well as those that involve skin overlying major joints
- Full-thickness burns on greater than 5% of the BSA in adults
- Significant electrical burns, including lightning injury
- Significant chemical burns
- Inhalation injury
- Burn injury in patients with preexisting illness that could complicate treatment, prolong recovery, or affect mortality
- Any patient with a burn injury who has concomitant trauma poses an increased risk of morbidity or mortality, and may be treated initially in a trauma center until stable before being transferred to a burn center
- Burn injury in patients who will require special social and emotional or long-term rehabilitative support

Initial Fluid Resuscitation in Adult Burn Patients

Goals of Fluid Therapy

The goals of fluid resuscitation in the adult burn patient are:

- Restore and maintain tissue perfusion
- Provide minimum amount of fluid necessary to maintain adequate tissue perfusion

First 24 hour resuscitation strategy

The resuscitation fluid of choice in the adult burn patient for the first 24 hours is lactated Ringer’s solution, which should be administered as follows:

- Volume: 2-4 mL/kg/%TBSA burn, where % burn is based on the TBSA of 2nd and 3rd degree burns only
- Rate: In general, 1/2 of the projected fluid volume should be administered within the first 8 hours following injury (not admission), then the remaining half should be administered over the next 16 hours. These rate recommendations are very general guidelines. Fluid needs must be individualized based on the patient’s response and reassessed on an ongoing basis (hourly in ICU patients). Two commonly used formulae for the rate of fluid administration are the Parkland formula and the Modified Brooke formula:
## Common Formulas for Estimating Fluid Requirements for Adult Burn Patients for the First 24 Hours Post-Burn

<table>
<thead>
<tr>
<th>Name of Formula</th>
<th>Fluid Used</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkland</td>
<td>LR</td>
<td>4 mL/kg/%TBSA burn</td>
</tr>
<tr>
<td>Modified Brooke</td>
<td>LR</td>
<td>2mL/kg/%TBSA burn</td>
</tr>
</tbody>
</table>
Post-operative and Post-admission Care of the Trauma Patient

Admissions to General Surgery Red and General Surgery Blue

- For all patients who go to the Operating Room directly from the Emergency Department, the trauma Chief Resident must notify the charge nurse in the Surgical Trauma Intensive Care Unit (STICU) of the pending admission, so that a bed can be made for the patient post-operatively. Ideally, this should be done prior to the patient leaving the Emergency Department.
- Consulting services may write orders on Trauma Service patients relative to the specific area of injury that service is treating. All other orders are the responsibility of the Trauma Service.
- There are standard trauma service admission doctors order sets that should be filled out on all Trauma service admissions.
- Specific burn admission orders should be filled out on all burn admissions, along with a Lund-Browder chart.

Indications for Admission to the Surgical Trauma Intensive Care Unit

Indications for admission to the STICU include:
- Cardiovascular instability during the preoperative or intra-operative course
- Prior history of cardiac, pulmonary or renal disease
- Ventilatory support required post-operatively
- Intra-operative hypothermia or coagulopathy
- Severity of injury that suggests a high potential of early postoperative complications

Routine STICU Care Orders

All trauma patients in the STICU must have:
- a continuous cardiac monitor.
- accurate intake and output measurements according to the following schedule:
  - Nasogastric output every shift
  - Chest tube output every two hours until output is less than 100 cc/hour, then every shift
  - Jackson-Pratt drainage every four hours (using sterile drainage collection bag)
  - Sump drainage every four hours
  - Intravenous intake as per STICU routine

Laboratory monitoring:
- Required labs, as well as their interval, will be determined by the admitting physician as the patient's clinical condition dictates.

Pulmonary Care:
• Intubated Patients:
  • Daily measurement of a rapid shallow breathing index, tidal volume and negative inspiratory force must be performed.
  • All intubated patients will undergo endotracheal suction hourly using a clean technique.
• Non-intubated Patients:
  • All non-intubated patients will receive the following pulmonary toilet:
    • Position change every one to two hours (or placement in a Rotobed)
    • Up in chair every shift if patient’s condition allows
    • Deep breathing and coughing every one to two hours

Wound Care:
• Closed surgical wounds
  • will remain dressed for 24 to 48 hours
  • After 24 hours, they may be left open to air.
• Open surgical wounds
  • will be dressed with normal saline soaked gauze and be changed every shift
  • The first dressing change is to be performed by the trauma surgeons.
• Contaminated trauma-induced wounds
  • may be dressed as above or may be dressed using antibacterial substances at the discretion of the surgeon.

Vascular Access:
• All intravenous lines (including IO lines) inserted in the Emergency Department will be removed within 24 hours of admission, unless deemed otherwise by attending physician.
• Peripheral intravenous catheters will remain in place no longer than 48 hours.
• Swan-Ganz catheters
  • Indications for insertion
    • Evidence of myocardial dysfunction
    • Persistent oliguria despite appropriate intravenous fluid therapy
    • Pulmonary failure required FIO2 > 60% or positive end-expiratory pressure equal to or greater than 10 cm H2O
    • Institution of cardioactive drugs (e.g., Dopamine, Dobutamine, Isoproterenol, Epinephrine, Norepinephrine)
    • Septic shock
  • Sites of insertion shall be selected according to the following priority:
    • Right internal jugular vein
    • Right subclavian vein
    • Left subclavian vein
    • Left internal jugular vein
    • Either femoral vein
  • Technique of insertion
    • Aseptic technique will be used.
    • A standard technique for puncturing the subclavian vein will be used.
• A guide wire is introduced into the subclavian vein.
• An introducer is then inserted over the guide wire and the wire is removed.
• The Swan-Ganz catheter is then inserted via the introducer.
• The catheter is then attached to a transducer and pressure monitor.
• The catheter is introduced in small increments until the right atrium, then the right ventricle have been entered (pressure tracings to serve as control).
• The balloon is then inflated with 1 cc of air and the catheter is again advanced until the pulmonary artery has been entered and the catheter is in the wedge position.
• The balloon is deflated and pressure tracing is checked to insure the catheter is not permanently wedged.
• If the position is acceptable, the catheter is fixed in place using several sutures.
• An occlusive sterile dressing is then applied.
• A chest radiogram will be obtained to verify the position of the catheter and to locate possible complications secondary to insertion.
• Use of Swan-Ganz catheters
  • Pulmonary capillary wedge pressures will be obtained every one to two hours.
  • Cardiac outputs will be obtained every 12 hours on a routine basis and with every acute change in the patient's condition.
  • These measurements may be obtained either by resident or intensive care nursing staff.
  • Dressing changes will be performed every 48 hours.
  • Swan-Ganz catheters will remain in place a maximum of five days.
• Arterial Catheters
  • Indications for Insertion
    • Monitoring of blood pressure in hemodynamically unstable patient
    • Patients requiring ventilatory support for greater than 24 hours
    • Patients requiring frequent laboratory tests for greater than 24 hours
    • Patients requiring the use of either pressor agents or intravenous antihypertensive medication
    • Patients with severe head injuries (GCS <= 8)
  • Sites of insertion shall be selected according to the following priority:
    • Radial artery (only with a negative Allen's Test demonstrating intact ulnar artery and palmar arch)
    • Femoral artery
    • Dorsalis pedis artery
    • Brachial artery
    • Temporal artery
  • Technique:
    • Percutaneous insertion will be used if technically feasible.
    • If percutaneous insertion fails, a surgical cut-down and insertion will be performed using aseptic technique.
• Arterial catheter dressing changes will be performed every 48 hours.

**Intracranial pressure (ICP) monitors**

Indications for Intracranial Pressure Monitoring
- Any patient with a head injury, GCS <= 8 and an abnormality on CT of the head
- ICP monitoring is appropriate in patients with severe head injury and a normal CT scan if two or more of the following features are noted on admission
  - age over 40
  - unilateral or bilateral posturing
  - systolic BP< 90 mmHg
- The ultimate decision for insertion of an ICP monitor is at the discretion of the Neurosurgical Attending. Indications and technique for placement of intracranial pressure monitoring catheters will be at the discretion of appropriately obtained neurosurgical consultation.
- Daily care of ICP monitors will be at the direction of the neurosurgical consultant.

**Foley Catheters**

In general, it is the policy of the trauma service to avoid foley catheters whenever possible, in an attempt to catheter associated urinary tract infections (CAUTIs). Foley catheters will remain in place until the following criteria have been met:
- The patient's condition is stable enough that she/he no longer requires hourly urine output measurements.
- The patient is alert enough to be able to use alternative devices (urinal or bedpan).
- There is no urinary tract injury requiring the Foley catheter to be maintained.

**Nasogastric Tubes**

Nasogastric catheters will remain in place until the following criteria have been met:
- There is evidence of a functioning gastrointestinal tract
- Nasogastric drainage is 1,000 cc or less for a 24 hour period (except Peds)
- There has been no significant gastric bleeding in the past 24 hour period
- There is no gastrointestinal tract injury requiring the nasogastric tube to be maintained.

**Chest Tube Management**

All patients who have chest tubes in place should get prophylactic antibiotics (2nd generation Cephalosporin) for 24 hours only.⁷³

*Indications for Removal*

The tube thoracostomy will remain in place until:

---

⁷³ EAST Trauma Practice Guidelines; Parameters for Prophylactic Antibiotics in Tube Thoracostomy for Traumatic Hemopneumothorax, Copyright EAST 1998. EAST Trauma Practice Guidelines; www.EAST.org
• Drainage from the tube is less than 200 cc in a 24 hour period (25 cc/24 hours for a pediatric patient).
• All air leakage has stopped.
• A chest radiograph demonstrates that the lung remains expanded with the tube off suction.

Removal of a chest tube placed for traumatic injury should proceed according to the algorithm below:

C, T/L/S Spine Clearance

All patients must remain in a c-spine collar until cleared. The following clearance algorithms have been universally approved by the BST, Orthospine, and Neurosurgery attendings. Any of the three services may clear a spine. Note that two protocols are provided, one for the obtunded patient, and one for the non-obtunded patient.
Assess Mental Status:
- GCS < 14?
- Disoriented?
- Inability to remember 3 objects at 5 minutes?
- Delayed or inappropriate response to external stimuli?
- Any focal motor or sensory deficit?

No → Clinically Intoxicated?
  - History of alcohol ingestion?
  - BAC > 0.08 mg/dl?
  → Yes → At treating MD discretion, may await sobriety with cervical precautions, then proceed with protocol
  → No

Yes → Proceed to obtunded protocol

Focal Neuro Deficit?
  → Yes → Spine consult
  → No

Midline Cervical Tenderness?
  → Yes → C-spine AP, lateral and odontoid or CT C-spine if patient is to undergo other CT Scans
  → No

Painful Distracting Injury?
- Long Bone Fracture?
- Visceral injury requiring surgical consult?
- Large laceration, de-gloving injury, or crush injury?
- Large burn?
  → Yes → Technically Adequate
  → No → CT-C-spine
  → No → Spine Consult*

Normal

No further evaluation. Discontinue cervical collar
C-spine Clearance in the Obtunded Patient

CT Scan of Cervical Spine:
- Foramen Magnum through T1
- 3 mm cuts
- Sagittal Reconstruction

MRI of cervical spine

Assess Mental Status:
- GCS < 14?
- Disoriented?
- Inability to remember 3 objects at 5 minutes?
- Delayed or inappropriate response to external stimuli?
- Any focal motor or sensory deficit?

Spine Consultation for lateral c-spine with flexion/extension under fluoroscopy (consider only if MRI contraindicated)

MRI Contraindicated
MUSC TLS Spine Trauma Management Protocol: Non-obtunded Patient

Asses Mental Status:
- GCS < 14?
- Disoriented?
- Inability to remember 3 objects at 5 minutes?
- Delayed or inappropriate response to external stimuli?
- Any focal motor or sensory deficit?

No

Proceed to obtunded protocol

Clinically Intoxicated?
- History of alcohol ingestion?
- BAC > 0.08 mg/dl?

No

Yes

At treating MD discretion, may await sobriety with TLS precautions, then proceed with protocol

Focal Neuro Deficit?

No

Yes

Is patient going to CT Scan for imaging of the Chest, Abdomen, AND Pelvis to rule out other injuries?

No

Yes

Spine Consultation

Midline Spine Tenderness?

No

Yes

Order CT reconstructions of T/L/S spine

Normal

Abnormal

Acquire plain films of T/L/S spine

Order CT reconstructions of T/L/S spine

Normal

Abnormal

Acquire spine films centered at region of abnormality

No further evaluation. Discontinue TLS precautions
Asses Mental Status:
- GCS < 14?
- Disoriented?
- Inability to remember 3 objects at 5 minutes?
- Delayed or inappropriate response to external stimuli?
- Any focal motor or sensory deficit?

Is patient going to CT Scan for imaging of the Chest, Abdomen, AND Pelvis to rule out other injuries?

Order CT reconstructions of T/L/S spine

Acquire plain films of T/L/S spine

Acquire Spine Films Centered at Region of Abnormality

d/c T/L/S spine precautions

Spine Consultation
Transfer to the Floor

The decision to transfer the patient from STICU to a surgical floor will be at the discretion of the attending surgeon, or the surgical critical care fellow.

Routine Postoperative Care

Patients who do not require STICU monitoring will be cared for on the general surgical floors, either 10W or 6E.

Routine Care:

- Laboratory studies will be at the discretion of the physician directly involved with that patient's care.
- Vital Signs:
  - Vital signs will be monitored every four hours for the first three days after surgery.
- I and O:
  - Accurate intake and output records will be maintained in the following fashion:
    - Urine output every four hours (or q void if not catheterized).
    - Nasogastric output every eight hours (q 4h in Peds).
    - Penrose and sump drainage every four hours (q 2h in Peds).
    - Chest tube output every eight hours (q 2h in Peds).
    - Gastrointestinal losses as incurred
    - Intravenous and oral intake every eight hours
- Pulmonary toilet:
  - Position change every one to two hours (or placement in a Rotobed)
  - Up in chair every shift if patient's condition allows
  - Deep breathing and coughing every one to two hours
- Ambulation:
  - will be begun on the first postoperative day and progressively increased as tolerated by the patient
  - Note that changes in weight bearing status may be ordered by the Orthotrauma or neurosurgical services
- Foley catheters:
  - Foley catheters will remain in place until the following criteria have been met:
    - The patient's condition is stable enough that she/he no longer requires hourly urine output measurements.
    - The patient is alert enough to be able to use alternative devices (urinal or bedpan).
    - There is no urinary tract injury requiring the Foley catheter to be maintained.
- Nasogastric tubes:
  - Nasogastric catheters will remain in place until the following criteria have been met:
    - There is evidence of a functioning gastrointestinal tract
• Nasogastric drainage is 1,000 cc or less for a 24 hour period (except Peds)
• There has been no significant gastric bleeding in the past 24 hour period
• There is no gastrointestinal tract injury requiring the nasogastric tube to be maintained.

• Surgical wounds:
  • Closed surgical wounds
    • will remain dressed for 24 to 48 hours
    • After 24 hours, they may be left open to air.
  • Open surgical wounds
    • will be dressed with normal saline soaked gauze and be changed every shift
    • The first dressing change is to be performed by the trauma surgeons.
  • Contaminated trauma-induced wounds
    • may be dressed as above or may be dressed using antibacterial substances at the discretion of the surgeon.
Medications in the Trauma Patient

Antibiotics

Indications:
- Any patient who will undergo a surgical procedure because of a traumatic incident.
- Any patient who has an obviously contaminated wound.
- Any patient who has clinical, radiographic or laboratory evidence of an established infectious process.

Usage:
- For abdominal trauma, Piperacillin/Tazobactam will be the antibiotic used routinely. If the patient has a history of a significant penicillin allergy, combination therapy using Clindamycin and an aminoglycoside will be employed.
- All patients undergoing exploratory laparotomy will receive one dose of the appropriate antibiotic(s) when the need for surgical intervention is determined.
- Antibiotics will be continued for a length of time as determined by the patient's condition and the operative findings.
  - Solid organ injury only – no post-op antibiotics
  - Stomach or small bowel injury - three days post-operatively
  - Colon, rectal or pancreatic injury - five days post-operatively
  - Any patient in shock during the procedure - five days post-operatively
  - Immunocompromised patients - five days post-operatively
- Standard dosages will be used.
- If a patient is receiving an aminoglycoside, the following lab data will be obtained.
  - Baseline serum creatinine level and daily levels
  - Baseline two hour creatinine clearance
  - Peak and trough antibiotic levels (until acceptable levels at a stable dosage are achieved) daily
- The aminoglycoside will be discontinued once serum creatinine level has exceeded normal and a repeat creatinine clearance will be obtained.
- For vascular and thoracic procedures, a first generation cephalosporin will be the preferred antibiotic to be started preoperatively and continued for three to five days.
- Other antibiotic usage will be guided by appropriate culture and sensitivity testing. Antibiotics may be modified at the discretion of the trauma surgeon.

Stress Ulcer Prophylaxis and Treatment

The following patients will be defined as high risk patients for development of stress bleeding:
- Any patient in shock as a result of a trauma.
- Any patient with injuries associated with a significant risk of subsequent sepsis (i.e. grossly contaminated wounds, colon or rectal injuries, significant tissue devitalization).
• Any patient who has sustained a significant head injury.
• Any patient who has sustained a significant thermal injury (ABA major burn criteria).
• Any patient with a prior history of peptic ulcer disease.
• Any pediatric patient.

Prophylaxis for stress bleeding will begin once the patient's condition has been stabilized or in the postoperative period, and will consist of antacid administration (po or per NG tube) at sufficient dosages and intervals to maintain gastric pH of greater than 5.

• Antacids will begin at 30 cc every four hours.
• Thirty minutes after antacid administration, a sample of gastric secretions will be obtained and measured for pH.
• If the pH is greater than 5, this process will be repeated in four hours.
• If the pH is less than 5, the dosage will be increased to 60 cc every four hours.
• The pH will be checked after the increased dosage and this schedule will be maintained if pH is greater than 5.
• If pH is less than 5 still, the dosage interval will be decreased to every two hours.
• Once two consecutive pH measurements are greater than 5, the frequency of pH checks will be reduced to once per shift.
• Any evidence of gastrointestinal bleeding while on the above regimen will constitute an indication for the addition of an H2 -- antagonist.
• Upper gastrointestinal endoscopy will be performed to ascertain the etiology of such bleeding.

Alternative prophylaxis with sucralfate (1 gm/q6 hours) can be used at the discretion of the trauma surgeon.

Please see the following page for an algorithmic approach to these guidelines.
Algorithm for Stress Ulcer Prophylaxis

STRESS ULCER PROPHYLAXIS GUIDELINES

Stress Ulcer Prophylaxis

Is stress ulcer prophylaxis needed? 
Prophylaxis is appropriate for patients admitted to the STICU with one or more risk factors.*

YES

Does patient have gastric or small bowel access with known or presumed absorption of feeding?

YES

Famotidine** 20mg via tube Q 12 hours.

NO

Famotidine** 20mg IV Q 12 hours.

NO

Continue periodic assessment

*RISK FACTORS
- Respiratory failure (mechanical ventilation anticipated > 48 hours)
- Coagulopathies (platelet count < 50,000, INR > 1.5, PTT > 2 X control
- Head injury with GCS < 10 or inability to follow simple commands
- Thermal injury involving > 35% TBSA
- Partial hepatectomy
- Major trauma with ISS ≥ 16
- Spinal cord injury
- History of gastric ulcer or bleeding during year prior to admission
- Presence of two of the following: sepsis, ICU stay > 1 week, occult or overt bleeding for ≥ 6 days, corticosteroid therapy (> 250 mg hydrocortisone or equivalent)

**Famotidine dosage adjustment in renal impairment
Decrease dose to 20mg IV/PO/via tube daily for patients with an estimated creatinine clearance ≤ 10 mL/minute

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Deep Vein Thrombosis Prophylaxis

The following patients are considered high-risk for the development of deep venous thrombosis and should receive prophylaxis:

- Any patient with a spinal cord injury.
- Any patient who will be confined to bed for a significant length of time (greater than 24 hours).
- Any patient who is morbidly obese.
- Any patient with prior history of deep vein thrombosis.
- Any patient older than 45 years of age who will be on prolonged bedrest.
- Any patient who has been diagnosed as having malignancy and will be on prolonged bedrest.
- Any patient with complex pelvic or long bone fractures.

High risk of bleeding is considered in the following scenarios:

- Closed head injury and an abnormal head CT. The CT scan must remain stable for >48 hours before considering the patient stable and low risk
- Hyphema
- Non-operatively managed solid organ injuries in patients stable for < 72 hours post injury
- Trauma and abnormal coagulation studies
- Severe pelvic fracture requiring ≥ 2 units of PRBCs and/or >5l of crystalloid over the first 24 hours

Prophylaxis

- Prophylaxis shall be started after the patient's initial care is completed and his/her condition has been stabilized.
- Compression boots are the mechanical DVT prophylaxis of choice in trauma patients.
- The patient shall be continued on prophylactic treatment for deep vein thrombosis until they are fully mobile.
- Compression boots will be administered according to the MUSC Protocol for caring for compression boots.
- Ultrasounds are required on all patients who have an abnormal clinical exam of lower extremities, have a h/o previous DVT or have been confined to bed for greater than 48 hours prior to compression boots being placed.
- Certain selected patients may be candidates (spinal injuries severe head injuries with GCS <8 for greater than 48 hours, and complex pelvic fractures) for prophylactic vena cava filter insertion to control thromboembolism. This must be done at the direction of the attending trauma surgeon.

The trauma service’s algorithm for DVT prophylaxis is found on the following page.
DVT Prophylaxis Algorithm

DVT/PE PROPHYLAXIS

DVT / PE Prophylaxis

All trauma patients should receive chemical and mechanical anticoagulant prophylaxis. If not possible consider IVC filter or weekly duplex screening

Foot pumps / SCD’s Contraindications may include established DVT, severe peripheral arterial disease, compartment syndrome, or LE cast/fixator.

Lovenox unless contraindicated. Contraindications may include hemothorax, hemorrhagic pericardial effusion, uncontrolled bleeding (stable liver and/or spleen injuries without active bleeding are not a contraindication to LMWH), major eye injury, uncorrected coagulopathy (platelet ct<50,000,INR.1.5,PTT>2Xcontrol), spinal anesthesia, history of HIT (heparin induced thrombocytopenia), or epidural catheter in place.

Renal concerns and Lovenox use
If patient has Estimated Creatinine Clearance < 30 or hourly urine output of < .5 cc/kg/hr send a Anti Factor 10A level and if >0.3 adjust Lovenox dose

Trauma Patients without Traumatic Brain or Spinal Cord Injury
Lovenox 30 mg SQ BID
Prophylaxis is continued until patient is fully ambulatory or discharged (if patient not ambulatory at discharge, has a fracture above the knee, or bilateral lower extremity fractures consult attending for consideration of possible home chemical prophylaxis for 10-14 days)

Patients with Spinal Cord Injury
Lovenox 30 mg SQ BID started 48-72 hours of injury. Consider chemical prophylaxis after discharge consult neurosurgery

EXCLUSION
1. Spinal hemorrhage (for example intramedullary or epidural hematoma
2. Unusual spinal column instability
Contact neurosurgery prior to any chemical prophylaxis

Patients with Traumatic Brain Injury
Contact neurosurgery/neurointensivist and trauma attending within 48 hours of admission to begin chemical prophylaxis
Clearly document plan in the medical record

Some risk factors for DVT include:
- Major trauma
- CHI/SCI
- Fractures of the hip/pelvis/leg
- Major surgery especially abdomen / pelvis / lower ext
- Age >40
- Prolonged Immobilization / paralysis >3 days
- Multiple Blunt Trauma
- Venous Groin Lines / major venous repair
- Prior VTE
- Obesity / CHF / Stroke /Smoking
- Hyper coagulable states
- Pregnancy

Revised 05/06/08

Revised 05/06/08
Pain Management Guidelines for Trauma Patients

All patients have the right to adequate analgesia and management of their pain.

Pain Assessment

Pain assessment and response to therapy should be performed regularly by using a scale appropriate to the patient population and systematically documented.

The level of pain reported by the patient must be considered the current standard for assessment of pain and response to analgesia whenever possible. Use of the numeric rating scale is recommended to assess pain.

Patients who cannot communicate should be assessed through subjective observation of pain-related behaviors (movement, facial expression, and posturing) and physiologic indicators (HR, BP, RR) and the change in these parameters following analgesic therapy.

General Principles

A therapeutic plan and goal of analgesia should be established for each patient and communicated to all caregivers to ensure consistent analgesic therapy.

PCA Guidelines

Scheduled opioid doses is preferred over an “as needed” regimen to ensure consistent analgesia. A PCA device may be utilized to deliver opioids if the patient is able to understand and operate the device.

<table>
<thead>
<tr>
<th>PCA Order-Writing Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Loading dose</td>
</tr>
<tr>
<td>Continuous infusion (basal rate)</td>
</tr>
<tr>
<td>Incremental dose</td>
</tr>
<tr>
<td>Lock out interval (delay)</td>
</tr>
<tr>
<td>1 hour limit</td>
</tr>
</tbody>
</table>

Oral Narcotics

The transition from intravenous to oral narcotics should be made as soon as possible in order to help facilitate discharge. Narcotics should be dosed as per the table below:

---

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### Oral Narcotic Analgesics Commonly Used in Trauma

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydromorphone (Dilaudid)</td>
<td>2 mg PO q 4-6 hours PRN pain</td>
<td>0.80-1.20</td>
</tr>
<tr>
<td>Oxycodone/APAP (Percocet)</td>
<td>1-2 tablets PO q 4-6 hours PRN pain</td>
<td>0.11-1.32</td>
</tr>
<tr>
<td>MS immediate release (IR)</td>
<td>15-30 mg PO q 4-6 hours PRN breakthrough pain</td>
<td>0.25-2.58</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>5-10 mg PO q 4-6 hours PRN breakthrough pain</td>
<td>0.15-1.80 (tablets)</td>
</tr>
<tr>
<td>Oxycontin</td>
<td>20-40 mg PO q 12 hours</td>
<td>2.88-11.52</td>
</tr>
<tr>
<td>MS Contin</td>
<td>30-60 mg PO q 8-12 hours</td>
<td>0.84-2.22</td>
</tr>
</tbody>
</table>

### Non-Opioid Analgesics

NSAIDS or acetaminophen may be used as adjuncts to opioids in select patients.

Ketorolac therapy should be limited to a maximum of 5 days. MUSC policy places an automatic stop date for all ketorolac orders at 48 hours. Ketorolac orders must be rewritten if therapy desired beyond 48 hours. Patients should be closely monitored for the development of renal insufficiency or gastrointestinal bleeding. Other NSAIDS (ibuprofen) may be used via the enteral route in appropriate patients.
It is the goal of the trauma service to wean all narcotics prior to discharge, if it is at all possible. Narcotic weans will begin at the first clinic visit after discharge, unless the patient is amenable to weaning immediately at discharge. Please give the patient the exact number of pills until the next follow-up appointment and please indicate this number in the patient’s discharge summary.

**Jurisdiction of Narcotic Prescriptions**

Narcotic prescriptions shall be managed per the following guideline:

- For the trauma patient seeing multiple services, the trauma team will be responsible for medication refills or referral to outpatient pain management services.
- Pain from isolated injuries shall be managed by the specific service treating the injury.

**Narcotic Wean Algorithm**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Intermittent Dose</th>
<th>Cost/Day ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen</td>
<td>325-650 mg PO q 4-6 hours; avoid &gt; 4 grams/day</td>
<td>0.16-0.48</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>400 mg PO q 4-6 hours</td>
<td>0.40-0.60</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>For patients &lt; 50 kg or &gt; 65 y/o or estimated CrCl &lt; 30ml/minute: 15 mg IV every 6 hours For patients &gt; 50 kg or &lt; 65 y/o or estimated CrCl &gt; 50 ml/minute: 30 mg IV every 6 hours Maximum duration for either regimen = 5 days</td>
<td>2.80 2.76</td>
</tr>
</tbody>
</table>

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Narcotics shall be weaned according to the following algorithm:

**ACUTE CARE SURGERY NARCOTIC WEAN GUIDELINE**

- **MS CONTIN WEAN**
  - 30 mg BID x 4 days
  - 15 mg BID x 4 days
  - 15 mg QD x 4 days

- **OXYCODONE WEAN**
  - 20 mg Q6 x 4 days
  - 10 mg Q6 x 4 days
  - 5 mg Q6 x 4 days
  - 5 mg Q8 x 4 days

- **OXYCONTIN WEAN**
  - 20 mg TID x 4 days
  - 20 mg BID x 4 days
  - 10 mg BID x 4 days
  - 10 mg QD x 4 days

- **METHADONE WEAN**
  - Wean by 20% every 3 days
  - Should be weaned to off by 3 weeks post discharge

---

**Surgical Antimicrobial Prophylaxis in Trauma**

*Abdominal Trauma*

---

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## If Penicilline Allergic

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clindamycin +</td>
<td>600 mg</td>
<td>Pre-op, then Q8H x 24 hours</td>
<td>$47.12</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>2.5 mg/kg</td>
<td>Pre-op, then Q12H x 24 hours</td>
<td>$3.35</td>
</tr>
</tbody>
</table>

## In the Event of a Drug Shortage

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin +</td>
<td>1 gm</td>
<td>Pre-op, then Q6H x 24 hours</td>
<td>$20.70</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>500 mg</td>
<td>Pre-op, then Q6H x 24 hours</td>
<td>$10.38</td>
</tr>
</tbody>
</table>

## Facial Trauma

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration*</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>1 gm</td>
<td>Upon admission, then Q8H until 24 hours post-op</td>
<td>$12.42/day</td>
</tr>
<tr>
<td>IF PENICILLIN-ALLERGIC: Clindamycin</td>
<td>600 mg</td>
<td>Upon admission, then Q8H until 24 hours post-op</td>
<td>$35.34/day</td>
</tr>
</tbody>
</table>

## Orthopedic Trauma: Closed Fractures

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin</td>
<td>1 gm</td>
<td>Pre-op, then Q8H x 24 hours</td>
<td>$16.56</td>
</tr>
<tr>
<td>IF PENICILLIN-ALLERGIC: Vancomycin</td>
<td>15 mg/kg</td>
<td>Pre-op, then Q12H x 24 hours</td>
<td>$24.00 (based on 1 gm/dose)</td>
</tr>
</tbody>
</table>

## Orthopedic Trauma: Open Fractures
### Antimicrobial Regimens for Common Infections in Trauma Patients

#### Antimicrobial Regimens for Nosocomial Pneumonia

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Dose</th>
<th>Duration*</th>
<th>Cost / Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefazolin +/− Gentamicin#</td>
<td>1 gm</td>
<td>Upon admission, then Q8H until 24 hours after wound closure If needed, start upon admission then Q8H x 1st 72 hrs#</td>
<td>$12.42/day $1.34/day $13.76/day</td>
</tr>
<tr>
<td>Vancomycin +/− Gentamicin#</td>
<td>15 mg/kg 1 mg/kg</td>
<td>Upon admission, then Q12H until 24 hours after wound closure If needed, start upon admission then Q8H x 1st 72 hours only#</td>
<td>$16.00/day (based on 1 gm / dose) $1.34/day $17.34</td>
</tr>
</tbody>
</table>

*Costs are approximate and subject to change.*
### Empiric Parenteral Regimens for Nosocomial Pneumonia*

<table>
<thead>
<tr>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>($)</td>
<td>(8 day regimen)</td>
</tr>
<tr>
<td>Pipercillin/Tazobactam</td>
<td>4.5 g IV q 6 hours</td>
<td>77.52</td>
<td>902.08</td>
</tr>
<tr>
<td>Tobramycin**</td>
<td>210 mg IV q 12 hours</td>
<td>11.24</td>
<td></td>
</tr>
<tr>
<td>Vancomycin***</td>
<td>1 gm IV q 8 hours</td>
<td>24.00</td>
<td></td>
</tr>
<tr>
<td>Cefepime</td>
<td>2 g IV q 8 hours</td>
<td>32.04</td>
<td>538.24</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>210 mg IV q 12 hours</td>
<td>11.24</td>
<td></td>
</tr>
<tr>
<td>Vancomycin</td>
<td>1 gm IV q 8 hours</td>
<td>24.00</td>
<td></td>
</tr>
<tr>
<td>Doripenem</td>
<td>500 mg IV q 8 hours</td>
<td>6.93</td>
<td>337.32</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>210 mg IV q 12 hours</td>
<td>11.24</td>
<td></td>
</tr>
<tr>
<td>Vancomycin</td>
<td>1 g IV q 8 hours</td>
<td>24.00</td>
<td></td>
</tr>
</tbody>
</table>

* All drugs require dosing adjustments for renal impairment

** Tobramycin dosing based on 3.0 mg/kg for 70 kg patient

*** Vancomycin dosing based on 15 mg/kg for 70 kg patient

Regimen should be streamlined once susceptibility data is available
Empiric Parenteral Regimens for Nosocomial Pneumonia in Patients With Penicillin/Cephalosporin Allergy*

<table>
<thead>
<tr>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (8 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg IV q 8 hours</td>
<td>6.36</td>
<td>332.80</td>
</tr>
<tr>
<td>Tobramycin**</td>
<td>210 mg IV q 12 hours</td>
<td>11.24</td>
<td>24.00</td>
</tr>
<tr>
<td>Vancomycin***</td>
<td>1 gm IV q 8 hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* All drugs require dosing adjustments for renal impairment

** Tobramycin dosing based on 3.0 mg/kg for 70 kg patient

***Vancomycin dosing based on 15 mg/kg for 70 kg patient

Regimen should be streamlined once susceptibility data is available.

Empiric Parenteral Regimens for Intra-abdominal Infections

<table>
<thead>
<tr>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moxifloxacin</td>
<td>400 mg IV daily</td>
<td>11.82</td>
<td>118.20</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>1 gram IV daily</td>
<td>56.89</td>
<td>568.90</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg IV q 12 hours</td>
<td>4.24</td>
<td>125.20</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>500 mg IV q 6 hours</td>
<td>8.28</td>
<td></td>
</tr>
<tr>
<td>Ampicillin/sulbactam</td>
<td>3 grams IV q 6 hours</td>
<td>13.64</td>
<td>136.40</td>
</tr>
<tr>
<td>Piperacillin/tazobactam*</td>
<td>3.375 grams IV q 6 hours</td>
<td>63.04</td>
<td>630.40</td>
</tr>
<tr>
<td>Doripenem*</td>
<td>500 mg IV q 8 hours</td>
<td>6.93</td>
<td>69.30</td>
</tr>
</tbody>
</table>

*Piperacillin/tazobactam and doripenem should only be considered for empiric therapy if P. aeruginosa is suspected (i.e., nosocomial vs. community-acquired infection).

Regimen should be tailored to susceptibility data, if available.
*Piperacillin/tazobactam and doripenem should only be considered for empiric therapy if P. aeruginosa is suspected (i.e., nosocomial vs. community-acquired infection).

Regimen should be tailored to susceptibility data, if available.

**Oral Step Down Regimens for Biliary Tract Infections**

<table>
<thead>
<tr>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moxifloxacin</td>
<td>400 mg IV daily</td>
<td>4.24</td>
<td>125.20</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg IV q 12 hours</td>
<td>11.82</td>
<td>118.20</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>500 mg IV q 6 hours</td>
<td>8.28</td>
<td></td>
</tr>
<tr>
<td>Ampicillin/sulbactam</td>
<td>3 grams IV q 6 hours</td>
<td>13.64</td>
<td>136.40</td>
</tr>
<tr>
<td>Piperacillin/tazobactam*</td>
<td>3.375 grams IV q 6 hours</td>
<td>63.04</td>
<td>630.40</td>
</tr>
<tr>
<td>Doripenem*</td>
<td>500 mg IV q 8 hours</td>
<td>6.93</td>
<td>69.30</td>
</tr>
</tbody>
</table>
### Oral Step Down Regimens for Biliary Tract Infections

<table>
<thead>
<tr>
<th>Drug (PO)</th>
<th>Regimen</th>
<th>Cost/day</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin/clavulanate</td>
<td>875 mg PO bid</td>
<td>1.46</td>
<td>14.60</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>400 mg PO daily</td>
<td>2.56</td>
<td>25.60</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>500-750 mg PO bid</td>
<td>0.30-0.44</td>
<td>6.20-7.60</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>500 mg PO qid</td>
<td>0.32</td>
<td></td>
</tr>
</tbody>
</table>

### Management of Urinary Tract Infections (UTIs)

#### Empiric Parenteral Regimens for Central Venous Catheter Infections

<table>
<thead>
<tr>
<th>Gram-Positive Organism Isolated on Gram Stain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug (IV)</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Vancomycin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gram Negative Organism Isolated on Gram Stain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug (IV)</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Pipercillin/Tazobactam</td>
</tr>
<tr>
<td>Tobramycin</td>
</tr>
<tr>
<td>Cefepime</td>
</tr>
<tr>
<td>Tobramycin</td>
</tr>
<tr>
<td>Doripenem</td>
</tr>
<tr>
<td>Tobramycin</td>
</tr>
</tbody>
</table>
Do not treat S. epidermidis bacteremia with drug therapy if only 1 blood culture is positive and patient is not clinically ill.

Tailor regimen for gram-negative infection based on culture and susceptibility data when available.

**Oral and Parenteral Regimens for Cellulitis**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dicloxacillin</td>
<td>500 mg PO q8h</td>
<td>1.14</td>
<td>11.40</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>1 gram IV q 8 hours</td>
<td>12.42</td>
<td>124.20</td>
</tr>
<tr>
<td>Augmentin</td>
<td>875 mg PO bid</td>
<td>1.46</td>
<td>14.60</td>
</tr>
<tr>
<td>Ampicillin/sulbactam</td>
<td>3 grams IV q 6 hours</td>
<td>13.64</td>
<td>136.40</td>
</tr>
<tr>
<td>Nafcillin</td>
<td>2 grams IV q 4 hours</td>
<td>92.28</td>
<td>922.80</td>
</tr>
</tbody>
</table>

**Oral and Parenteral Regimens for C. Difficile Colitis**

---

Parenteral Regimens for Treatment of Central Venous Catheter Infections

<table>
<thead>
<tr>
<th>Confirmed MRSA or MRSE*</th>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vancomycin</td>
<td>1 gram IV q 12 hours</td>
<td>16.00</td>
<td>160.00</td>
</tr>
</tbody>
</table>

Confirmed MSSA

| Nafcillin | 2 grams IV q 4 hours | 92.28 | 922.80 |

---

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Oral and Parenteral Regimens for C. difficile Colitis

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metronidazole</td>
<td>500 mg PO qid</td>
<td>0.32</td>
<td>3.20</td>
</tr>
<tr>
<td></td>
<td>500 mg IV qid</td>
<td>8.28</td>
<td>82.80</td>
</tr>
<tr>
<td>Vancomycin*</td>
<td>125-250 mg PO qid</td>
<td>2.64-5.28</td>
<td>26.40-52.80</td>
</tr>
</tbody>
</table>

Parenteral Anti fungal Regimens

<table>
<thead>
<tr>
<th>Drug (IV)</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost (10 day regimen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphotericin B</td>
<td>1 mg/kg/day IV (70 mg)</td>
<td>1.98</td>
<td>19.80</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>400 mg IV daily</td>
<td>6.87</td>
<td>68.70</td>
</tr>
<tr>
<td></td>
<td>800 mg IV daily</td>
<td>13.74</td>
<td>137.40</td>
</tr>
<tr>
<td>Ambisome</td>
<td>5 mg/kg/day IV (350 mg)</td>
<td>28.98</td>
<td>289.80</td>
</tr>
<tr>
<td>Caspofungin</td>
<td>50 mg IV daily</td>
<td>11.31</td>
<td>113.10</td>
</tr>
<tr>
<td>Voriconazole</td>
<td>6 mg/kg IV X 2, then 4 mg/kg q 12 hours</td>
<td>33.66 (day 1), then 22.44</td>
<td>235.62</td>
</tr>
</tbody>
</table>

Oral Anti fungal Regimens

Management of Hospital Acquired (HAPS), Ventilator-Associated (VAP) and Healthcare-Associated Pneumonia in Trauma Patients

Hospital guidelines for HAP, VAP and HCAP were developed in 2005, based on the American Thoracic Society’s (ATS) guidelines for managing these types of pneumonia.

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79 06/07/10
According to our institutional guidelines, the diagnosis of HAP, VAP, and HCAP depends upon the presence of new or progressive radiographic infiltrates as well as other clinical features (fever >101.3°F, leukocytosis or leukopenia, change in oxygenation status and purulent secretions). Pathogenic bacteria in quantity, in culture, in intubated patients, in the absence of signs and symptoms of pneumonia, is NOT diagnostic of pneumonia.

Two sets of blood cultures from separate sites and cultures of lower respiratory tract secretions should be performed in all patients with suspected HAP, VAP, and HCAP, preferably before antibiotics are administered. A sterile culture of respiratory tract secretions in the absence of a new antibiotic in the past 72 hours makes the diagnosis of bacterial pneumonia less likely. Candida in respiratory secretions is almost always colonization, not infection.

Initial empiric antimicrobial therapy should include 3 drugs to cover for multi-drug resistant pathogens. Empiric drug selection is based on our unit-specific antibiogram and should include:

- Doripenem 500 mg IV q 8 hours OR

### Management of Urinary Tract Infections (UTIs)

#### Oral Regimens for Acute Uncomplicated UTI

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMP/SMX DS</td>
<td>1 PO bid</td>
<td>0.30</td>
<td>0.90 (3 days)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>250 mg PO bid</td>
<td>0.26</td>
<td>0.78 (3 days)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>100 mg PO qid</td>
<td>2.64</td>
<td>7.92 (3 days)</td>
</tr>
</tbody>
</table>

#### Parenteral Regimens for Acute Uncomplicated Pyelonephritis

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>200 mg IV q 12 hours</td>
<td>3.44</td>
<td>48.16 (14 days)</td>
</tr>
<tr>
<td>Cefepime</td>
<td>1 gram IV q 12 hours</td>
<td>10.70</td>
<td>149.80 (14 days)</td>
</tr>
<tr>
<td>Ampicillin/sulbactam</td>
<td>3 grams IV q 6 hours</td>
<td>13.64</td>
<td>190.96(14 days)</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>3.375 grams IV q 6 hours</td>
<td>63.04</td>
<td>882.56 (14 days)</td>
</tr>
</tbody>
</table>

#### Parenteral Regimens for Complicated UTI/Catheter Infections

<table>
<thead>
<tr>
<th>Drug</th>
<th>Regimen</th>
<th>Cost/day ($)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg IV q 12 hours</td>
<td>4.24</td>
<td>59.36 (14 days)</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>3.375 grams IV q 6 hours</td>
<td>63.04</td>
<td>882.56 (14 days)</td>
</tr>
<tr>
<td>Doripenem</td>
<td>500 mg IV q 8 hours</td>
<td>6.93</td>
<td>97.02 (14 days)</td>
</tr>
</tbody>
</table>
MUSC Trauma Manual

- Piperacillin-tazobactam 4.5 grams IV q 6 hours, PLUS
- Tobramycin 3 mg/kg IV q 12-24 hours or 7 mg/kg IV q 24 hours, PLUS
- Vancomycin 15 mg/kg IV q 8-12 hours or Linezolid 600 mg IV q 12 hours

All drugs listed above require dosing adjustments in patients with renal insufficiency.

Pharmacokinetic/dynamics for tobramycin and vancomycin are altered in trauma patients. Consult with Brian McKinzie, PharmD (pager 13540), to determine initial starting doses for these drugs.

Desired peak and trough levels for these drugs are:
- Tobramycin peak: 10-12 micrograms/mL; trough: < 1 micrograms/mL
- Vancomycin trough: 15-20 micrograms/mL

Please consult with Brian McKinzie, PharmD (pager 13540) before altering doses of these drugs.

Drug levels should be obtained when the drug concentration is deemed to be at steady state. Consult with Brian McKinzie, PharmD (pager 13540) to determine optimal timing for ordering vancomycin and tobramycin levels.

Drug therapy should be narrowed after 48-72 hours, based on the results of gram stain, culture and susceptibility data, and the patient's response to therapy (respiratory rate, temperature, SaO2, WBC, etc.).

The recommended duration of therapy is 8 days unless patient has multi-drug resistant pathogens (example: Pseudomonas), therapy may then increase to 10-14 days depending on clinical response.

According to our institutional guidelines, the diagnosis of HAP, VAP, and HCAP depends upon the presence of new or progressive radiographic infiltrates as well as other clinical features (fever >101.3°F, leukocytosis or leukopenia, change in oxygenation status and purulent secretions). Pathogenic bacteria in quantity, in culture, in intubated patients, in the absence of signs and symptoms of pneumonia, is NOT diagnostic of pneumonia.

Two sets of blood cultures from separate sites and cultures of lower respiratory tract secretions should be performed in all patients with suspected HAP, VAP, and HCAP, preferably before antibiotics are administered. A sterile culture of respiratory tract secretions in the absence of a new antibiotic in the past 72 hours makes the diagnosis of bacterial pneumonia less likely. Candida in respiratory secretions is almost always colonization, not infection.

Initial empiric antimicrobial therapy should include 3 drugs to cover for multi-drug resistant pathogens. Empiric drug selection is based on our unit-specific antibiogram and should include:
- Doripenem 500 mg IV q 8 hours OR
- Piperacillin-tazobactam 4.5 grams IV q 6 hours, PLUS
- Tobramycin 3 mg/kg IV q 12-24 hours or 7 mg/kg IV q 24 hours, PLUS
- Vancomycin 15 mg/kg IV q 8-12 hours or Linezolid 600 mg IV q 12 hours
All drugs listed above require dosing adjustments in patients with renal insufficiency.

Pharmacokinetic/dynamics for tobramycin and vancomycin are altered in trauma patients. Consult with Brian McKinzie, PharmD (pager 13540), to determine initial starting doses for these drugs.

Desired peak and trough levels for these drugs are:

- Tobramycin peak: 10-12 micrograms/mL; trough: < 1 micrograms/mL
- Vancomycin trough: 15-20 micrograms/mL

Please consult with Brian McKinzie, PharmD (pager 13540) before altering doses of these drugs.

Drug levels should be obtained when the drug concentration is deemed to be at steady state. Consult with Brian McKinzie, PharmD (pager 13540) to determine optimal timing for ordering vancomycin and tobramycin levels.

Drug therapy should be narrowed after 48-72 hours, based on the results of gram stain, culture and susceptibility data, and the patient's response to therapy (respiratory rate, temperature, SaO2, WBC, etc.).

The recommended duration of therapy is 8 days unless patient has multi-drug resistant pathogens (example: Pseudomonas), therapy may then increase to 10-14 days depending on clinical response.

**MUSC Guidelines for Off-Label Use of Factor VII (ReVIIA) in Trauma**

Institutional guidelines for use of Factor VII in trauma have been established and can be downloaded at http://www.musc.edu/pharmacy/services/medusepol/FactorVII/Factor7TraumaGuidelines.pdf. These guidelines address criteria for use, actions to perform prior to considering Factor VII, dosing guidelines, contraindications, and monitoring parameters.

**Prevention of Contrast-Induced Nephropathy**

Sodium Bicarbonate

Order 150 mEq NaHCO3 in 1 L D5W to infuse at 3 mL/kg/hour for 1 hour prior to intravenous contrast, followed by 1 mL/kg/hour for 6 hours after intravenous contrast.

Acetylcysteine

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80 06/04/10
81 05/27/07
Order acetylcysteine 600 mg PO BID before and after intravenous contrast.\textsuperscript{83}

**Management of Hyperglycemia in Trauma Patients\textsuperscript{84}**

Tight blood glucose (BG) control, defined as maintaining BG levels between 80-110 mg/dL, has been shown to decrease morbidity and mortality in critically ill surgical patients. Critically ill trauma patients with hyperglycemia, defined as 2 BG measurements > 110 mg/dL within a 24 hour time interval or 1 BG measurement > 140 mg/dL, will be managed with the STICU Glucose Management Protocol. This protocol can be downloaded from the STICU web site at http://www.musc.edu/medcenter/nursing/unit/STICU/ under the section on protocols and guidelines.

BG control should also be maintained at normal (or close to normal) levels for trauma patients admitted to the floor service. Insulin orders should be initiated on all admissions to the trauma floor service. The target BG range is 80-140 mg/dL with BG monitoring ac and hs for patients taking an oral diet, or q 4 hours for patients who are NPO or are receiving parenteral or enteral nutrition. Correction (aspart) insulin should be ordered using the HIGH DOSE ALGORITHM (or correction scale #3 on new forms).

Patients transferred from the STICU to the floor may be receiving basal (NPH) insulin in addition to correction insulin to maintain their BG in the target range. Patients without a history of diabetes and a normal HgA1C may have their basal insulin decreased by 50% per day once stabilized on the floor. Once the patient has been tapered to 10 units of

<table>
<thead>
<tr>
<th>Oral Anti fungal Regimens</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drug (PO)</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Fluconazole</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Nystatin</td>
</tr>
<tr>
<td>Voriconazole</td>
</tr>
</tbody>
</table>


\textsuperscript{84} 05/27/07
basal insulin per day it can be discontinued. Patient with diabetes should be resumed on their home diabetes medication regimen as soon as it is safe to do so. Consider a DMS consult in diabetic patients who are not maintained in the target range on their home diabetes medication regimen.

A comparison chart of insulin products can be downloaded at: www.musc.edu/pharmacieservices/medusepol/InsulinComparisonChart.pdf.

**Nutrition Guidelines for Trauma Patients**

The adult PN guidelines include appropriate indications for PN, body weight calculations, methods to estimate daily calorie and protein needs, conversion factors for carbohydrate, protein and lipids, suggested laboratory tests for monitoring PN, a calculation for maximally concentrating a PN, and contents of standard multivitamin and trace elements added to PN.

The adult EN guidelines include body weight calculations, methods to estimate daily calorie and protein needs, a calculation of water requirements for patients receiving EN, the enteral formulary, and the procedure for administering Pro-Stat 64® via enteral tubes.

In general, nutrition for trauma patients is initiated at 25 kcal/kg/day and 1.5 grams/kg/day protein. Please consult with Emily Chapman, RD (pager 12255) or Brian McKinzie, PharmD (pager 13540) for nutrition issues in the STICU, and Kristi Fogg, RD (pager 12461) or Brian McKinzie, PharmD (pager 13540) for nutrition issues on the trauma floor patients.

The enteral formula commonly used in trauma patients is Promote®, Crucial® may be used in patients without sepsis for wound healing purposes and Nepro® may be used in patients with renal insufficiency. ProStat® 64 is a protein supplement that can be administered via feeding tube in addition to the protein supplied by the enteral formula. Each dose provides 15 grams of protein.

Enteral formulas may be delivered via gastric or small bowel feedings. Continuous infusion is the preferred method of delivery for both feeding routes. Enteral feedings should NOT be held secondary to high gastric residuals unless the residual is > 200 mL, regardless of the rate of the enteral infusion.

**Special situations:**

**Permissive Underfeeding Guidelines**

A permissive underfeeding protocol was developed by the Nutrition Support Team in 2005 to assist in optimizing blood glucose control in patients receiving specialized nutrition support. This protocol can be downloaded at http://www.musc.edu/cce/ORDFRMS/pdf/underfeeding.pdf.

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Guidelines for Juven® Supplementation

Juven® is a therapeutic drink that contains 15.5 grams protein and 75 calories per packet. It is a combination of arginine (7 grams), glutamine (7 grams), and beta-hydroxy-beta-methylbutyrate (HMB) (1.5 grams), and may be considered for use in some specific patient populations. These guidelines can be downloaded at http://www.musc.edu/cce/ORDFRMS/pdf/juvenguidelines.pdf.

Guidelines for Use of Immune-Enhancing Enteral Formulas

Immune-enhancing enteral formulas are specialized formulas that are enhanced with glutamine, arginine, and omega 3 fatty acids. These formulas may be considered for use in some specific patient populations. These guidelines can be downloaded at http://www.musc.edu/cce/ORDFRMS/pdf/immuneenteral.pdf.

Guidelines for Glutamine Supplementation

Glutamine is a conditionally essential amino acid which has been shown to be beneficial in specific patient populations. Guidelines for Glutamine Supplementation have been established and can be downloaded at http://www.musc.edu/cce/ORDFRMS/pdf/enteralglutamineguide.pdf.

Adult Enteral Nutrition Formulary Substitution Guidelines


Methylene Blue Guidelines

Guidelines for the use of methylene blue were established in 2006 to discourage the routine use of methylene blue in tube feedings to monitor patients for aspiration. Guidelines for appropriate use of methylene blue can be downloaded from the Pharmacy Services web site at http://www.musc.edu/pharmacyservices/medusepol/methyleneblue.pdf.

Prevention and Management of Alcohol Withdrawal Syndrome in Trauma Patients

An Adult Alcohol Withdrawal Syndrome (AWS) Practice Guideline was developed in 2001 and is used to manage trauma patients at risk for AWS. The AWS order set is available in Epic.
Treatment of Deep Venous Thrombosis (DVT) and Pulmonary Embolism (PE)

Pulmonary Embolism

Patients with documented DVT or PE may be treated with unfractionated heparin (UFH) IV or low molecular weight heparin (LMWH). Standardized heparin protocols have been developed for the institution. UFH must be ordered using the standardized order set.

LMWH guidelines for treatment of proximal DVT and PE are listed below:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Cost/day ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enoxaparin</td>
<td>1 mg/kg bid</td>
<td>83.02 (80 mg syringe)</td>
</tr>
<tr>
<td>anti Xa</td>
<td>-</td>
<td>209.00</td>
</tr>
</tbody>
</table>

LMWH cost calculated for a 70 kg patient; anti Xa level should be drawn 4 hours after the dose. The adult anticoagulation treatment physician order set should be utilized:

**Cost of UFH IV Therapy**

<table>
<thead>
<tr>
<th>Drug/lab test</th>
<th>Dose</th>
<th>Cost/day ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFH</td>
<td>80 units/kg loading dose</td>
<td>15.00 (per bag)</td>
</tr>
<tr>
<td></td>
<td>18 units/kg/hour maintenance dose</td>
<td></td>
</tr>
<tr>
<td>aPTT</td>
<td>-</td>
<td>29.00 (cost to patient per level)</td>
</tr>
</tbody>
</table>

UFH cost calculated for a 70 kg patient. Treatment with UFH or LMWH should continue for at least 5 days, and warfarin should be overlapped with UFH or LMWH for at least 4-5 days. (For massive PE or severe ileofemoral thrombosis, a longer period of heparin therapy may be warranted.) Warfarin 5 mg PO should be initiated on day 1, if possible.

Warfarin should be continued for at least three to six months (target INR 2-3). If warfarin is contraindicated, a treatment dose of LMWH should be used for the duration of therapy.

Direct Thrombin Inhibitors

DTIs are used for prophylaxis and/or treatment of thrombosis in patients with suspected HIT, and in patients refractory or allergic to heparin.
<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Cost/day ($)</th>
<th>Clinical Pearls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argatroban</td>
<td>0.5 micrograms/kg/min*</td>
<td>591.78</td>
<td>Argatroban will falsely elevate the INR</td>
</tr>
<tr>
<td>Bivalirudin</td>
<td>0.2 mg/kg/hour**</td>
<td>857.60</td>
<td>Agent of choice for patients with hepatic insufficiency</td>
</tr>
</tbody>
</table>

*Requires dosage adjustment for hepatic insufficiency

**Requires dosage adjustment for renal insufficiency (refer to: http://www.musc.edu/cce/ORDFRMS/pdf/dtiforhpi.pdf)
Appendix

OR Priority Scale

Patients who require surgical intervention are scheduled for the operating room according to MUSC’s OR priority scale. The operating attending will choose the patient’s priority based upon the following system:

- **Level 1** – The attending surgeon should communicate with the Doctor of the Day (DOD) on all Level 1 case requests, unless precluded by patient instability requiring the surgeon to remain at the bedside.
  
  - A: life or limb threatening emergency requiring immediate OR access or access within 30 minutes; classic “stat” case. (If an attending surgeon from the relevant specialty is not immediately available, the case can be started by a senior resident on the specialty service, with an attending from the Trauma Service if feasible, until the relevant specialist comes to the OR; such instances will be reviewed by the OR Surgical Director at the next OR management group meeting.
  
  - B: emergency requiring OR access within less than 2 hours.

- **Level 2**: life or limb threatened if not in OR within 2-6 hours; attending surgeon and patient must be available at time of OR posting.

- **Level 3**: increased morbidity if not in OR within 12 hours; some attending surgeon flexibility re: timing feasible.

- **Level 4**: increased morbidity or prolonged hospital stays if not in OR within 24-36 hours; some attending surgeon flexibility re: timing feasible

- **Level 5**: elective case; done when attending surgeon, patient and OR availability allow, preferably in the attending surgeon’s block time, with inpatients given priority over outpatients.

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