I. GENERAL ADMINISTRATIVE POLICIES AND OVERVIEW

A. GENERAL GUIDELINES

Introduction

The management of trauma is always a team effort and as a team member, either now or in the future, the assigned physician must learn to integrate his/her personality and skills into that team effectively. The Trauma Chief Resident (PGY-III, IV) must become proficient in trauma resuscitations (blunt and penetrating), provision of acute surgical critical care, the coordination of rehabilitative needs and services, and the administrative aspects of Trauma Services. Therefore, the UMass Memorial Trauma Service is designed to contain the physician and nurse elements with which the graduated surgeon will work in the future, whether it be in private practice, a community hospital based practice or a university teaching hospital.

The Trauma Service consists of two PGY-III/IV General Surgery (Trauma Chief) residents, a PGY-III Emergency Medicine resident, a PGY-II Emergency Medicine resident, and two PGY-I General Surgery residents. In addition, the Trauma Service at the UMass Memorial Trauma Center has a Trauma Program Manager, three Trauma Nurse Practitioners, Case Manager, Social Worker, Injury Prevention Coordinator / Educator and Trauma Registry personnel. Third and fourth year medical students may have elective rotations on the team, primarily as observers.

In addition to participating in the 2000+ Trauma “activations” per year, trauma residents and students are exposed to all aspects of surgical critical care, operating room and endoscopic procedures. They also participate in and help teach on-going didactic sessions including journal club, case presentations, literature reviews, grand rounds and morbidity/mortality conferences.

B. GOALS AND OBJECTIVES

I. PGY-III/IV General Surgery (Trauma Chief)

The Trauma Chief functions as the overall team leader for all adult and pediatric trauma cases. At the end of their rotation, the PGY – III/IV should:
Be able to successfully integrate the various members and functions of the adult and pediatric trauma services into a highly effective and efficient resuscitation, acute care management, rehabilitation and follow up care team. The Trauma Chief has an opportunity to exercise significant responsibility and authority, yet receives close support and supervision from the Trauma Director and Surgical Trauma Attending faculty.

Be clinically experienced in all of the minor, as well as the more advanced resuscitative and operative skills, and teach those skills to junior members of the team.

Be confident in the theoretical and clinical principles of trauma resuscitation and management as well as the critical diagnostic and therapeutic decisions necessary to provide appropriate and timely trauma care for adults and children.

Be able to integrate and coordinate subspecialty consultant staffs appropriately into the initial and ongoing management of the multiple trauma victim by virtue of having developed an understanding of the global nature of trauma management. This encompasses the pre-hospital through the rehabilitative phase, demonstrating the ability to manage complicated intra-operative problems that require advanced technical skills.

II. PGY III Emergency Medicine Resident
At the end of this one month rotation, the PGY-III EM Resident should:

Be able to demonstrate how to function as both a team member and leader (with the immediate advice and support of the PGY-IV Surgery /Trauma Chief) of the Trauma Resuscitation Team, integrating all elements of appropriate and timely diagnostic skills and ongoing management. It is important that the Emergency Medicine resident learn to perform the minor, as well as some of the more advanced surgical skills necessary to resuscitate and stabilize the multiply injured trauma patients. This should include the ability to perform tube thoracostomy, surgical airway, endotracheal intubation, peritoneal lavage, FAST exam, peripheral and central venous catheterization and urinary catheterization. Operative exposure is not absolutely necessary for the Emergency Medicine resident, but further intraoperative observations help correlate the mechanism of injury, anatomic derangements, and diagnostic study results.

Express an understanding of the necessary principles and practices in post resuscitation trauma care, as well as an understanding of how initial resuscitation may influence later phases of care, including
cooperative management, potential complications and the physical and psychosocial rehabilitation of the patient.

May be in charge of daily work rounds on the service if delegated by the Chief providing the front line decision making on Trauma Service patient issues.

Teach and supervise more junior residents in trauma management, resuscitation procedures and decision making.

III. Emergency Medicine Resident PGY-II/General Surgery Resident PGY-I

The junior Surgical Resident and Emergency Medicine resident on the Trauma Service are expected to:

Learn the principles and technical skills of trauma resuscitation and critical decision making as outlined in the ATLS curriculum.

Under the guidance of a Senior Surgical resident/Emergency Medicine resident, perform the basic and some of the more advanced surgical diagnostic and therapeutic techniques necessary for timely, efficient and successful trauma resuscitations.

Be able to function in the various roles as a Trauma Team member including, on occasion, the team leader in the management of certain non-critical trauma cases, under the direct supervision of senior residents or attendings.

Obtain experience in the operating room (particularly the Surgical resident) by assisting in operative cases and participating in the decisions made by senior team members during critical and emergent operative cases.

SUMMARY

Each of the members assigned to the Trauma Service should gain certain knowledge and skills concerning trauma resuscitation and management during their rotations. These include:

An understanding of how mechanism of injury relates to physical findings and diagnosis of injuries, and may contribute to future morbidity and mortality.

An understanding of the anatomy and physiology of traumatic injuries as well as the principles, concepts and techniques of acute
and ongoing injury management, based on the latest clinical research and experience.

An understanding of how trauma frequently must be managed with a “minimum of information, a maximum of effort, in a minimum amount of time” through an efficient, multidisciplinary team approach.

An understanding of the administrative, operational and performance improvement aspects of a Trauma Service and Trauma Center. This includes an appreciation of the necessary integration of a Trauma Service into a Trauma Center, and into a Trauma System, as well as the belief that the best trauma care is provided when all of these elements are present and are complimentary.

An understanding of, and sensitivity to, the emotional and physical changes (from the seemingly minor to the devastatingly major) caused by traumatic injury and its sequelae to the patient and family. One must gain an appreciation of the psychological impact of managing critically injured patients upon team members, including physicians, nurses, medical students, technicians and others. Burnout, stress, and fatigue should be recognized and addressed openly.

C.  CONFERENCES AND TRAUMA CLINIC

**Monday**
6:00 AM: Sign out rounds
5:00 PM: Department of Surgery Morbidity/Mortality
6:00 PM Sign out rounds

**Tuesday**
6:00 AM: Sign out rounds
11:30 AM: Patient Multi-Disciplinary Rounds
1:00 PM: Trauma Clinic (2:00 PM,
  First Tuesday of the month)
6:00 PM: Sign out rounds

**Wednesday**
6:00 AM (3rd Wednesday): Trauma Performance Improvement Committee (Attendings Only)
6:00 AM: Sign out rounds
7:00 AM: Surgical Grand Rounds
5:00 PM: Neurocritical Case Conference
6:00 PM: Sign out rounds

**Thursday**
6:00 AM: Sign out rounds
6:30 AM: Trauma Educational Conference
First Thursday: Journal Club
Second and Third Thursday: Case presentation/literature review
D. COMMUNICATION PROTOCOLS

Trauma Beepers/Status and Definitions
There are three patient LEVELS which will be utilized over the Trauma Team beepers. The status of these LEVELS are the same for pediatric and adult trauma patients, but the message will distinguish between an adult or pediatric patient:

I  “Adult/Pedi Trauma ETA . . . (mins): Indicates anticipated time of arrival of patient. Entire Trauma Team responds before patient arrival.

II “Adult/Pedi Trauma Level III Alert”-(Consult): Indicates the need for a NON-EMERGENT evaluation only. The Trauma Chief (or no less than a PGY - III resident) should respond within 30 minutes to the ED for consultation. The Surgical Resident will communicate with the Attending Trauma Surgeon immediately following initial evaluation on ALL adult and pediatric consults, regardless of the findings. The MD Trauma H&P will be completed as a consultation note. NOTE: Residents are reminded that consultation is a collaborative effort. Communication with the ED Attending about the findings and status of the patient is important. Criticism about the appropriateness of an “Alert” or about the workup in progress is inappropriate at the time of the consult. These concerns should be raised at the weekly Trauma M&M.

Level III  Adult and Pediatric “Level I or Level II” Alert
The page received by the Trauma Team defines impending trauma activation which is based on physiologic criteria and mechanism of injury.

NOTE: There is a test of the beepers each morning at 9:00 a.m. If you don’t receive the test on your beeper, call Lifeflight at 1-5704 and report the problem.
Protocol:

An Emergency Dept. RN and / or Emergency Medicine physician may make the decision to activate the Trauma Team prior to patient arrival after receiving the pre-hospital CMED report and giving consideration to the following guidelines. If a patient is initially triaged to EM for evaluation and immediately meets any of the criteria listed below, OR a patient’s clinical condition changes such that the criteria are now met, the EM attending may make the decision to activate the Trauma Team for resuscitation or consultation.

These guidelines are neither inclusive nor exclusive, recognizing that patient presentation may vary from initial report and that patient condition may change at any time.

E. CRITERIA FOR TRAUMA TEAM ACTIVATION

Introduction: The appropriate field triage of the trauma patients that require Trauma Center care is the critical first step in a well organized system of trauma care. Delayed and/or inadequate resuscitation after arrival at a trauma center is often the cause of early in-hospital deaths. Therefore, the immediate identification of, and secondary triage to the Trauma Team for expedited care of those patients who have the highest likelihood of having a serious injury is the critical second step. An over triage rate of 30 -50% may be necessary to capture those patients who do require emergent, comprehensive trauma care. The UMass Memorial Medical Center Level 1 Trauma Center has adopted some of the field / ED triage guidelines suggested by the American College of Surgeons (ACS) Committee on Trauma to assist in identifying when it is appropriate to activate the Trauma Team, Adult and Pediatric.

Purpose: To immediately identify those adult trauma patients with actual or potentially serious injuries based on mechanism of injury, physiologic data and pre-hospital report. The activation of the Trauma Team provides immediate and expeditious resuscitation and management of the trauma patient.

Criteria for Trauma Team Activation, Adult and Pediatric Policy #2013 outlines the components.

DEFINITION:

Adult: All patients age 18 and over
Pediatric: All patients under the age of 18 years
Any patient, initially stable, and then deteriorates, automatically defaults to a Level I Criteria activation.

All trauma patients are categorized by their level of acuity in accordance with the following criteria:

**LEVEL I CRITERIA**
The Trauma Team assumes all care of Level I trauma patients and is expected to be in the trauma bay upon the patient’s arrival.

- Any intubated patient SaO2 < 90% or respiratory compromise requiring intubation
- Adult systolic blood pressure 90 mm Hg or < 2 times the pediatric patient’s age plus 70 mm Hg.
- Respiratory rate <10/min (for adult and pediatric) or > 30 respirations /min (adult) or > 40 respirations/min (pediatric). Any abnormal respiratory rate or effort for all ages.
- Glasgow Coma Scale (GCS) ≤ 10 (adult) or ≤ 8 (pediatric)
- Any inter-hospital trauma transfer receiving blood products to maintain vital signs
- All gunshot wounds to the head, neck, chest, or abdomen. Any gunshot wound to an extremity proximal to the elbow or knee (adult)
- All gunshot wounds in patients less than 18 years old
- All stab wounds and penetrating injuries to any body area, with large blood loss at the scene, ongoing hemorrhage, or with a rapidly expanding hematoma (arterial bleeding)
- Major impalement injuries of any body region
- Major crush injury to the torso and/or pelvis, with or without open wounds
- Complete or partial amputation, proximal to the elbow or knee
- Other blunt or penetrating injury to the neck, chest or abdomen, with evidence of:
  - Saliva or air bubbling from a neck wound, difficulty in phonation
- Stridor or with evidence of a cerebral infarction/stroke
- flail chest, massive hemopneumothorax or a large, open chest wound
- rapidly expanding abdomen, abdominal evisceration or large, open abdominal wound

- Emergency Medicine Attending physician discretion

LEVEL II CRITERIA
The Trauma Team assumes care of Level II trauma patients upon the team’s arrival in the Trauma Room. The Trauma Team is expected to be in the trauma bay upon the patient’s arrival.

- External head or scalp injury with GCS > 10 but < 14
- Altered mental status (GCS < 14) with recent history of trauma
- Disoriented and combative patient, with external signs of trauma
- Significant facial trauma, without signs of airway compromise
- Non-bleeding penetrating wound through the platysma not meeting Level I Criteria
- Pneumothorax or hemothorax, without respiratory compromise
- Obvious multiple rib fractures, without respiratory compromise
- Non-bleeding penetrating wound, NOT meeting Level I Criteria
- Significant abdominal tenderness, NOT meeting Level I Criteria
- Seatbelt contusions on neck or abdomen
- Injuries above and below diaphragm (adult)
- Pelvic instability or significant pain on movement
- Blood at urinary meatus or gross hematuria
- Spinal cord paralysis or peripheral neurological deficit of extremity
- Amputation (partial/complete) proximal to the wrist or ankle
- Crushed or mangled extremity, without amputation
- Two or more long bone fractures
- One or more open long bone fractures
- Burns > 10% body surface area (adult and pediatric). Face or genitalia > 5% body surface area
- Any clinical signs of inhalation injury. Any burn with associated history of trauma (fall, explosion)
- Combination of external signs of trauma and associated burns
- High voltage electrical burns
- Motor vehicle crash > 40 mph with one of the following:
  - Intrusion into the passenger compartment > 12 inches
  - Ejection from the vehicle
  - Death at scene in same vehicle
  - Extrication time > 20 minutes
  - Motorcycle crash > 20 mph or separation of rider from bike at any speed
- Any pedestrian vs. auto > 5 mph
- Any pedestrian thrown from or run over by an automobile
- Bicycle crashes (> 5 mph) or with significant impact from auto
- All falls ≥ 20 ft
- Falls from any height in ages < 6 yrs or ≥ 55 yrs with:
  - Evidence of head injury
  - Multiple rib fractures
  - Long bone fracture (excluding femoral neck/head)
  - Abdominal complaints
  - Facial trauma, without signs of airway compromise
  - Non-bleeding penetrating wound through the platysma not meeting Level I Criteria
  - Pneumothorax or hemothorax, without respiratory compromise
  - Fall from horse or kicked by horse
  - All trauma patients transported by helicopter
  - Two or more system injuries in pediatric patient
  - Pregnant trauma patients with significant mechanism of injury
• Hypothermia (< 32° C) patients
• Any drowning, with associated injury
• Assault patient, with loss of consciousness
• Intentional injury patient requiring more than simple suturing
• Patients with recent history of hanging
• Age > 55 years with significant mechanism of injury
• Any patient with significant mechanism of injury and significant co-morbid medical condition (cardiac, respiratory, IDDM, cirrhosis, morbid obesity, immunosuppression, bleeding disorders, use of anticoagulants)
• Emergency Medicine Attending physician discretion
• Any patient who was initially stable, but deteriorates (upgrade to Level I Criteria)
• Obvious multiple rib fractures, without respiratory compromise
• Non-bleeding penetrating wound, NOT meeting Level I Criteria’s

Level III Criteria (Consults)
These patients are evaluated by Emergency Medicine physicians, using appropriate diagnostic studies and laboratory tests, and they consult the Trauma Team when injuries are identified.
• All intoxicated (alcohol or drug) patients with evidence of traumatic injury
• Patients with a recent history of traumatic event (< 24 hours) requiring hospital admission. Must have normal vital signs, GCS of 15 and not meet Level I or II Criteria.
• Patients initially accepted in transfer by Orthopedics, Plastics, or Neurosurgery for single system injury
• Awake and alert patient with no evidence of external injury, and involved in an MVC< 40 MPH
• Any pedestrian struck at < 5 mph, awake and alert, and with evidence of traumatic injury
• Falls < 20 ft with evidence of injury
• Patients with history of assault, no loss of consciousness, with evidence of injury
• Found down patients with evidence of traumatic injury
• Patients with co-morbid medical conditions and evidence of injury
• Any pediatric burn > 5% but < 10% BSA, without involvement of face, genitalia and/or smoke inhalation, or with other injuries
• All pediatric falls > 5 ft but < 20 ft
• Child or elder abuse cases (suspected or actual) requiring hospital admission

Procedure:

1. Any patient, who was initially stable but deteriorates, should be upgraded to a Level I or II patient, based on clinical assessment.

2. Obtain relevant information from pre-hospital personnel to assure appropriate triage. Advanced Trauma Life Support© (ATLS) resuscitation measures should be undertaken while arranging for transfer to the University Campus. In this instance, there should be direct communication between the Memorial ED physician and the University Trauma Surgeon.

3. The Attending Trauma Surgeon is expected to be present in the trauma bay upon arrival of all patients meeting Level I Criteria, when advance notification is possible. If advance notification is not possible, they must be present within 15 minutes of Trauma Team activation.

4. It is the Trauma Chief Resident’s responsibility to communicate to the Attending Trauma Surgeon regarding the patient’s initial examination by paging the Attending to #11076 (trauma bay telephone) for all Level II patients within 10 minutes of the patient arrival, and immediately after the initial evaluation is complete. In a patient’s condition deteriorates, it is the Trauma Chief Resident’s responsibility to notify the Attending Trauma Surgeon via the Life Flight Communications Center.

5. When a probably isolated or single-system injury is being admitted to another surgical service, a request for a Trauma Service consultation can be made by the ED or admitting service to the on-call Trauma Senior Resident. The final disposition of the patient will be determined by the on-call Trauma Attending.
F. DOCUMENTATION

The complete and accurate documentation of all aspects of care given to trauma patients from the pre-hospital phase through resuscitation, hospitalization and discharge is critically important in trauma care. This importance cannot be stressed enough from a research, medico-legal and quality of care standpoint, and is the direct responsibility of those physicians and nurses providing care to the patient. The ultimate responsibility for assuring that the physician documentation is completed thoroughly and accurately rests with the Trauma Chief Resident in conjunction with the Trauma Attending. The forms to be completed have been designed to eliminate duplication, to secure data accurately and efficiently, and to document patient care effectively. They are:

- **ED Trauma Nursing Record**: **MUST** have arrival times of the Trauma Attending and Trauma residents clearly recorded.
- **Trauma Center Evaluation Form** (doubles as admission H&P) must have all orders signed by a physician on the Trauma Nursing Flow Sheet. This includes verbal orders – no exceptions.
- **Standard Trauma Admission Orders** (separate Adult & Pediatric)
- **ED Critical Care Holding Orders** for ICU patients “held” in the ED
- **Patient Discharge Instruction (PDI)** form (doubles as f/u clinic information form)
- **Trauma Service Daily Progress Note** (standard form): front side completed by the resident, before AM rounds. Back side is completed by the Trauma Attending, on rounds. Should be completed on ALL patients.
- **Tertiary Care form**: The Trauma Tertiary Survey should be performed 24 hours after admission. The purpose of this survey is to identify any injuries that may not have been evident or suspected during the initial evaluation (primary and secondary surveys). The tertiary survey consists of:
  1. Query the patient, mental status permitting, regarding any localizing symptoms he or she may not have noticed previously. New complaints may lead to accused examination
  2. Re-examine the patient. New findings may lead to further studies
3. Review the final official reports of all initial radiographic studies

- ALL Deaths must have following documented:
- Report to Trauma Registry (6-3882) NO EXCEPTIONS
- Call to NEOB
- Call to Medical Examiner

G. ADMINISTRATIVE TRAUMA OFFICE

The Trauma Service is supported on an administrative and clinical level by three Administrative Assistants. The lead assistant is located on the third floor, room S3-711. This person is responsible for the following:

- Administrative support for the Director of Trauma
- Administrative support for the trauma Clinical Staff
- Compilation of the monthly Trauma/Surgical ICU/General Surgery on-call roster
- Assists with administrative issues with the Surgical ICU Fellowship and interactions with the ACGME
- Administrative support for the SICU Nurse Practitioner program
- Organization and coordination of any recruitment activities for the Trauma Service and the Surgical ICU

There are two other administrative assistants. One (S3-711) serves as the Clinical Coordinator of all inpatient and outpatient Trauma/General Surgery patient activities and the other (H3-523) serves as administrative support for all trauma related non-clinical activities. The Clinical Coordinator role and responsibilities include:

- Scheduling trauma and general surgery operative cases
- Scheduling trauma and general surgery clinic appointments
- Participates in trauma/general surgery clinic, serving as administrative support for the clinic on Tuesday and Thursday afternoons in collaboration with the trauma staff.
- Intake for all patient related phone calls for scheduling, prescription refills, patient questions, consultation requests and follow-up appointments
• Organizes and maintains the “shadow file” on all discharged trauma patients

The administrative support for trauma related activities is responsible for:

• Scheduling and organizing monthly trauma-related meetings and conferences
• Attend and take minutes for monthly trauma conferences, Performance Improvement activities and the Trauma Operations Committee
• Compiles and disseminates minutes from administrative meetings
• Organizes CME activities for the monthly Performance Improvement and Trauma Operations Committee meetings as well as for the weekly Trauma Educational conference
• Organizes and maintains individual “score cards” for the Trauma Surgeons and Trauma Liaisons from the various subspecialties who participate in trauma care

• Serves as the lead administrative support for all ACS Trauma Site Review Verification activities
• Serves as liaison between the Office of Continuing Education and the Trauma Service for ATLS activities.
• Serves as administrative support for the Trauma Program Manager

H. TRAUMA REGISTRY

The UMass Memorial Trauma Service maintains a Trauma Registry for all adult and pediatric trauma patients for the purposes of statistical analysis, research, performance improvement and ongoing clinical patient care. This data has been accumulated over the past 18 years and encompass nearly 40,000 individual patients, making this a rich resource for on-going research and analysis. Such a data bank is only as good as the individual data items it contains and thus must be accurate and up to date, making accurate documentation and good communication critical to the Registry. Any patients seen by the Trauma Team as an activation or consult are included. Trauma Registry data are available for research, performance improvement activities and support of Trauma Service activities regarding specific patient populations, mechanisms of injury, morbidity/mortality, etc. The Trauma Registrar compiles an annual report, summarizing Trauma Service activities for the previous year. This report is available on request and is sent to various administrative leaders and
the members of the Trauma Service. In addition, our data is annually sent to the ACS National Trauma Data Bank where it becomes part of a national benchmark for outcomes research on traumatic injury. By participating, we receive our own “benchmark” report that compares our own outcomes with that of the larger data bank. The Trauma Registry also submits trauma data to the State of Massachusetts Trauma Registry.

The Trauma Registrar is available to assist with trauma scoring, research requests, and other such inquiries. A form for data requests must be completed, approved by the Chief of the Trauma Service and submitted to the Trauma Registry. These forms are available in the Registry office located in H3-525. The telephone numbers are 774-442-8626, 774-443-7797, and 774-442-5199.

I. INJURY PREVENTION COORDINATOR

The Injury Prevention Coordinator is responsible for the planning and coordination of injury prevention and activities for identified target populations. Develops, implements and evaluates injury prevention programs. Serves as a liaison for both adult and pediatric programs to related agencies and personnel within the UMass Memorial Medical Center community. Establishes short and long term goals of injury prevention initiatives and pursues external funding opportunities. Documents system-wide injury prevention activities.

2. TRAUMA TEAM MEMBERS RESPONSIBILITIES

**Trauma Attending Physician**
Responsible for supervising all aspects of care of the trauma patient from admission to discharge and follow-up care. Presence at resuscitations is mandated by established criteria.

**ED Attending Physician**
Notified of every trauma patient’s arrival. Responsible for communication with the Trauma Attending and Senior Resident concerning expected arrival of the patient.

- The Trauma Team leader, in absence of Trauma Attending or senior trauma resident, is responsible for the airway management of the trauma patient.
Senior Surgical Resident

The most senior Trauma Team member or surgical person in attendance (Attending Surgeon/ Trauma Senior/ PGY4/5 Surgical Resident) is the designated Trauma Chief. In Level II activations, the Senior Surgery Resident and the ED Senior Resident may alternate being the team leader with the ED resident being the Team Leader on even days and the Surgical Resident on uneven. Has overall responsibility for the trauma patient, direction of the Trauma Team, including notification of, and communication with, consultants and family.

Specific responsibilities include:

- Receive report from EMS/ transport team
- Perform primary and secondary survey
- Delegate and direct other team members in specific resuscitation tasks and diagnostic or therapeutic interventions
- Coordinate all aspects of the resuscitation and makes decisions regarding priorities in resuscitative interventions, diagnostic, and operative management in collaboration with the Trauma Attending Surgeon.
- Notify and appraise Subspecialty and other consultants of the patient’s clinical condition. Receive assessments from consultants.
- Designate responsible person to complete trauma documentation (H & P to 100 % completion) and review the forms for accuracy and completeness. Medical students are not able to document on this form.
- Responsible for adherence to existing trauma protocols.
- Communicate with patient, family, Medical Examiner and Organ Bank, concerning patient status, progress or deterioration.
- All patients operated on by the Trauma Service must be rounded on by the Surgical Senior Resident.
- Complete a transfer summary on all trauma ICU patients prior to transfer to floor or rehabilitation.
- Responsible for initiation and completion of Trauma Tertiary Survey. May delegate to other team members.
- Responsible for the completion of discharge/ transfer paperwork (PDI’s and summaries) of patients – may delegate and supervise completion of work by other team members. S/he will inform Attending Physician if discharge work is anticipated to be incomplete.
- Attend clinic, evaluate and manage patients in follow-up care.
- Maintain trauma census list and update findings and treatments. May delegate to other team members.
- Responsible for reporting all trauma deaths to the Registry Office.
Senior ED Resident
During trauma activations, responsible for:

- Airway management
- Stabilize c-spine stabilization
- Direct transfer of patient to trauma stretcher
- Performs primary survey
- Obtain patient info (name, date-of-birth, allergies, medications)
- Performs other roles as assigned by the Team Leader
- Update trauma census list, findings and treatments
- Pre-round on ICU patients and if needed, floor patients
- Discharge management of trauma patients in the ED
- Discharge summaries for the ICU patients
- Update and complete the Trauma Tertiary Survey

Junior Resident
During trauma activations, responsible for:

- Assist in patient transfer to trauma stretcher
- Achieve patient exposure by cutting off all clothing.
- If RN is unable to obtain peripheral venous access, may be requested to draw blood via femoral stick (if requested by team leader);
- If directed by team leader, obtain arterial blood gas (ABG) by radial or femoral arterial approach
- Perform back and rectal exam (visual and digital), noting presence of external blood and /or injury; sphincter tone, location of prostate (as applicable in males); performs hematology occult testing; and relay findings verbally to the Trauma Team
- Performs visual inspection of urinary meatus for injury and/or blood; inserts Foley catheter (only in the absence of blood)
- Perform other duties as designated by the trauma senior resident
- Completes trauma History and Physical form
- Maintain trauma census list and updates findings and treatments

Floor responsibilities include:

- Round on patients and documents in daily trauma progress notes. Progress notes should include mechanism of injury and a list of injuries and any other active issues
- Follow up on labs and other diagnostic tests
- Perform discharge paperwork (PDI, discharge summaries) as needed and/or directed. All admitted patients should have PDIs. Any patient
being transferred to another service, whose hospitalization exceeds 48 hours, or who goes to another facility, need a transfer or discharge summary.

- Communicate with consultants and sub-specialists; review recommendations with Senior Surgical Resident.

**Trauma Program Manager**

- Report to the VP of Emergency and Ambulatory Services.
- Collaborate with the Trauma Chief, performs a wide variety of administrative, performance improvement, clinical, education, injury prevention/outreach, fiscal and research duties.
- Provide oversight and coordinates the American College of Surgeons (ACS) verification of the hospital as a Trauma Center.
- Collaborate with a multidisciplinary team to assure comprehensive performance improvement initiatives are integrated into the Service’s plans and activities.
- Manages trauma staff.
- Serve as a liaison and resource to other departments within the Medical Center and other agencies on an ongoing basis.
- Assure compliance with identified regulatory agencies

**Trauma Nurse Practitioner**

- Responsible for patient care on the floor and in ICUs. Performs daily trauma rounds w/ the team and Attending Physician.
- Communicate with subspecialty and consult teams.
- Facilitate discharge planning, communication with Social Services, PT/OT services and Physiatry.
- Manage weekly Multi-Disciplinary Trauma Conference
- Work in collaboration with the Trauma Attending and House Staff to develop a total plan of care for the trauma patient throughout their hospitalization, from the ED, ICU, floor, discharge, and follow-up.
- Review patients daily with the Case Manager, Social Worker, and therapists to develop a plan of care
- Act as a resource for nurses throughout the hospital.
- Responsible for follow up of outpatient phone calls as well as prescription renewal
- May assist with procedures under the direction of the Trauma Attending
- Provide educational and Administrative responsibilities
- Coordinates Outpatient Clinic.
- May run a Level II trauma activation under supervision of the Trauma Attending.
- Perform ISTAT Aog and/or INR in Trauma Room
## TRAUMA DEATHS

All deaths must be reported to the Trauma Registry by either leaving a message at ext 774-442-3882, or by leaving a note under the door (H3-523) of the Trauma Registry office. **No exceptions!** It is the responsibility of the service Senior Resident to complete or delegate this and ensure that this is accomplished.

New England Organ Bank and Medical Examiner must also be notified as indicated.

## INITIAL SCREENING LABS AND X-RAY PANELS

### A. Pediatric Trauma Resuscitation Profile - EDPTRP (Age 0-18 yrs)

<table>
<thead>
<tr>
<th>Serum Profile</th>
<th>X-ray Profile</th>
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</thead>
<tbody>
<tr>
<td>CBC</td>
<td>- CXR (AP)</td>
</tr>
<tr>
<td>Lactate</td>
<td>- C-spine (Lateral)</td>
</tr>
<tr>
<td>Type and Screen</td>
<td>- Pelvis (AP)</td>
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<tr>
<td>LFT’s</td>
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<tr>
<td>Lipase</td>
<td></td>
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<tr>
<td>Amylase</td>
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<tr>
<td>Beta HCG (&gt; 12 yrs old)</td>
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<tr>
<td>ETOH (&gt; 14 yrs old)</td>
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</tr>
<tr>
<td>ABG (All Level I Traumas)</td>
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<tr>
<td>Urine Tox Screen</td>
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</tbody>
</table>

### B. Adult Trauma Resuscitation Profile for MALE Patient - EDATRP

<table>
<thead>
<tr>
<th>Serum Profile</th>
<th>X-ray Profile</th>
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</thead>
<tbody>
<tr>
<td>CBC w/o diff</td>
<td>- CXR (AP)</td>
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<tr>
<td>Lactate</td>
<td>- Pelvis (AP)</td>
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<tr>
<td>Type and Screen</td>
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<tr>
<td>ETOH</td>
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<tr>
<td>ABG (All Level I Traumas)</td>
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<td>BMP</td>
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<td>Tox Screen</td>
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C. Adult Trauma Resuscitation Profile for FEMALE Patient - EDATRPF

<table>
<thead>
<tr>
<th>Serum Profile</th>
<th>X-Ray Profile</th>
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<tbody>
<tr>
<td>CBC w/o diff</td>
<td>- CXR (AP)</td>
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<tr>
<td>Lactate</td>
<td>- Pelvis (AP)</td>
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<tr>
<td>Type and Screen</td>
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<td>Tox Screen</td>
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<tr>
<td>ETOH</td>
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<td>ABG (All Level I Traumas)</td>
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<tr>
<td>BMP</td>
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<td>Beta HCG</td>
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**TRANSFUSION MEDICINE** (See Blood Administration Policy #2070).

Routine Hepatitis B screening is not to be done. An HbSag is the appropriate screening test for patients with a known history of hepatitis B, or those patients at risk for infection.

HIV TESTING CAN ONLY BE DONE WITH THE PATIENT’S OR LEGAL NEXT OF KIN’S WRITTEN CONSENT. See the UMMHC policy and procedure for “HIV Testing Procedures”.

**BLOOD ALCOHOL LEVELS FOR DIAGNOSTIC PURPOSES**

**PURPOSE:** To ensure patient safety and guide medical evaluation and treatment of trauma patients.

**Procedure:**

1. Blood alcohol levels are obtained from patients based on age, pre-hospital information, relevant past medical history, and/or clinical presentation. (See Initial Screening Labs). It is imperative to ascertain baseline levels so that treatment and medications can be adjusted as necessary. Patients with multiple injuries may receive analgesia, sedative and paralytic agents and/or anesthesia, which are potentiated by alcohol ingestion.

2. The patient’s skin will be prepped with Chlorhexidine prior to the blood draw. No specific permission or consent forms are needed to obtain blood alcohol levels for medical diagnostic purposes.
3. When a blood alcohol level is drawn for medical diagnostic purposes, the result of the test is to be considered a confidential part of the medical record. **Blood alcohol (and toxicology) results on adults and minors will not be released to any non-medical (i.e. police, media, family, etc) person or any medical personnel not directly involved in the care of the patient without expressed and written consent from the patient.**

**BLOOD ALCOHOL LEVELS FOR LEGAL PURPOSES**

**PURPOSE:** The patient must be under arrest and in police custody “for operating a motor vehicle under the influence of ALCOHOL or OUI”.

**Procedure:**

1. The arresting officer must obtain **witnessed informed consent** (officer will have to refer to the Massachusetts guidelines for drawing blood in an OUI/alcohol case). The officer must sign the form and his/her signature must be witnessed by a Registered Nurse or a licensed Physician.

2. If the patient refuses to give consent or is unable, hospital personnel must recognize that refusal to consent and decline to draw the sample. A urine toxicology test cannot be requested by law.

3. After written consent is obtained, in the presence of the officer, the **Registered Nurse, Licensed Medical Technician or Licensed Physician** will prepare the patient’s skin with non-alcohol based solution (Betadine) and draw (2) 10ml red top tubes containing a powdered anticoagulant.

4. The tubes will be labeled with patient’s name, date and time, as well as the signature and title of the person drawing the blood.

5. The tubes will be given to the officer, documenting the date, time and his/her name and badge number, and the police department name on the medical record.
6. A photocopy of the “Request to Submit to a Chemical Test” form will be made. The original form is to be sent with the patient’s medical record.

7. **NOTE**: If the licensed Physician has also sent an ETOH level to the UMMHC Lab for medical diagnostic purposes, results of the level cannot be given to the officer.

8. According to Massachusetts law, medical exceptions in the statute are: hemophiliacs, diabetics and persons having a condition requiring anticoagulants.

This guideline is written in accordance to the Chapter 90, Section 24 of Massachusetts general law.

**RADIOLOGY**

- Radiology technicians respond to the trauma suite for trauma activations.
- Preliminary readings of studies are made by the Radiology Resident. Final readings are done by the Radiology Attending.
- If a final reading is needed urgently, request that the Radiology Resident ask for an Attending Radiologist to review it.
- If a final reading is not available by the next day at noon, please request a read from the Radiology Attending.
- Activation of the Interventional Radiology Team is made by the Radiology Resident.

**TRAUMA CT PANELS**

- **Panel 1**
  - CT Head w/o contrast
  - CT C-Spine w/o contrast
  - CT Abdomen/Pelvis with contrast
- **Panel 2**
  - CT Head w/o contrast
  - CT C-Spine w/o contrast
  - CT Chest with contrast
  - CT Abdomen/Pelvis with contrast
  - CT Dedicated TLS Spine
- **Panel 3**
  - CT Head w/o contrast
  - CT C-Spine w/o contrast
  - CT Angio Neck with and without contrast
Panel 4 CT Head w/o contrast
• CT C-Spine w/o contrast
• CT Angio Chest with and w/o contrast
• CT Abdomen/Pelvis with contrast
• CT Cystogram with contrast
• CT Dedicated TLS Spine
Panel 5
• CT Abdomen/Pelvis with contrast

TRAUMA RADIOLOGY PANELS

Panel 1
• Chest PA/AP apical or lateral
Panel 2
• Chest PA/AP apical or lateral
• Pelvis (1 view)
Panel 3
• Lumbar Spine AP & Lateral
• Thoracic Spine (2 views)

OBTAINING AN EMERGENT CT SCAN OR ANGIOGRAM

a. Angiogram (Adult and Pediatric)

During daytime and weekday hours the Trauma Chief should contact the Attending Angiographer directly in the angiography suite

After 5PM and weekends, contact the Radiology Resident as soon as it is suspected that an angiogram will be needed or as soon as the decision to perform an angiogram is made. The Radiology Resident must be given appropriate clinical information to communicate the indications for the procedure. He/she will contact the Radiology Attending on call, who will respond immediately. Any difficulty in obtaining an arteriogram should be referred immediately to the Attending Trauma Surgeon on call for discussion with the Attending Radiologist.

Note: A trauma team physician member and ED/ critical care nurse (in addition to the angio nurse) must stay with the patient during the procedure.

b. CT Scans: (Adult and Pediatric)

Daytime/weekdays: The CT tech should be notified ASAP, indicating which studies are needed (i.e. head, abd etc.). The tech will
notify the subspecialty adult or pediatric Radiologist on call to interpret the studies.

**Weekends/Nights:** Same as #1. The Radiology Resident on call will be notified by the tech to assist with the completion of the study and interpret results immediately.

**Note:** It is not necessary to obtain approval for emergent CT scans from an attending adult or pediatric Radiologist at any time. A radiologist may be consulted by the techs for assistance, but this should not delay a study.

If the Radiology resident questions the need for a CT study, the exam is not canceled but immediately referred to the Attending Radiologist on call for discussion with the trauma chief or Attending Trauma Surgeon.

In cases of multiple patients requiring CT scan studies, prioritization will be done by the Trauma Surgeon and Radiologist.

**FORENSIC EVIDENCE**

- Please attempt to save forensic evidence whenever possible. Avoid cutting clothing through bullet holes or stab wound sites of clothing.
- Exit wounds and entrance wounds are not always typical and these wounds should be referred to as a gunshot wound (GSW). A description of the wound and its location should be noted.
- Bullets have to be initialed on the blunt end – do not disturb identifying grooves. DO NOT handle the bullet with metal clamps.
- Save all clothes for examination by the detectives/police.
- Photographs are helpful to Law Enforcement.
- Discovered illegal substances must be reported and given to the police.

**DIRECTED INTERVENTIONS (SUBSTANCE ABUSE, AND VIOLENCE)**

If a patient tests positive for alcohol and/or substance of abuse, a Social Work evaluation is mandatory. Suspicion for abuse, negligence, or complex psychosocial needs associated with the injury should also be handled by Social Work consultation.
Do not divulge results of drug and/or alcohol screening to law enforcement or family members. Only patients can be offered this information.

**IMMEDIATE TRANSFER TO OPERATING ROOM**

The OR should be informed as soon as there is suspicion that a patient may need to go directly to the Operating Room. This may require contacting the OR prior to the arrival of the patient.

- There is a phone in the trauma bay that connects directly to the OR.
- In the situation that the OR has been informed but the patient does not require transfer to the OR immediately, the OR should be contacted as soon as this determination is made (they may be holding cases).
- The elevators directly outside of the trauma bay lead directly to the OR – these require an ID to activate and the OR should also be informed if a patient is to be transported by these elevators.

**INFORMED CONSENT (SEE POLICY #1036)**

- Informed consent in an emergency situation is not needed, but attempts to obtain consent for all procedures should be made with the patient (if able) or closest next of kin. This includes telephone consent (documented as such, or utilizing the “Oral Consent for Treatment” form in the E.D.).
- Informed consent MUST be obtained for all subsequent, non-emergent procedures from the patient/legal next of kin.
- Informed consent should be viewed in terms of direct discussion between the physician and patient. The signing of an informed consent form is only an attempt to document the fact that the patient genuinely understands the contemplated procedure and agrees to submit to it. Only a person who is conscious and rational (i.e. not under the influence of medication or alcohol) is capable of giving valid, knowledgeable consent to treatment. It is the physician's duty to obtain the patient’s consent and to be sure that all the patient’s questions have been answered. Consent may be withdrawn at any time. The order in which consent should be obtained from the “legal next of kin” is as follows:
1. If the patient is unable to make decisions and has executed a Health Care Proxy appointing an agent, this agent should provide consent.
   a. Spouse (“ex-spouse or Common law” marriage is not recognized in MA)
   b. Children of legal age
   c. Parent (s)
   d. Sibling(s) of legal age
   e. Grandparents followed by aunt, uncle, or first cousin (of legal age)

2. If a guardian has been appointed, a copy of the court order establishing “LEGAL GUARDIANSHIP” must be examined and placed in the medical record. The guardian must sign consents.

OBTAINING CONSENT BY TELEPHONE

When a patient is unable to give consent and the legal guardian or closest next of kin is not physically present, telephone consent may be obtained. The physician telephones the patient’s legal guardian or next of kin to make initial contact and provide information about the situation interprets treatment needed and requests permission to treat. The physician documents oral consent by completing and signing the hospital approved consent form. A telephone witness (nurse, physician assistant or other physician) should be used for all telephone consents (i.e. via speaker phone, conference call or confirmation by the witness). After the telephone conversation is complete, the telephone witness should counter sign, date and time the consent form.

INTER-SERVICE TRANSFERS

A stable patient with only single-system active issues may be transferred off the Trauma Service to the service addressing those active issue(s) if the Trauma Attending agrees and the other service accepts the patient. The Orthopedic Service requires a dictated transfer summary upon acceptance. The transfer is to be initiated by the senior residents, nurse-practitioners or Attending physicians only. Once the other service has accepted the patient, an order must be written in the medical record with the accepting MD’s name.

UNIVERSAL PRECAUTIONS

All trauma patients are to be considered potentially contagious and full barrier precautions (gown, mask, eye-shields, gloves) will be taken.
in the trauma bay by all members of the trauma team within the gray circle outlined on the trauma room floor.

3. **PRIMARY SURVEY**

Is defined as:

- Airway maintenance with cervical spine protection
- Breathing and ventilation
- Circulation with hemorrhage control
- Disability; neurologic status
- Exposure/Environment (completely undress the patient, but prevent hypothermia)

**TEAM LEADER RESPONSIBILITIES**

The success of the team is the responsibility of the Team Leader. The Team Leader should not participate in the practical procedures but should:

- Organize the team
- Assimilate the clinical findings and physical measurements
- Devise immediate and definitive plans for management to return the patient to a physiological normal state.
- Make appropriate decisions regarding tests, therapeutic interventions and the need for transfer.

**ATTENDING TRAUMA SURGEON**

The Trauma Attendings presence in the Emergency Department is to provide optimal trauma care for adult and pediatric trauma patients under the direction of the Attending Trauma Surgeon, and to direct the resuscitation and management plan of the critically injured patient, which is essential for optimal trauma care. For those less critically injured patients, when the Attending Surgeon is not physically present, timely and efficient communication is critical to ensure optimal trauma care. Although not all trauma patients will require the immediate presence of the Attending Surgeon, the following minimal criteria defines those patients who have actual or potentially critical injuries, and do require the presence of the Attending Surgeon in the ED within a specified period of time. The Trauma Attending Surgeon is responsible for the evaluation and management of all trauma admissions and consults triaged by the Emergency Department to the Trauma Service.
**Senior Resident**

The senior resident on the service, standing to the left of the patient and involved in the completion of the primary survey, secondary survey, ordering the immediate initiation of therapeutic maneuvers (e.g. IVF, O2, needle decompression, bleeding control), coordinates the team effort with constant awareness of time elapsed. *Silence is key in the Trauma Room. This allows all members of the team to hear the report and the physical findings of the patient.*

**ED Attending or ED Senior Resident**

They are in charge of airway control, ventilation, and C-spine in line traction; facilitating placement of the cervical collar. The ED Attending is in charge of the resuscitation process until the **Trauma Surgeon** on call arrives.

**Primary Nurse**

Stand at the upper left side of the patient, coordinates nursing care, takes first vital signs, places vital monitoring/therapeutic equipment on the patient (e.g. defib pads, Pulse Oximeter, etc), places a primary and/or secondary IV line.

**Junior Resident**

Stands at the right lower portion of the bed. The principal tasks are to assist as needed with completion of secondary survey, proceed with interventions such as invasive procedures (e.g. central venous access, chest tube placement) under the supervision of the team leader. Obtains the first ABG, performs a rectal exam, and places Foley catheters and nasogastric tube. This resident is in charge of all the physician documentation (history, physical and procedure).

**Secondary Nurse**

Stands and documents the resuscitation, limits access to the trauma room to authorized personnel only, announces important laboratory values and assists the primary nurse with any activities as indicated.

**Medical Student:**

This student will be at the foot of the bed and helps his fellow junior resident in the completion of different aspects of the examination, simple tests and procedures (e.g. rectal examination, wound cleansing, etc). They may not document in the Trauma H&P.
**Trauma Nurse Practitioner (NP)**

They document the Trauma History and Physical, write orders, and complete applicable paperwork as clinically indicated. In the absence of the second resident, the NP may perform their duties. In the setting of multiple trauma activations, the NP can act as the team leader for a level II trauma patient under the supervision of the Trauma Attending Physician.

**Respiratory Therapist**

Will stand near the upper portion of the bed and assists the ED Attending, ensuring the delivery of the correct ventilation settings and oxygenation.

**ER Technician**

Will stand at the upper right portion of the bed and assists the Trauma Team in clothing removal, transport of the patient, CPR compressions, processing lab samples, obtaining blood products. Also coordinates the medical orders with the rest of the hospital (e.g. drug order to pharmacy, X-ray orders, and Lab work orders).

**X-Ray Technologists**

Performs the necessary X-rays as requested.

*The GOAL is to proceed to the Operating Room or CT scanner when the patient is hemodynamically stable, preferable in less than 30 minutes.*

**Airway**

- Ensure open airway is present.
- Assume that the cervical spine is injured until proven uninjured.
- Maintain a rigid collar on the patient at all times until the C-spine is cleared. If neck is being examined, the stabilization will be done manually.
- Look and listen for evidence of upper airway problems and potential obstructions (vomitus, bleeding, loose or missing teeth, and facial trauma). Utilize appropriate adjuncts (OPA/NPA), as indicated, to maintain patency. Use caution in the presence of facial trauma. During intubation, the in-line immobilization of the neck **MUST** be maintained.
- Every patient with multiple injuries should receive 100% O2 via NRB.
• Once the airway is secure, observe for neck swelling, position of the trachea, and venous distension

**Difficult intubation:**

• Call anesthesia and continue ventilating the patient with BVM, performing the chin lift, or jaw thrust with OPA/NPA and appropriate usage of large-bore rigid suction device.
• LMA and intubating LMA should be available in the room, as well as the flexible bronchoscope.
• Definitive airway will be gained with a tracheal tube, nasotracheal tube and/or surgical airway (cricothyroidotomy or tracheostomy.) Familiarize yourself with the location of these trays.
• Position of the tube should be checked by auscultation, CO2 detectors and physical assessment. The utilization of CO2 detectors and x-rays are considered to be adjuncts. The chest x-ray should always be checked for confirmation of appropriate endotracheal tube placement.

**Breathing**

• Ensure bilateral ventilation by inspecting adequate movement and auscultation for breath sounds. Listen in the axilla for ventilation of the periphery of the lung and over the epigastrium to ensure that the stomach is not being inflated.
• Expose the chest and observe chest wall movements.
• Determine respiratory rate, depth and work of breathing.
• Reassess mental status.
• Obtain pulse oximetry reading.
• Assure adequate O2 administration.
• Intervene if inadequate ventilation is evident (needle decompression or tube thoracostomy) Use the largest tube for hemothorax or hemopneumothorax (36-40 Fr.)
• For sucking chest wounds, place a one-way dressing over the wound.

**Circulation and hemorrhage control**

• For sucking chest wounds, place a one-way dressing over the wound.
• Check for pulse, and if pulse not present, consider thoracotomy.
• Assess mental status and skin for signs of hypoperfusion.
• Apply direct pressure to external bleeding. A tourniquet should only be required in cases of near or complete amputation, with massive external bleeding.

• Assess adequate venous access is obtained. Two large bore (16-14 gauge) IV lines or a large bore central line should be inserted (remove in 24hrs). If the patient is in shock, an 8 Fr single lumen catheter should be placed. (Arrow or Cordis “Introducer” or equivalent). Consider intra osseous access if other options are not available.

• Initial fluid resuscitation should be crystalloid (LR or NS). LR is contraindicated in severe brain injury due to its hypotonicity and low Na level.

• If the patient does not respond to 2 liters of crystalloids, transfuse type O, uncrossed match. O-positive can be used for most patients so that O-negative blood can be reserved for use in women of child bearing age.

• Once control of shock and external bleeding control has been initiated, the search for internal hemorrhage must begin.

• CXR, Pelvis X-ray and FAST examination should be performed promptly. **DO NOT TAKE PATIENT TO CT SCAN if he/she is hemodynamically unstable.**

### SPECIAL CONSIDERATIONS IN CIRCULATION

#### Pelvic Fractures:

• Control of hemorrhage is essential (angiography with coiling, admission to SICU and resuscitation)

• Temporary stabilization:
  - Force-controlled circumferential pelvic belt:
    - Pelvic binder or other available compression device.
    - T-Pod (Ortho team should be present for the placement of this device).
  
  These stabilize pelvic hematoma, provide pain relief, are easy to use, facilitate nursing care and definitive care can be delayed. Skin breakdown is a concern with these devices.

• Definitive stabilization
  - External fixation
  - ORIF

### SPECIAL CONSIDERATIONS IN CIRCULATION

#### Penetrating torso wounds with Shock

• Should be taken to the OR immediately.
Selected patients with hemorrhagic shock and circulatory collapse that is unresponsive to fluid resuscitation can be considered for ED thoracotomy

**ED Thoracotomy (EDT)**

- Used for patients in extremis after penetrating injury and to a lesser extent after blunt injury. The therapeutic goals include: control of hemorrhage, effective cardiac compression, cross-clamping the pulmonary hilum in the case of air embolism or massive bronchopleural fistula, relief of cardiac tamponade and cross-clamping of descending aorta for lower torso hemorrhage control.

- Outcomes are better for penetrating injuries (8-10%) rather than blunt injuries (approx 1%). The patients who best respond to EDT are patients with penetrating chest trauma, with signs of life upon presentation to the ED, or those who lost them within 10 minutes of arrival to the ED.

- Blunt trauma in patients who have no signs of life upon arrival should not have an ED thoracotomy performed.

Once the decision to perform an ED Thoracotomy has been made, a left anterior lateral thoracotomy is made that extends from the sternum below the nipple, to the mid-axillary line. After entering the thorax, the intercostals are transected with scissors. The chest retractor is placed and opened. Additional exposure can be gained by using the scalpel to divide the costochondral junction of the 5th, 4th and 3rd ribs, or alternatively, a Lebske knife or trauma shears may be used to divide the sternum transversely. If air embolism is found, the pulmonary hilum is clamped or the affected lung may be twisted 180° and air in the aorta evacuated. When hemopericardium is present, this may be divided longitudinally from the aortic root to the apex, identifying the phrenic nerve. The hemopericardium is evacuated and pressure is applied to control the hemorrhage. Temporary repair with staples can be performed or tamponade the orifice with a Foley catheter. After this is been addressed, the descending aorta can be clamped, opening the posterior mediastinum. Once the intravascular volume is restored and if the patient responds, they must be transported to the OR for repair of their injuries.

**Disability**

- Assess early so as to document neurologic deficits before giving IV sedation or paralytics.
- Determine the patient’s glucose level.
- Give IV Narcan if an opiate overdose is suspected.
• Document GCS and gross motor and sensory status of all four extremities.
• Recognize the need for cerebro-protection measures in cases of brain injury. These patients should be intubated and sedated with rapidly reversible agents such as propofol and midazolam. Hyperventilation is not indicated unless brain herniation is believed to be occurring at that moment.
• Mannitol (1.0 g/kg IV) is indicated in patients with a low GCS and asymmetric pupils if they are not in shock.

Exposure/Environment

• Complete exposure of the patient is particularly important in patients to avoid missed injuries.
• Environmental control involves assessing the patient’s core temperature and preventing hypothermia.
• The room should be maintained at a temperature which is as warm as possible and the patient should be covered with blankets.
• Rapid infusion of blood products and crystalloid solutions should be accomplished by use of a rapid infusion fluid warmer (“Level 1” or equivalent).

End Points of Resuscitation - 2 categories (Global and Regional)

a. Global O2 delivery
   ▪ Mixed venous O2 saturation should be monitored.
   ▪ Assess base deficit and lactate levels.

b. Regional level
   ▪ Splenic perfusion can be measured by gastric tonometry, intramucosal pH or the gap between intramucosal and arterial PCO2.

Measurement parameters include:

• Physical examination
• Oxygen delivery, CI (>4.5L/min/m2) O2 delivery (> 600ml/min/m2). Increase intravascular volume followed by inotropes if necessary, and blood products to reach a Hct of 30.
• Mixed venous oxygen saturation (SvO2) >70%
• RVEDVI is more accurate than CVP and PCWP
• Arterial base deficit: serum bicarb (base deficit 2-5 mild illness, 6-14 moderate illness and > 14 severe illness). Approximately 2/3 of trauma with increasing base deficit have ongoing bleeding.
• Arterial lactate. Try to normalize of the lactate in 24 hrs. Normalization of lactate between 24-48 hrs brings the mortality down to 25%. If lactate is not normalized by 48 hrs, the mortality is 86%.
• End-tidal carbon dioxide level. You will see an increase if there is a reduction on the cardiac output and/or if there is abnormal distribution of pulmonary blood flow.
• Gastric tonometry. Measures the pHi (intramucosal ph) using a special ballooned NGT. pHi < 7.32 has a mortality of approximately 37% while pts with higher pHi’s usually survive.
• Tissue oxygen and carbon dioxide electrodes. There is a strong correlation with subcutaneous oximetry and mortality as well as CO2 measurement. A transcutaneous PCO2 > 60torr for >30min has shown to have almost a 100% mortality.
• Near Infrared Spectroscopy (NIRS) measures skeletal muscle oxymetry levels by a non-invasive method. This provides reliable information, correlating well with ongoing resuscitation.

4. SECONDARY SURVEY DEFINITIVE CARE

• Guidelines for Subspecialty Consultation
• Overview

Subspecialty Consultation

Subspecialty consultation should be made based upon specific indications as noted below. Consultations should be included in discussion and agreement with the Trauma Attending. Individual notification time should be noted on the Trauma H&P form. Lack of timely or appropriate response by the sub-specialist should be communicated to the Trauma Attending Physician.

• Individual services
• Severe Brain Injury (BTF guidelines)
• Minor brain Injury

• Brain Injury

1. Definition: Minor brain injury refers to those patients with GCS of 14 or 15 and no or minimal CT scan findings. Examples are small brain contusions, minimal
subarachnoid hemorrhage or minimal subdural or epidural hematoma, all without evidence of increased intracranial pressure. Loss of consciousness may or may not have been identified.

2. In general, neurosurgical consultation is not required for minor brain injury. The appropriateness of neurosurgical consultation in any given case should be discussed with the Trauma Attending Physician.

3. Patients who maintain or regain a GCS of 15 performance level with negative CT findings are candidates for possible discharge. Other injuries should be discussed with the Trauma Attending. All patients with abnormal mental status or CT findings should be admitted for observation. (It should be noted that amnesia for events of the injury {retrograde amnesia} does not constitute abnormal mental status, while ongoing amnesia for current events does)

4. In general, patients admitted for neurological observation should be admitted to an intermediate level of care. Exceptions to this should be discussed with the Trauma Attending on an individual basis.

5. Patients admitted with positive CT findings should have particular attention paid to coagulation parameters. Pathological coagulopathy should be reversed. Reversal of intentional therapeutic coagulopathy (coumadin, antiplatelet agents), may be a complex risk/benefit decision regarding the indications for anticoagulation and the extent of head injury. This should always be discussed with the Trauma Attending Physician.

6. Familiarize yourself with the Factor VII. Refer to Pharmacy protocols for intracranial bleeding and off-label use.

7. Patients admitted with minor head injury and positive CT findings should have a follow-up CT scan within 12 hours. For very minimal findings, with normal mental status, a follow-up CT may be deferred, after discussion with the Trauma Attending.

8. Deterioration of mental status is an indication for immediate CT scan. Discussion should be held with the Trauma Attending. Airway control and transfer to the intensive care may be appropriate. Progression of CT scan findings warrants an urgent neurosurgical consult.
9. Patients with preservation of normal mental status and stable follow-up CT can be mobilized and cleared for discharge. Issues such as fall risk, possible syncope, substance abuse and home supervision must be resolved prior to discharge. Physical therapy and occupational therapy consults should be considered as appropriate. Minor concussive symptoms do not necessarily preclude discharge.

- **Reversal of Coagulopathy**

*Transfusion coagulopathy:* Patients with “massive transfusion” (> 10 units pRBC) will develop deficits in labile clotting factors, platelets and fibrinogen.

1. **General Principles:** (Refer to Transfusion Policy #2070).

2. **Absence of ongoing bleeding:** Patients in whom surgical hemostasis is not obtained (i.e. pelvic fractures) and in whom small amounts of bleeding are catastrophic, (i.e. intracranial hemorrhage, spinal cord and globe) must have meticulous normalization of coagulation, even in the apparent absence of ongoing bleeding. INR, PTT and fibrinogen should be normalized and platelet count >50,000 maintained.

3. **Ongoing bleeding:** Patients with ongoing bleeding may require empiric replacement, even if parameters appear normal. Consumptive coagulopathy is empirically treated. DDAVP and concentrated factor VII should be considered and discussed with the Trauma Attending. Hypothermia and acidosis must be corrected.

*Therapeutic (Intentional- Iatrogenic) Coagulopathy:* Many trauma patients have received coumadin and antiplatelet agents (ASA, Plavix). The extent of coumadin coagulopathy is assessed by INR via bleeding time.

1. **General principles:**

- Decisions to correct therapeutic coagulopathy is a risk/benefit judgment regarding the risk of bleeding with a particular injury complex versus the risk of anticoagulation withdrawal. In general, the short term risk of coagulation withdrawal is minimal for atrial fibrillation. (1% per year). Mechanical heart valves may develop minimal thrombosis or catastrophic thrombosis at any time when anticoagulation is withdrawn. Though never studied in large populations, the risk of thrombosis...
of a mechanical valve in the aortic position appears small in the short term. The risk in the mitral position is greater. In the setting of anticoagulation for DVT/PE, the risk of recurrence upon withdrawal varies with the patient's risk factors.

2. **Patients with major intracranial hemorrhage: mass lesions, diffuse SAH, significant brain contusions:**
   - These patients should have anticoagulation actively reversed with fresh frozen plasma (coumadin) and platelets (ASA, Plavix) to normal, regardless of the reasons for which it was instituted. Patients who were anticoagulated for prior pulmonary embolism or deep venous thrombosis should receive IVC filter as soon as possible.

3. **Patients with minor intracranial hemorrhage**
   - Individualized judgment is required. In general, anticoagulation for all indications can be held though it may be possible to avoid active reversal with minimal intracranial lesions. In general, anticoagulation for atrial fibrillation and aortic valves can be held or reversed safely, if necessary, in the short term. If anticoagulation for DVT/PE is to be held, an IVC filter should be considered. Discussion with the Trauma Attending is mandatory.

4. **Patients with major extracranial injury only**
   - In general, anticoagulation for atrial fibrillation should be held. If surgical hemostasis is achieved (i.e. radial artery ligated, or splenectomy, etc) it may be possible to continue anticoagulation for more critical indications and avoid reversal of antiplatelet effects. Where surgical hemostasis is not achieved (i.e. pelvic fractures or liver hematoma) vital signs and hematocrit should be carefully monitored, and reversal of coagulopathy may be necessary if parameters indicate ongoing blood loss. The appropriate use of interventional angiography for the spleen, liver and pelvis may mitigate the need to reverse anticoagulation.

5. **Reinstitution of coumadin:**
   - For extra-cranial injury, coumadin can be re-instituted when clinical exam, vital signs and hematocrit indicate bleeding has ceased. The duration of observation off anticoagulation should be tailored to the nature of the need for anticoagulation and the risk of withholding it (i.e.-anticoagulation for atrial fibrillation and aortic valve replacement can safely be held for a number of days but the safe duration for pulmonary embolism and mitral valve replacement is unknown). Reinstitution of
cousmin after intracranial bleed remains controversial. As baseline criteria, the lesions should be stable on repeat head CT. Discussion should be held with the Trauma and Neurosurgery Attendings.

- Spine

Cervical Spine: Evaluation and Clearance

1. General principles:
   - Plain x-rays, particularly in the setting of altered consciousness are unreliable for ruling out bony or cervical spine injury, especially in the anatomically dense cranial to C2 region. Similarly, in the absence of reliable physical exam, a small percentage of unstable ligamentous injuries are not identified by CT scan.

2. Clinical clearance:
   - With normal mentation, absence of alcohol or substance intoxication, narcotic analgesia, or significant distracting injury, clinical clearance may be undertaken. This clearance requires the absence of spine or neurologic complaints, absence of cervical spine tenderness on exam, a normal peripheral neurologic exam and the absence of pain on full range of motion. This modality of cervical spine clearance is applicable to the majority of patients.

3. Other patients with normal mentation:
   - The majority of patients will require a CT scan with three dimensional reconstruction to rule out bony and most ligamentous injury. A negative exam rules out an unstable cervical spine to a reliability of 94-98% (depending on source). This should be followed by a range of motion exam (ROM) to complete the assessment for ligamentous injury. Pain on range of motion indicates continuation of cervical immobilization and MRI study for soft tissue (ligamentous) injury. The sensitivity of MRI for ligamentous injury decreases markedly by 72 hours after injury.
4. **Patients with abnormal mentation:**

- These patients will have received an initial CT scan of the cervical spine. If they are expected to regain normal mental status within 24-48 hours, (e.g. alcohol intoxication), the cervical collar may be maintained for eventual clinical clearance. IF they are not expected to regain normal mental status (traumatic brain injury), an MRI should be performed to rule out ligamentous injury and complete clearance. If the patient is too unstable to travel to MRI within 72 hours, the cervical collar will need to remain in place for 6 weeks or until mental status improves and clinical clearance is possible. Patients with minor stable fractures (i.e. spinous process, transverse process) do not require spine consultation.

5. **Indication for spine specialty consultation (see above):**

- All patients with an identified cervical spine injury should have a full CT of the thoracic and lumbar spine to identify concurrent injuries unless they can be definitively ruled out by clinical exam, under the direction of the Trauma Attending.

**Thoracolumbar Spine Evaluation and Clearance**

1. **General principles:**

- Patients with blunt trauma will require clinical or radiological clearance of the thoracolumbar spine.

2. **Patients with normal mentation and absence of significant distracting injury:**

- Can have clinical clearance attempted. Back pain, tenderness to spine palpation, deformity or related lower extremity neurologic deficit mandates radiologic imaging. CT scan of the chest and abdomen, with computerized reconstruction is the preferred study. Neurologic deficit will also require an MRI scan and spine consultation should be obtained.

3. **Patients with abnormal mentation after blunt trauma**

- Will require radiologic clearance of the thoracolumbar spine as above.
4. Patients with penetrating trauma:
   - If in proximity to the thoracolumbar spine, the patient’s peripheral neurologic function should be assessed in the trauma room, mentation permitting. Proximity to the spine can be rapidly assessed by plain radiography if emergency abdominal or thoracic surgery is planned. CT scanning can be utilized if non-operative management of other injuries is planned. Defects or vertebral fractures require spine specialty consultation to be prioritized based on urgency of other treatments.

5. Head of the bed:
   - Elevated greater than 30 degrees for all patients after the TLS films are reviewed by the Trauma Team.
   - **Transmediastinal Injury**

   1. General principles:
      - Trans mediastinal injury refers to a penetrating injury, usually a gunshot wound, that traverses the mediastinum (i.e. left to right and/or front to back). Most patients who incur such injuries either die in the field or arrive unstable, though a small percentage of such patients arrive in stable condition. The immediate life-threatening injuries possibly include, tension pneumothorax, hemothorax, great vessel injury, cardiac injury with tamponade or exsanguination Esophageal or tracheobronchial injury may not manifest immediately, but may be life threatening nonetheless.

   2. Hemodynamically abnormal:
      - Airway control should be achieved, empiric 0 neg blood administered and resuscitation per ATLS protocol.

      - Bilateral tube thoracostomies should be placed to treat tension pneumothorax and assess hemothorax. The Autotransfuser should be used.

      - If tube thoracostomies do not reveal pneumothorax or hemothorax, or if the patient fails to stabilize, pericardiocentesis should be performed. If the patient is profoundly unstable, E.D. thoracotomy should be considered as an alternative.

      - When maximal possible stability is achieved, the patient should be transferred to the Operating Room. Assessment for other
specific injuries can be determined intra-operatively. Empiric transfusion should continue if pleural or pericardial blood was obtained. The nature of the surgical incision will depend upon the anticipated injuries.

3. Hemodynamically normal:
   - The classical “semi-invasive” evaluation of trans-mediastinal injury involves chest x-ray, bronchoscopy, esophagoscopy, pericardial window or echocardiogram and aortic arch arteriography. Currently, thin-cut dynamic CT scan with intravenous and oral contrast is an acceptable initial diagnostic study. Further evaluation and treatment is based on findings of this study. An abdominal scan should also be performed to rule out transdiaphragmatic penetration and associated intra-abdominal injury.

- Penetrating Trauma

   Head

   General Principles:
   1. Most penetrating head trauma occurs consequent to gunshot wounds and is invariably lethal. Patients arrive with profound alteration of consciousness and should have their airway promptly controlled and mechanical ventilation instituted with normocapnia maintained. This is always a neurosurgical emergency and prompt consultation should be obtained. If signs of impending herniation are noted (dilated pupil, Cushing’s Response, brain tissue expressing from open wound) Mannitol bolus should be given (50 gm boluses) pending neurosurgical arrival. Antibiotics for gram positive organisms should be administered for the open skull fracture and open brain injury. The patient should be fully disrobed and examined for other possible sites of penetrating injury.

   Neck

   General Principles:
   2. High velocity penetrating injuries to the neck usually injure vital structures and require operative exploration / treatment. Low velocity injuries such as stab wounds and lacerations by knives or other sharp objects may not require full surgical exploration. For purposes of penetrating injury, the neck remains divided into three zones.
a. The presence of “hard signs” of injury (shock, enlarging hematoma, crepitus, respiratory distress, bruit, hemoptysis or hematemesis) is an indication for surgical exploration.

b. Significant hemoptysis or respiratory distress should prompt emergent airway control. Oral intubation may not be possible and emergent cricothyroidotomy or tracheostomy (for laryngeal injuries) may be necessary.

c. In the absence of hard signs, penetration of the platysma should be assessed. This is classically done by local wound exploration but may also be done radiologically by thin-cut CT scan. Integrity of the platysma indicates closure of the wound and either discharge of the patient or a brief period of observation is warranted.

d. Penetration of the platysma classically indicates zone specific treatment
   - Zone I – neck angiography and laryngoscopy
   - Zone II – surgical exploration
   - Zone III – aortic arch angiography.

e. Alternatively, asymptomatic penetrating injury of all three zones may be assessed by CT angiogram with oral contrast. This modality may identify esophageal, vascular or tracheobronchial injuries. Choice of modalities of evaluation should be discussed with the Trauma Attending. Further treatment is based on results of the initial studies.

Chest
General Principles:

a. Immediate life-threatening injuries include tension pneumothorax, hemothorax, cardiac injury and great vessel injury. Esophageal injury and tracheobronchial injury often present in a delayed fashion but may be equally as lethal.

Unstable patients:

a. Resuscitation should begin per ATLS protocol with large bore IV catheters. 0 neg blood should be given without delay as hemorrhage is a likely cause of shock. Airway control is always appropriate.

b. A tube thoracostomy should be placed on the side of injury and an autotransfer chest drainage system should be used. Chest tube output greater than 1500 ml is an indication for thoracotomy. Massive air leak may similarly indicate tracheobronchial injury which may require surgical repair.
c. In the event no air or bloody output is obtained, a contralateral chest tube should be placed. A chest radiograph should be done as soon as possible after chest tube placement.

d. Patients who are adequately resuscitated and stabilized may be further evaluated by thoracic and abdominal CT scans. They may still require urgent surgery if thoracostomy output is sufficient to indicate major vascular injury or if there are CT findings of vascular, esophageal injury or hemopericardium.

e. Failure of the patient to resuscitate despite modest chest tube drainage, adequate blood transfusion, a clear chest x-ray or distended neck veins, may indicate pericardial tamponade. FAST exam may be useful in assessing hemopericardium. A pericardiocentesis should be performed. In the presence of profound hypotension, ED thoracotomy may be appropriate. The patient should be transferred to the Operating Room when maximal feasible resuscitation has been achieved.

f. It should be remembered that projectiles following courses low in the thorax may penetrate the diaphragm and cause unidentified intra-abdominal injury. This is particularly likely if intra-thoracic injuries are insufficient to explain initial shock. This should be investigated at surgery by carefully examining the diaphragm and identifying the course of the projectile.

Stable patients:

a. Stable patients with penetrating thoracic injury should have chest radiographs obtained. Treatment is based on the findings of the initial radiograph. Pneumothorax or hemothorax should initially be treated with a thoracostomy tube. If a significant hemothorax is apparent on x-ray, an autotransfer chest drainage system (Atrium chest drainage systems) should be employed. Thoracostomy tube output greater than 1500 ml initially or 250 ml/hr for 4 hours indicates surgical exploration is necessary.

b. Stable patients who have no indication for surgical exploration should have a thin-cut CT angiogram of the thorax and abdomen with oral and intravenous contrast. Hematoma around major vessels or within the pericardium may indicate injury to the heart or great vessels. Air or fluid around the esophagus may indicate injury to that organ. These findings usually indicate the need for surgery.
Abdomen, thoraco-abdomen, flank or back stab wounds

*General Principles:*

3. Gunshot wounds to the abdomen are most often penetrating. In either case, hard signs of injury (shock, peritoneal signs, free air on chest x-ray, intra-abdominal missile on abdominal x-ray or evisceration are definite indications for laparotomy.

4. For stable patients, the task is to determine whether the peritoneum and/or the compartments bordering the peritoneum have been violated. These compartments are the thorax above, the pelvis below and the retroperitoneum along the flanks and back. The retroperitoneum contains portions of the GI tract including colon and duodenum, the urinary tracts, the aorta, vena cava and pancreas.

5. In general, penetrating injuries lateral to an imaginary vertical line through the nipples may injure, in addition to peritoneal contents, lateral retroperitoneal structures such as ascending or descending colon, kidneys or ureters. Penetrating wounds below the iliac crests may injure pelvic structures such as bladder, rectum or internal iliac branches. Wounds above the costal margin may violate the thorax. Wounds to the back may injure any posterior retroperitoneal organ in addition to peritoneal structures.

*Management of stable patients without clinical indication for surgery:*

a. For flank, back or possible pelvic wounds, injury is best assessed by triple contrast CT scan of the abdomen and thorax (oral, rectal and IV). Findings such as peritoneal or retroperitoneal air, hemoperitoneum, significant retroperitoneal hematoma, contrast, air or stranding around extraperitoneal intestine are indications for surgery. Renal injuries may not require surgical exploration if
vascular supply and ureteral drainage is intact and the hematoma is confined to Gerota’s fascia.

b. Anterior abdominal stab wounds felt to be non-penetrating may be initially assessed by local wound exploration in the Trauma Room or Operating Room. Integrity of the anterior fascia rules out intra-abdominal injury. The wound may then be irrigated and loosely closed. The patient may be admitted for a brief period of observation or discharged after discussion with the Trauma Attending.

c. Penetration of anterior fascia as determined by local wound exploration creates the need to rule out peritoneal penetration. This may be accomplished by several modalities. Diagnostic laparoscopy can be used to visualize the peritoneum and will also identify free fluid or blood in the peritoneum. A CT scan may show the tract of the injury and rule out peritoneal penetration. If there is evidence of abdominal penetration, a formal laparotomy should be performed.

d. The rare gunshot wound which is felt to be non-penetrating (“tangential”) is best assessed by triple contrast CT. Hematoma, air and shrapnel can often delineate the path of the projectile and rule out peritoneal penetration. If peritoneal penetration remains unclear, laparoscopy or laparotomy is indicated.

e. Penetrating pelvic injuries include urinary tract, bladder, internal iliac arterial branches and extraperitoneal rectum. Ureteral injuries will require surgical repair. A Urology consultation may be appropriate. Extraperitoneal bladder penetration is treated with decompression via a Foley catheter. Large pelvic hematomas which may relate to internal iliac vascular injury are best approached with angio-embolization. Rectal injuries will require diversion, washout and presacral drainage.

Extremities:

General Principles:

• Immediate concerns with penetrating extremity trauma involve vascular injury with external blood loss, hematoma and/or ischemia and possibility of compartment syndrome. Secondary functional concerns involve neurologic and muscular (tendon) injury with possibility of functional loss. Though not often the case with low velocity injury (stab wounds), gunshot wounds may create fractures and secondary projectiles of bone fragments. Crush injury may create a compartment syndrome and may also trigger renal failure from the systemic release of myoglobin. Patients can be divided into those who are
symptomatic and those who are not. In all cases, except those with external blood loss, treatment of extremity injury takes secondary priority to the emergent treatment of life-threatening cranial and thoracoabdominal injury.

Asymptomatic patients:

a. Asymptomatic patients are those who have no signs of external or internal blood loss (unexplained hypotension, anemia or “large amounts of blood” in the field). They have no neurologic or motor complaints. Asymptomatic patients should have a thorough vascular exam to document normal pulses, absence of bruits and perfusion status of the extremity. Hematocrit should be checked. Proximity arteriography has not been shown to be necessary. Motor and sensory function should be assessed. Subtle motor weakness may be a response to pain or local muscular injury but may also indicate nerve injury. A radiograph should be performed to rule out retained foreign body for stab wounds and fractures in the case of gunshot wounds. Removal of bullet fragments is generally not necessary. If evaluation is negative, the wound may be locally debrided and cleaned. Stab wounds may be loosely closed to allow for drainage. Gun shot entrance and exit wounds are generally treated as open wounds. If adequate debridement and irrigation have been performed, the administration of antibiotics after injury has not been proven to decrease infection, but a short course may be given after discussion with the Trauma Attending. It may be appropriate in specific cases to monitor the wound for a period of time for development of hematoma.

Symptomatic Patients

The table below indicates appropriate initial options for various findings in penetrating extremity trauma. Multiple system extremity trauma requires a coordinated approach among specialty consultants. Appropriate prioritization is critical for an optimal outcome. Discussion should occur between the Trauma Attending and consultants regarding prioritization of treatments:
<table>
<thead>
<tr>
<th>Vascular:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive external hemorrhage</td>
<td>Local control with pressure (tourniquets generally not effective): resuscitate as necessary; transport to OR</td>
</tr>
<tr>
<td>Anemia, heavy blood loss at scene, history of hypotension</td>
<td>Exploratory surgery vs. arteriography</td>
</tr>
<tr>
<td>Bruit</td>
<td>Vascular ultrasound vs arteriography; consider vascular consult</td>
</tr>
<tr>
<td>Hematoma</td>
<td>Monitor for increase in size, Vascular ultrasound vs arteriography; monitor perfusion and rigidity of extremity for possible compartment syndrome; Suspicion of compartment syndrome requires vascular study and compartment pressure measurement or exploratory surgery with fasciotomy. Consider vascular consult.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Orthopedic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture</td>
<td>Timely antibiotics as fractures are considered to be open fractures (Orthopedic consult); Definitive treatment if patient stable without complex injury vs. external fixation as temporary/definitive treatment</td>
</tr>
<tr>
<td>Compartment syndrome with fracture</td>
<td>Probable fasciotomy with definitive treatment or external fixation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neurologic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Localized motor or sensory deficit c/w distal peripheral</td>
<td>Generally no treatment. May or may not resolve.</td>
</tr>
</tbody>
</table>
### nerve injury

<table>
<thead>
<tr>
<th>Description</th>
<th>Treatment/Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global sensory or motor deficit c/w peripheral trunk injury, (i.e femoral or brachial)</td>
<td>Attempt at repair may be appropriate if patient is stable. Delayed repair often without decrement in outcome. Prognosis variable depending upon transaction vs. contusion. Plastic consult generally placed. Rare nerve compression by hematoma may indicate timely surgery.</td>
</tr>
</tbody>
</table>

### Soft tissue

<table>
<thead>
<tr>
<th>Description</th>
<th>Treatment/Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare significant defect from gunshot or shotgun.</td>
<td>Treat as open wound initially. Debride. Local wound care with a variety of options. May require Plastics techniques when stable if large defects are present.</td>
</tr>
</tbody>
</table>

### Blunt Trauma

**Aortic Injury**

*General Principles:*

6. Aortic injury, or blunt aortic transection should be suspected with high velocity deceleration mechanism (i.e. car vs tree) when there is an abnormal mediastinal silhouette, particularly around the aortic knob and descending aorta (aortic stripe). These uniformly occur adjacent to the ligamentum arteriosum at the distal part of the arch. There may be secondary tears at the aortic annulus, particularly with vertical decelerations. The following facts should be kept in mind: This injury is asymptomatic and may present as sudden death. This injury is based on deceleration and need not be associated with bony chest wall injury. The injury alone will not cause shock in the absence of rupture and hemothorax. If the patient is
hypotensive, alternative sources of bleeding should be sought.
Hemothorax, in association with aortic transaction, indicates beginning rupture and impending death. For the most part, thoracic aortic transection is uniformly fatal if untreated.

Diagnosis:

7. Suspicion based on chest x-ray finding of abnormal mediastinal contour. Other findings are sub-pleural hematoma dissecting upward from the mediastinum to the thoracic inlet (apical cap), depression of the left mainstream bronchus or deviation of the NG tube to the right. The traditional "gold standard" for diagnosis is arteriography but this has largely been supplanted by dynamic CT angiogram. Many cardiac surgeons today will operate based on CT scan alone.

8. Generally, treatment will be surgical with interposition graft. Perfusion techniques require heparin but may be used in absence of head injury and may decrease the incidence of paraplegia from this procedure. If surgery is contraindicated due to severe head injury, the patient may be treated by anti-impulse therapy with b-blockade and anti-hypertensives to decrease the force of cardiac ejection. This is an extrapolation of the treatment of non-traumatic dissection and its benefit is not proven. Intraluminal stents placed by interventional angiographic techniques have been successful, but their role is still being defined.

Cerebrovascular Injury

General Principles:
- Blunt cerebrovascular injury to the carotid arteries can occur from hanging injuries or blunt anterior neck impact. It may occur solely from hyper-extension in patients with calcific carotid vascular disease, or it may occur from skull fractures that cross the carotid foramen. Blunt vertebral artery injuries can occur from cervical spine fractures that involve the
vertebral foramina. Blunt cerebrovascular injury may constitute dissection or occlusion; rarely transection.

**Diagnosis:**
- Suspicion is raised by mechanism of injury, especially with the finding of a laceration or abrasion along the anterior neck. Additional signs include a bruit or evidence of an unexplained focal neurologic deficit or more global cerebrovascular accident. Vascular ultrasound may indicate turbulence or an intimal flap. Diagnosis is by angiogram or CT angiogram.

**Treatment:**
- Repair of significant carotid vascular injury is generally done, whereas minor intimal tears, particularly those located in inaccessible vertebral locations, are often treated with antiplatelet drugs or more formal anticoagulation. Repair may not be indicated if a large or hemispheric stroke has already occurred. Neurosurgery and vascular consults

**Blunt Esophageal Injury**

**General principles:**
- Blunt esophageal injury is uncommon and occurs consequent to an abdominal impact. A rapid septic mediastinitis then occurs and the pleural space may or may not also be contaminated.

**Diagnosis:**
- Factors raising suspicion of esophageal injury include pneumomediastinum, hydro pneumothorax in the absence of rib fractures and food material expressing via a thoracostomy tube. Initial diagnostic options include CT scan with esophageal contrast or formal esophagram, if the patient is stable. Fiberoptic or rigid esophagoscopy may be necessary.

**Treatment:**
- Treatment is generally surgical and immediate. Many procedures are described, but the salient components are wide surgical pleural and mediastinal exposure, toileting and thorough chest tube drainage. The actual perforation may or may not be repairable depending on the time since injury. Gastrostomy and feeding jejunostomy are usually done. Esophageal diversion remains controversial. Broad spectrum antibiotics are
administered and the patient remains NPO until healed. In patients for whom surgery is especially risky due to concurrent head injury, treatment may be conservative with esophageal tube, antibiotics and TPN, if contamination is minimal and there is no sepsis.

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Diagnosis / treatment:
- Suspicion of tracheal or proximal bronchial transection should arise when there is pneumomediastinum. There may be mild hemoptysis. Occlusion of the bronchus or narrowing of the trachea may at times be evident on CT. There may or may not be respiratory distress based on the degree of volume loss or narrowing. Diagnosis is by fiberoptic bronchoscopy and initial treatment involves airway control only if there is respiratory compromise. An endotracheal tube should be passed beyond the obstruction over the bronchoscope. For bronchial injury,
the tube should be passed down the contralateral (uninjured) bronchus. Surgical repair will be required and the timing is based on the adequacy of respiratory function (degree of air leak, oxygenation and ventilation) and associated injuries. Delayed repair is often successful.

Suspicion of distal bronchial transection should arise when there is a persistent large air leak after chest tube placement for pneumothorax. The lung may or may not expand. Suspicion of distal bronchial occlusion should rise when there is persistent whole lung atelectasis. Diagnosis is by bronchoscopy. Mechanical ventilation should be avoided if the patient is stable. A second thoracostomy may be placed for large air leak in an attempt to increase suction and inflate the lung. Patients in respiratory distress should be intubated down the contralateral lung. Timing of surgical repair is based on adequacy of ventilation and severity of other injuries.

Patients who remain with poor respiratory function but are not surgical candidates may be treated with a variety of ventilator strategies including independent lung ventilation with CPAP (continuous positive airway pressure) or jet ventilation.

Diaphragmatic Injury

Basic principles:
- Diaphragmatic rupture occurs due to blunt abdominal impact and is often associated with significant other intra-abdominal injuries. Herniation is predominantly left sided where the stomach is the most common organ to herniate. Spleen, splenic flexure of colon, left kidney and small bowel may also participate. Right sided herniation may occur more commonly than realized with the liver preventing detectable herniation in some cases.

Diagnosis:
- Symptoms may be minimal. When symptomatic, respiratory distress is the most common finding. Alternatively, the symptoms may be only those of associated injuries. Chest radiograph may show obvious gross herniation or only subtle diaphragmatic irregularities. Any irregular diaphragmatic contour after blunt abdominal trauma should be investigated. Differential diagnosis includes subpulmonic effusion, atelectasis, tenting of the diaphragm or acquired / congenital
eventration. Diagnosis is by CT scan with coronal views and reconstruction. For patients who are intubated on arrival, diaphragmatic tear may not present with herniation until positive pressure ventilation is discontinued.

**Treatment:**
- If there is respiratory distress, initial treatment is by nasogastric tube to decompress the stomach. Intubation may be required. Full trauma evaluation should proceed in the usual fashion. Associated injuries are the rule. Surgical repair is required and is performed through the abdomen to allow assessment of associated injuries. When diagnosis is delayed, repair is often through a thoracotomy approach to release associated adhesions.

**Pulmonary Contusions**

**Basic principles:**
- Pulmonary contusions occur from disruption of the interstitial tissue of the lung with bleeding into alveoli. Contusions cause respiratory compromise due to shunting and decreased compliance of lung tissue. Pulmonary contusions generally reach their maximum dimension within 24 hours if coagulation is normal and then begin to resolve over the next week if infection in the contusion does not occur. Maximum respiratory impairment from the contusion alone probably occurs within 24 hours.

**Diagnosis:**
- Early patchy, non-lobar infiltrates after blunt trauma or deceleration should raise suspicion of pulmonary contusion, particularly if peripheral and associated with local chest wall injury. A CT scan should be done as plain x-rays generally underestimate the extent of contusion.

**Treatment:**
- Associated chest wall injury should be treated with pain control. Patients should be resuscitated as needed for other injuries. Volume of resuscitation fluid has not been shown to correlate with worsening of contusion or total ventilator days. Normal coagulation should be confirmed. Oxygen and chest physiotherapy should be given as needed. Ventilatory support should be instituted as needed. Currently steroids and prophylactic antibiotics have no role in the treatment of pulmonary contusion.
Bony Chest Wall Injury – Rib Fractures/Flail Chest/Sternal Fracture

**Basic principles:**
- Three or more double rib fractures constitutes a flail chest. These bony chest wall injuries cause respiratory impairment by the pain, splinting and atelectasis they produce. Also, there are often underlying pulmonary contusions which further compounds the problem (see above). Hemothorax and pneumothorax are often associated with this injury constellation. Multiple rib fractures / flail chest are high mortality injuries in the elderly or those with respiratory co-morbidities. The sternum may be fractured at the sternomanubrial junction, the body or may be separated from the costal cartilage articulations in which case this is defined as “flail sternum”. Here again, the issue is mostly pain and the association with blunt cardiac injury is empiric only.

**Diagnosis:**
- Fractured ribs are painful and chest wall deformities may be visible. Flail chest or flail sternum in patients breathing spontaneously may demonstrate “paradoxical respiration” whereby the flail segment “sucks in” as the chest wall moves out with inspiration. All rib fractures may not initially be visible on conventional chest radiographs. CT scan should be considered to identify associated injuries.

**Treatment:**
- Pain control is the main component of treatment. In general patients with 4 or more rib fractures and age > 55 should be strongly considered for regional pain control methods such as epidural analgesia. Younger patients with more severe injury or co-morbidity should be similarly treated. Incentive spirometry is the best indicator of the adequacy of pain control and if inadequate, analgesia should be upgraded. Concurrent pneumothorax and pulmonary contusion should be treated as described above. Ventilatory support should be provided if the patient is failing. Noninvasive ventilatory support combined with optimal pain control may avert the need for intubation in some cases. The benefits of surgical repair of multiple rib fractures or flail chest has not been proven but can be considered if thoracotomy is required for concurrent injuries.
Blunt Trauma – Abdominal

Blunt Splenic Injury

Background:

- The spleen is injured by deceleration or direct impact. Splenic injury is associated with left lower posterior rib fractures. Blunt splenic injury is graded I through IV (see table). All injury grades are candidates for initial non-operative management as long as the patients are hemodynamically stable. The grade of injury correlates with the likelihood of success of non-operative management. Angio-embolization may increase the likelihood of successful non-operative management particularly in the higher grade injuries.

- Removal of the spleen carries the risk of fatal “OPSI” or overwhelming post splenectomy infection. This risk has generally been assessed at 1% for the elderly, but this figure has recently been brought into question. In general, splenic salvage is preferred. Delayed rupture of the spleen after trauma has been documented up to 14 days post injury. It remains controversial whether delayed rupture is a separate entity from the initial injury or represents unappreciated ongoing bleeding.

Diagnosis:

- In the stable patient, splenic injury is suspected by physical exam and FAST exam and confirmed and graded by CT scan. CT scan will allow grading of the injury which will help determine treatment. In the unstable patient, the decision for surgery may need to be based on clinical findings.

Treatment of the Stable Patient:

Initial management:

- Non-operative management is the initial strategy. Patients should be admitted to at least an intermediate level of care with cardiac monitoring. Frequent hematocrit checks, and physical exams should be done. (e.g. Q6H x 24, Q8H x24, Q12H x24, daily). Absolute indications for angio-embolization include a splenic artery pseudoaneurysm on CT or a contrast blush in the body or hilum indicating ongoing bleeding. Relative indications for embolization include a high grade injury (high grade III, grade IV) where the risk of failure of non-operative
management is greater. Selective branch artery embolization is preferable to preserve splenic function but main artery embolization may be needed with a high grade injury. An alternative for high grade injury where a specific bleeding site is not seen is diffuse embolization with gelfoam rather than occlusive coils. Gelfoam will lodge in peripheral vessels and may be less likely to permanently decrease splenic blood flow.

Failure of non-operative management:
- Assessment for failure of non-operative management requires close and ongoing monitoring. Persistent transfusion requirements to maintain hematocrit or stable vital signs are generally assumed to indicate the need for further intervention. Patients who are hemodynamically stable but have dropping hematocrits may need repeat angiography. Patients who are unstable and do not stabilize with further transfusion require prompt surgery. Splenic repair (“splenorrhaphy”) is preferred, but surgery for high grade lesions usually leads to splenectomy.

Success of non-operative management:
- Patients who have stable hematocrits, vital signs and an improving exam may have their laboratory studies decreased and their activity level increased over several days. There is no evidence that follow-up or serial CT scans alter management of blunt splenic injury but a “pre-discharge” scan can be done to document stability of the injury. There is also no standard regarding length of hospitalization, but most patients with isolated blunt splenic injury will be in the hospital 3 to 7 days. Discussion should be held with the Trauma Attending in regard to advancing activity and discharge. Perhaps more important than length of hospitalization is that the patient maintains light activity for several months after discharge. The immunologic function of the embolized spleen is not known. Patients who have had main splenic artery embolization should receive Pneumovax and other vaccinations for encapsulated organisms per the current CDC standard.

Treatment: Unstable patient:
- Patients who are admitted to the trauma bay with shock and fluid around the spleen on FAST exam are presumed to have a splenic injury as the cause of blood loss. Since a definitive diagnosis is not made and the patient cannot travel to CT, other sources for shock should be ruled out by physical
exam and chest / pelvic radiographs while initial resuscitation is underway. Subsequently, patients who fail to resuscitate should be taken emergently to the Operating Room. Splenorrhaphy is preferred if bleeding can be controlled. High grade injuries in unstable patients usually result in splenectomy. The post-operative splenorrhaphy patient should be monitored as frequently as the embolized patient. The post-splenectomy patient should recover uneventfully and receive vaccination prior to discharge.

Blunt Hepatic Injury

Basic Principles:
- Blunt injuries to the liver may range from minor lacerations / hematomas through widespread disruption of the hepatic parenchyma with exsanguination from the highly vascular organ. Additionally, deceleration may lead to tears of the hepatic veins or hepatic vein / vena cava junction. This “retrohepatic vascular injury” may cause massive and fatal bleeding even in the absence of parenchymal injury.

Diagnosis:
- In the stable patient diagnosis is suspected from RUQ tenderness and a positive FAST exam. The injury is confirmed and graded by CT scans. (See hepatic injury grading scale). The patient with severe injury is often unstable with a positive FAST exam and diagnosis is often made during emergency surgery. At that time, the injury can be evaluated but the severity is often underestimated by gross inspection. In the absence of severe parenchymal injury, torrential bleeding from behind the liver, which is partially controllable with packing and pressure, may indicate retrohepatic vascular injury.

Treatment: stable patient:
- The stable patient is always managed conservatively as hepatic surgery is fraught with risk. ICU admission is appropriate for the higher grade injuries (III, IV). All patients should be kept NPO and at bed rest. Coagulation should be assured as normal and serial hematocrits, physical exams and vital signs are monitored. Patients who have significant visible contrast blushes on CT scan should have hepatic angiography for possible angio-embolization. For the highest grade injuries (III, IV) with visible bleeding on CT but a dropping hematocrit, embolization should also be considered as it may avert the need
for surgery. Discussion should be held with the Trauma Attending and Interventional Radiologist.

Patients who remain stable are generally mobilized between 3 days and 1 week depending on severity of injury. Diet is advanced and hematocrit monitoring is decreased to daily. The benefit of follow-up CT scan has not been shown but is done by some surgeons to identify intrahepatic bilomas for further follow-up. Alternatively, a HIDA nucleotide scan at 5 days may identify intrahepatic or extrahepatic collections and aid in timely drainage. Serial liver function monitoring is insensitive and has not been shown to predict complications early on.

Discussion should be held with the Trauma Attending in regards to follow-up studies. There is no standard for “return to activity” after hepatic injury. Patients with significant injuries should probably rest at home for several weeks and then follow light activity only for one to two months.

Unstable patient:

- As noted, diagnosis is made at surgery. Techniques of surgical management of hepatic injury are beyond the scope of this manual. However, for the unstable patient undergoing emergency hepatic surgery, the most common procedure is “damage control” consisting of packing and temporary closure. This is followed by ICU care with correction of acidosis, coagulopathy and hypothermia. Patients who stabilize may, in discussion with the Trauma Attending be considered for secondary angioembolization.

Blunt Renal Injury

Basic Principles:

- Lesser degrees of force delivered to the kidney may disrupt the renal parenchyma to varying degrees. This may result in a perirenal hematoma confined to Gerota’s fascia. In general, peripheral parenchymal injuries do not result in life threatening bleeding, but if the laceration is deeper and hemorrhage escapes Gerota’s fascia, significant retroperitoneal blood loss can occur. More severe degrees of force may also disrupt the more rigid renal pelvis and collecting system resulting in urinary leakage. Additionally, deceleration may stretch the renal artery resulting in intimal tears with possible thrombosis and devascularization of the kidney.
**Diagnosis:**

- Diagnosis and grading is usually made by abdominal CT with IV contrast. The integrity of the blood supply and vascularization of the kidney should be assessed. A delayed or excretory phase study is important to visualize the collecting system and excretion of contrast.

**Treatment:**

- Surgical intervention for renal injury carries a high rate of nephrectomy. Consequently, non-operative management is preferred even with severe parenchymal injuries when at all possible. No intervention may be required if the blood supply is intact, the renal parenchyma is vascularized on CT, and the excretion is intact. Significant urinomas should be monitored by serial hematocrits and follow-up CT scan as necessary. An enlarging urinoma or obstruction of urinary drainage may often be satisfactorily treated by percutaneous nephrostomy. An enlarging retroperitoneal hematoma in association with active extravasation from the kidney on CT (“contrast blush”) can often be treated by angio-embolization. A devascularized kidney in association with a renal artery injury is a definite indication for emergency surgery unless the patient is unstable from other injuries or the warm ischemic time is prolonged. In discussion with the Trauma Attending, Urology consultation may be considered for complex renal injuries. (See consultation guidelines.) Foley urinary drainage and hydration should be maintained until gross hematuria clears.

**Blunt Bowel and Mesenteric Injury**

**Basic Principles:**

- Immediate blunt rupture of colon or small bowel due to compressive force is rare but severe contusion or intramural hematoma can progress to rupture or obstruction. Compression of duodenum or small bowel between a seat belt and the lumbar spine in a motor vehicle collision may result in hematoma or rupture of these organs. Blunt mesenteric injury may be due to direct impact or deceleration with stretch of vessels at fixation points. The consequence of either may be tearing with hemorrhage or thrombosis with segmental devascularization of intestine.

**Diagnosis / Treatment:**
Mesenteric hemorrhage:
- Intra-abdominal hemorrhage is suspected by clinical signs of blood loss (anemia, tachycardia, hypotension, poor capillary refill) abdominal pain and a positive FAST exam. Unstable patients will require surgery. Stable patients will receive a CT scan often showing significant hemoperitoneum in the absence of solid organ injury. A discrete mesenteric hematoma may or may not be visualized. Stable patients may be followed by serial hematocrits and physical exam. Persistently dropping hematocrit is an indication for laparotomy. Unstable patients should be taken promptly to surgery.

Bowel “rupture”:
- Immediate rupture of the colon or small bowel at the time of injury may present as free air on chest x-ray or more commonly on CT scan. Early on there may be significant tenderness or peritoneal signs. In other instances free air is not identified and peritoneal signs may develop over hours. These may be masked if the patient has altered mental status or abnormal hemodynamics due to distant blood loss. Duodenal rupture may have an especially subtle presentation due to its retroperitoneal location. If missed, a more classical picture of sepsis will develop and should prompt repeat CT scanning. The treatment for blunt intestinal rupture is antibiotics and prompt surgery. Small bowel perforation is usually adequately treated by resection, primary anastomosis and peritoneal toilet. Colon perforation may require colostomy. Duodenal perforation is difficult to treat and may require procedures to de-functionalize the duodenum.

Mesenteric thrombosis / bowel hematoma:
- Localized, traumatic mesenteric thrombosis may lead to segmental bowel infarction with local and systemic signs of sepsis developing hours to days later. Sublethal ischemia to bowel may present as ischemic stricture and bowel obstruction up to a week later. Bowel hematoma usually do not obstruct in the colon or small bowel but may do so in the duodenum, particularly in children. As with any obstruction, diagnosis is by CT scan with oral contrast or formal small bowel series. In the multi-trauma patient, these obstructions may easily be mistaken for ileus. Bowel infarction is treated by resection and anastomosis or colostomy as appropriate. Obstruction by
hematoma may initially be treated conservatively with nasogastric drainage and parenteral nutrition. Delayed stricture will require surgical resection.

Blunt Pancreatic Injury

Basic Principles:
- Blunt pancreatic injury can range from minor contusions and peripheral lacerations of the gland to complete transections with pancreatic ductal disruption. “Seatbelt injuries” may injure the pancreas by compression against the vertebral column. The most uncommon and serious form of this injury may involve combined pancreatic and duodenal injury with disruption of the pancreatic head and ampulla.

Diagnosis:
- Patients with pancreatic injury may have abdominal pain, tenderness and peritoneal signs. However, because of the retroperitoneal location of the organ and the immediate nature of trauma evaluation, signs and symptoms may initially be minimal. CT scan may show edema and fluid around the pancreas and may identify significant cracks in the body of the gland. Amylase and lipase will not in initially be elevated. Delayed presentation may be one of abdominal pain and tenderness, sepsis or merely persistent ileus. Amylase may be elevated and delayed CT scan will usually identify the findings described above.

If significant fluid collections are noted around the pancreas on CT, but the gland does not appear completely transected, it becomes important to know the integrity of the main pancreatic duct. This information can often be obtained noninvasively via MRCP (magnetic resonance cholangiopancreatography) in the stable non-ventilated patient. ERCP (endoscopic retrograde cholangiopancreatography) will often permit therapeutic stenting of a ductal injury which may avert the need for surgery.

Treatment:
- Minor injuries with an intact duct, minimal fluid collections and no evidence of abdominal sepsis can be treated conservatively with NPO and parenteral nutrition. Moderate collections can be drained percutaneously under CT or ultrasound guidance. Antibiotics are not indicated unless infection is suspected.

Indications for surgery include complete disruption of the gland with large fluid collection or a ductal injury that cannot be successfully treated by ERCP. Surgical procedures include distal pancreatectomy.
and/or drainage. If there is a contraindication to surgery, these injuries have been successfully managed by a combination of ERCP stenting and percutaneous drainage of collections. The rare combined pancreatico-duodenal injury may need to be treated by staged operative procedures. Complex pancreatic injuries should be managed in discussion with the Trauma Attending and Gastroenterology consultant when appropriate.

5. **SPECIAL CONSIDERATIONS**

**Hypothermia**

**General Principle:**
Hypothermia is defined as a core temperature of less than 35°C. Mild hypothermia in trauma victims is between 36°-34° C. Moderate 34-32°C and cardiac conduction disturbances become apparent. < 32°C is severe hypothermia and the risk of V-Fib increases even further. 57-66% of trauma patients have hypothermia at admission.

**Diagnosis:**
Mortality is almost 100% if trauma patients present with hypothermia < 32°C. These patients require larger resuscitation, more blood transfusions and longer hospital stay. When persistent hypothermia combines with persistent metabolic acidosis, life threatening coagulopathy is imminent. Hypothermia is multifactorial, but it is important to consider that around 12% of trauma patients present with hypothermia, and up to 92% drop their temperatures during initial assessment.

A temperature gradient of 10-15°C between body and room temp can result in important radiant losses. Consequently, we should have a keen awareness of the temperature management at all times.

Direct effects of hypothermia include: platelet dysfunction, increase effect on fibrinolysis, decrease cardiac output, hypotension and fatal arrhythmias (Brady, inversion of T-wave, prolongation of PR, QRS, QT intervals, and J-wave identified as well), depression of medullary respiratory center, bronchospasm, and drop in cerebral blood flow by 6-7% per 1°C drop. Also, pupillary reflex and deep tendon reflexes are lost below 27 °C. Small bowel motility is slowed at temperatures less than 32°C, and below 26.7°C, gastric mucosal erosions, ulcers and pancreatitis develop.
Hypothermia Protocol

- This protocol requires initiation and written order by a MD or MLP and may be overridden by a MD or MLP at any time.
- Rectal temperature probes will be used for patient temperature screening
- Protocol will be considered complete when the patient’s body temperature (BT) is ≥ 37° C (*98.6° F) and is classified as resuscitated by responsible physician.

Exclusion criteria:
- PH <6.5
- Potassium >10 mmol/L
- Signs of severe trauma and temperature <32°C

All other patients may be included even those in traumatic arrest unless the patient has a temperature >32°C

A. Surgical/Trauma Patients

STAGE I PROTOCOL
1. Body Temperature > 36°C (96.8°F) – Institute preventive therapy:
   a. Monitor and record BT upon entrance to each treatment area (ED, ICU, OR and Radiology) and every 20 minutes thereafter.
   b. Remove wet/cold clothing
   c. Apply dry warm linens and clothes
   d. Maximize the room temperature to 85°F
   e. If intubated, warm humidified air (39°C/102.2°F)
   f. If intubated, place an esophageal or rectal probe. PA catheter should be avoided.
   g. Document initiation of Hypothermia Protocol on nursing flow sheet

STAGE II PROTOCOL
2. BT <36°C (96.8°F) >32°C (89.6°F) – Mild/Moderate Hypothermia with perfusing cardiac rhythm:
   a. Use of all of the above
   b. Apply cardiac monitoring
   c. If the patient’s body temperature decreases <36°C (96.8°F), insert an esophageal or rectal thermometer for continuous temperature monitoring
d. Measure blood sugar level and proceed to treat accordingly

e. Use Active External/Rewarming Therapy:
   1. Place convective air blanket (Blair-Hugger® and set at “High”
   2. Place convective warm water under blanket (Blanketrol system®) under and around the patient
   3. Cover patient with aluminum sheet (“Space blanket”)
   4. Warm humidified oxygen (39°C/102.2° F)

f. Use of Active Core Rewarming
   1. Warm all IV fluids and blood products via rapid infuser (42°C/107.6°F) and/or “Hot Line” (40°F) infuser, limit to 2-4 liters of Crystalloids if no associated injuries
   2. Intubate if ventilation and/or oxygenation are not adequate, and proceed to connect the ventilator warmer set at no <37°C and no >40°C
   3. If above measures do not improve the patient’s temperature adequately consider:
      a. Placement of bilateral chest tubes (40FR) and start pleura irrigation with NS.
         Infuse 1 liter at a time alternating sides. (One infusing, the other draining)
      b. Place a peritoneal catheter for rewarming if there are no signs of abdominal trauma history and physical findings and FAST is negative


  g. Document initiation of Hypothermia protocol on nursing flow sheet
  h. Place a Foley catheter, NGT and send ABG, Lytes, Lactate, LFT’s BUN/Cr.
  i. Nursing to document strict I’s and O’s throughout the resuscitation process
  j. DO NOT transport until core temperature is >35°C
STAGE III PROTOCOL

1. **Body Temperature <36°C (96.8°F) > 32°C (89.6°F)** – Moderate Hypothermia with NON PERFUSING cardiac rhythm.
   OR
   **Body Temperature <28°C (82.4°F)** Severe Hypothermia with NON PERFUSING cardiac rhythm
   a. Use all of the above
   b. Intubate the patient and connect to gas warmer/humidifier
   c. Start CPR
   d. Move to the OR for Cardio pulmonary bypass
   e. Document initiation of Hypothermia Protocol on nursing flow sheet

2. **Body Temperature <28°C (82.4°F)** Severe Hypothermia with PERFUSING cardiac rhythm
   a. Treat as a moderate hypothermia
   b. Move to the OR for Cardio pulmonary bypass

**Exclusion Criteria:**
- **PH <6.5**
- **Potassium>10 mmol/L**
- **Signs of severe trauma and temperature <32°C**
- All other patients may be included even those in traumatic arrest unless the patient has a temperature >32°C

**Near Drowning**

**General Principle:**
Near drowning refers to survival of asphyxia from a submersion episode. Up to 15% of drowning patients die from asphyxia without aspirating water into their lungs. This entity is referred to as “dry drowning”. Secondary drowning refers to the delayed onset of pulmonary insufficiency from acute ARDS after a near-drowning episode. The temperature of the water is classified as warm (>20°C), cold (<20°C) and very cold (5°C). Groups at risk are children < 5 and boys age 15-19.

**Diagnosis:**
Type of immersion: Fresh water is hypotonic and rapidly absorbed across the alveoli into the circulation. This causes an increase in blood volume and hemodilution resulting in “hypo-electrolymia” and hemolysis. Conversely, sea water osmolality is 4 times greater. This induces water to be drawn into the alveoli with potential of hemoconcentration, hyperelectrolemia and decreased blood volume. Aspiration of > 11cc/kg is required for blood volume to be altered, and > 22cc/kg for electrolyte imbalances. The average patient aspires between 3-4 cc/kg. In reality, most patients are
intravascularly depleted (hypovolemic) regardless of the type of water.

A combined respiratory and metabolic acidosis caused by hypercapnia and anaerobic metabolism is often encountered. Gas exchange is affected with a minimal amount of fluid aspiration (1-3cc/kg). With resuscitation, the hypercapnia improves, but hypoxia continues, signifying intrapulmonary shunt, progressing to ARDS. V-fib or V-tach and asystole can develop quickly due to the hypoxia and electrolyte imbalance. The extent of brain injury will depend on the duration of hypoxia. Also, immersion hypothermia can occur.

**Management:**

- Any patient with documented LOC, loss of pulse or hypoxia must be admitted for observation.
- BLS/ACLS at scene. At initial resuscitation, associated trauma must be considered, (especially head and neck injuries), and ABC’s evaluated.
- ICU admission will be needed to treat the ARDS that will develop, and the secondary bacterial infection resulting from the aspiration.
- If ischemic brain injury is present, this should be treated with the normal TBI/ intracranial hypertension protocols.

**Trauma in Pregnancy**

**Anatomic/physiologic changes in pregnancy and diagnosis:**

First, one must identify the fetal approximate age. We must take in consideration that the pregnant patient tends to be anemic and hypervolemic. If the patient presents with tachycardia and hypotension, these have to be investigated. If the patient is lying on her back she may have a drop of the cardiac output as high as 30% and in this case, should be placed in left lateral decubitus position. Respiratory changes are primarily related to minute ventilation. Hypocapnia develops after the second trimester and a compensatory metabolic acidosis is seen in these states. The main gastrointestinal finding is the high propensity towards bronchial aspiration for loss of lower esophageal sphincter tone and increased gastrointestinal reflux disease (GERD).
General considerations:
Trauma is the leading non-obstetric cause of maternal mortality. About 6-7% pregnant women will experience some kind of trauma. Please refer to OB/GYN Emergencies and Pregnant Trauma Management Protocol. These patients can be stratified by groups.

- **First group**: injured women who are unaware of their pregnancy. Identification is important for the risk of X-Rays in this age group. The fetus is not monitored when of non-viable age.
- **Second Group**: <22 weeks, resuscitation is aimed towards the mother since the fetus is non-viable.
- **Third group**: >22 weeks. This group need adequate monitoring for the baby and support of the mother.
- **Fourth group**: patients in perimortem stages, early C-section. Pregnant females >22 weeks who do not respond to resuscitation or are in hemodynamic collapse must have emergent C-section within 4 minutes.

Management:
Penetrating trauma is managed essentially the same as for the non-gravid patient. Stab wounds tend to have better prognosis than GSW, and the fetus is more likely to have an injury than the mother. Blunt trauma follows the guidelines for the non-pregnant patient. It should be noted that maternal shock is responsible for 80% of fetal mortality. After ABC’s, place fetal monitor. Fetal tachycardia could be one of the early sings of maternal hypoperfusion. NGT decompression and supplemental O2 should be supplied. If a chest tube is necessary, this has to be placed in the 2nd intercostal space above the normal level. Always avoid a complete supine position, placing the patient in the left decubitus position. Vaginal exam should be performed looking for amniotic fluid or ruptured membranes or incomplete abortion if the fetus is less than 10 weeks. Laboratory studies should attempt to identify DIC secondary to placental abruption. If transfusion is needed O neg blood should be administered. Radiographs should not be deferred because of concern for the fetus. OB-GYN involvement should be obtained as early as possible with attention to possible placental abruption, uterine rupture and the possibility of c-section if the gestation is greater than 26 weeks. If the patient is perimortem, a stat C-section should be performed. Prior to discharge, the patient should be counseled for injury prevention and domestic violence as appropriate.
OB/GYN EMERGENCIES AND PREGNANT TRAUMA MANAGEMENT PROTOCOL

INTRODUCTION:

Although the arrival of a pregnant trauma patient can be an emotionally charged situation, the health care team should avoid distractions and the urge to focus on the fetus before adequate assessment and stabilization of the mother. The secondary diagnosis of pregnancy should not generally alter the routine trauma resuscitative procedures and interventions. However, recognizing that the apparently stable mother may be compensating at the expense of the fetus does justify an aggressive approach to evaluation and resuscitation.

If delivery of a child occurs, the Pediatric Surgery Attending should be notified.

PURPOSE: To expeditiously provide comprehensive trauma and obstetric care to those injured women who are pregnant

PROTOCOL:
The following protocol should be used for emergent OB/GYN ED consults and ALL trauma patients with a viable pregnancy:

OB/GYN residents are in-house at the University Campus from 0800 - 1700, Monday through Friday only. From 1700 - 0800 Monday through Friday, and 0800 - 0800 on Saturdays, Sundays and holidays the OB/GYN ONCOLOGY resident will provide coverage for OB/GYN emergencies (including pregnant trauma patients) from the Memorial Campus. There is also an OB/GYN Attending on call for the University Campus ED from home during these same times.

I. TRAUMA: As soon as it is known at the University Campus that a pregnant trauma patient with a known or suspected gestation of > 20 weeks is expected to arrive, the Memorial Labor and Delivery Charge RN wireless phone (508-421-1000) should be called by the University Campus ED Resource Nurse:

A. All available clinical information should be communicated

B. Request that the OB/GYN ONCOLOGY resident on call be paged and respond immediately to the University Campus

C. Request that a Memorial Campus Labor & Delivery RN respond as soon as possible to provide fetal monitoring
*If there is no answer on the L&D Charge RN wireless, call the L&D unit directly at 508-793-6311 and ask for the Charge RN.

II. The L&D Charge RN will:
A. Page the OB/GYN Oncology resident on call and advise him/her to go immediately to the University Campus.
B. Initiate arrangements to provide a Memorial Campus L&D RN to provide fetal monitoring in trauma patients. *Continuous fetal monitoring is required for all trauma patients with a > 20 weeks gestation.

III. The OB/GYN Oncology Resident on call will:
A. Respond to the University Campus immediately. *They may use the parking space in ED lot designated for “Trauma Physician”.
B. Determine a preliminary, approximate gestational age; confirm presence or absence of fetal heart rate (FHR); initiate placement of fetal monitor (if OB resident is present prior to patient’s arrival); provide interpretation of fetal monitor tracings continuously until the arrival of the Memorial L&D RN. If further obstetrical evaluation determines the fetus to be pre-viable, any further fetal monitoring needs will be determined by the OB/GYN consultants. Provide input and make recommendations for obstetrical clinical management and support of the mother and fetus.
D. Notify the Attending Neonatologist at the Memorial Campus neonatal ICU (NICU; 508-793-6581) of all consults so that the NICU can prepare for any potential deliveries/transfers.

IV. The OB/GYN Attending On Call (for University Campus) will:
A. Respond to the University Campus if requested to so by the Emergency Medicine Attending, Trauma Chief Resident, Trauma Attending Surgeon and /or OB/GYN Oncology Resident.
B. Notification of the OB/GYN Attending on call to respond is the responsibility of the University ED.

RESUSCITATION MANAGEMENT RESPONSIBILITIES:

I. University E.D. M.D. (Trauma Chief Resident / EM Attending):
The MD in charge of the trauma resuscitation will be responsible for obtaining a doppler fetal heart tone/rate immediately following the primary survey and after maternal life saving interventions are completed.
II. **University ED RN:**

The ED RN will place the fetal monitor (kept in ED) on immediately following primary survey and MD evaluation of FHR to monitor fetal heart rate (and store tracings) until the arrival of the OB/GYN resident or L&D RN. A FHR should be documented manually or by monitor every 5 minutes.

The Memorial Campus L&D RN role is to provide fetal monitoring ONLY. There must be a written order for “continuous fetal monitoring” in the admission orders. Discontinuation of fetal monitoring also requires a written order, either by the Trauma Team or OB/GYN.

**Emergent Delivery:**

- Emergent caesarean section deliveries will be performed in the Operating Room by the OB/GYN service. The O.R. should receive as much advance notice as possible.

- Resuscitation and evaluation of the neonate will be provided primarily by the Memorial Campus neonatal ICU physician / nurse practitioner (call 793-6581), with backup provided by the University PICU Resident/Attending. The NICU Attending will take responsibility for providing MD / NP attendance at the delivery.

- Both the NICU and PICU attendings should receive as much advance notice as possible to arrange resuscitation and transport of the neonate to the Memorial Campus NICU.

- It is the responsibility of the OB/GYN Oncology resident on call to notify the ICU Attending of the status of the mother/fetus on all consults.

**Admission / Discharge/ Transfer of Pregnant Trauma Patients:**

A. All pregnant trauma patients requiring hospitalization for observation and / or management of traumatic injuries should be admitted to the Trauma Service at the University Campus, with OB/GYN consultation. The Memorial L&D RNs will be responsible for providing ongoing fetal monitoring on a shift by shift basis.
B. In the ABSENCE of ANY traumatic injuries or issues (and after a reasonable period of observation), the decision to transfer to the Memorial Campus (or any other facility) for further obstetrical observation and/or treatment, is made between the Trauma Attending surgeon, OB/GYN Attending and the patient’s private obstetrician. There must be a receiving OB ATTENDING who will assume responsibility for coordinating prenatal needs at that facility. Contact should also be made between the Trauma Team and a Trauma/General Surgery Attending at the receiving facility to serve as a consultant for any new trauma issues.

C. Arrangements for transfer, (and doppler fetal monitoring during transfer if necessary per OB/GYN) are the responsibility of the managing service (i.e. Trauma or EM) and the OB/GYN resident and Attending.

D. Pregnant trauma patients should not be discharged from the hospital (ED or inpatient) without OB/GYN consult input, as well as private obstetrician notification for follow up care.

PREGNANT TRAUMA: RADIOGRAPHIC IMAGING AND DIAGNOSTIC STUDIES

Special precautions must be taken for radiographic imaging procedures of pregnant patients. The radiation dose can be effectively minimized by limiting the images of the abdomen, however, in emergency situations the diagnostic information necessarily obtained outweighs the radiation risk.

Radiation dosimetry information should be obtained on all trauma patients known to be or, in particular, those discovered to be pregnant after radiologic studies have been done.

I. Plain Film Radiographs

A) All pregnant trauma patients may, and should have (as indicated by protocol), cervical spine, chest and emergent extremity films with negligible radiation to the conceptus occurring. Subspecialty consultation (i.e. Orthopedics, Plastics) should be involved to assist in decision making for obtaining questionable “emergent” films (i.e. extremities, pelvis, lumbar spine).

B) Special consideration should be given to pelvic and lumbar spine films. There is a small but significant risk to the conceptus for these films. Therefore, judicious use of both the need for and the number of views taken should be priority. Shielding of the abdomen with lead is required for all radiographic procedures, except where it will interfere with the image (the radiologist should make this
determination). The Trauma Chief / Attending and OB/GYN resident should be involved to assist in decision-making for obtaining pelvic, abdominal and lumbar films.

The scout film radiographs at the CT scan (if needed) will often provide adequate radiologic information and reduce exposure by 30-60%. This should be considered in the non-emergent evaluation of the pelvis and lumbar spine.

I. Ultrasound / CT Scan / Diagnostic Peritoneal Lavage

**Less than 20 weeks gestation:** Order of consideration

1. Ultrasound study performed to visualize the peritoneal cavity for the presence of blood or fluid and the viable fetus.

2. Diagnostic peritoneal lavage (see specific technique under “Diagnostic Peritoneal Lavage”)

3. CT Scan: OB/GYN resident or attending should be notified in the non-emergent case. In excluding intraperitoneal hemorrhage ultrasound and diagnostic peritoneal lavage should be the first considerations in evaluation.

**Over 20 weeks gestation**

1. Obtain ultrasound to visualize placenta

2. CT scan as needed in the emergent situation, however, in-house OB/GYN resident should be consulted prior to radiologic evaluation in the non-emergent scenario.

**Strangulation**

An act of strangulation is designated life-threatening if the forensic specialist finds signs of severe strangulation resulting in cerebral hypoxia, such as:

- Congestion and hemorrhage in the conjunctiva and the facial skin
- Report of loss of consciousness
- Uncontrolled loss of urine while being strangled.
Other clinical signs are:

- Abrasions, lacerations, contusions, or edema of the neck, depending on how the patient was strangled
- Subconjunctival and skin petechiae cephalad to the site of choking (Tardieu spots)
- Severe pain on gentle palpation of the larynx, which may indicate laryngeal fracture
- Mild cough
- Stridor
- Muffled voice
- Respiratory distress
- Hypoxia (usually a late finding)
- Mental status changes

CT scan and MRI can give objective clues. In strangulation by hanging, the primary signs are the presence of a strangulation mark and underlying subcutaneous dissection. The absence of either of these findings excludes hanging. In case of severe strangulation the two main signs are subcutaneous and intramuscular hemorrhage.

Management:

- Assessment and treatment of airway status and breathing is paramount
- Unless the patient experiences volume loss, fluid restriction is prudent to help prevent ARDS and cerebral edema.
- Monitor the patient for cardiac arrhythmias.
- Tracheal intubation may be required emergently with little warning.
- Cricothyroidotomy is indicated for any patient with airway deterioration, should endotracheal intubation be unsuccessful.
- Alternately, percutaneous translaryngeal ventilation may be used to temporarily ventilate a patient
- ENT and Psychiatry consults

Traumatic Asphyxia

General considerations:
This is a type of asphyxia caused when ventilation is compromised due to external forces over the chest or upper abdomen making respiration impossible (eg. building collapse, car falling on the chest, avalanches). It is also called “mechanical fixation of the chest”.
**Diagnosis:**
Physical findings are petechiae in the face resulting from chest compression. This pressure interferes with venous return of blood to the heart. Impaired venous return in combination with continued arterial supply causes venous and capillary engorgement, leading to rupture of small vessels particularly in areas with little adjacent connective tissue support (eg, the conjunctivae and eyelids). Other findings are purple coloration of the face, cervico-facial edema, thoracic subcutaneous hemorrhages, rib fractures, hearing loss due to edema of the eustachian tubes, and vision loss due to retinal hemorrhages (Purtscher's retinopathy).

**Management:**
For victims found alive, the process often resolves with ventilatory support for several days. Pulse oximetry is often inaccurate due to edema of upper extremities. Other problems are the possibility of upper airway edema and fiberoptic intubation or surgical airway may be needed.

**Syncope**

**General considerations:**
Patients who fall constitute a small percentage of overall trauma admissions (20.7%). Elderly patients usually fall from standing and have higher mortality than their younger counterpart. Syncope has been associated with poor prognosis, especially if it is secondary to cardiac abnormality in which case mortality ranges from 18.5-33%. If in the mechanism of the trauma there is no “mechanical” explanation such as tripping or equipment breaking, the patient should undergo a syncope work up.

**Diagnostic modalities:**
- ECG, cardiac monitoring (Holter), Echocardiography, electrophysiology studies (EPS), and tilt-table testing. Also for the non-cardiac syncope cases EEG and carotid duplex should be added. The important factor here is the mechanism of the trauma and the deficits present on the patient.
- Echo: if chest injury is involved or there is high suspicion of cardiac etiology
- EEG: if seizure activity is identified
- Carotid duplex: when a neurologic reason is sought after cardiac reasons have been ruled out.
- Tilt-table testing: if balance/hearing problems are identified
- Neurology consults (CNS etiology)

When the etiology of syncope is identified, the correct consultation should occur. If trauma issues have been resolved, the patient should
be transferred to the appropriate service to manage the cause of the syncope, usually Medicine (Cardiology) or Neurology.

**Rectal Injuries**

**General Considerations:**
Anatomy of the rectum is crucial to the analysis of the rectal injuries. The rectum is about 15cms long and extends from the rectosigmoid junction to the anus. The most important aspect of the rectal anatomy is the serosal coverage; the upper two-thirds of the rectum has serosa on the anterior and lateral walls, whereas the lower one-third lacks serosa circumferentially and the posterior rectum is completely without serosa.

**Diagnosis:**
Physical exam, CT scan, and definitive diagnosis will be determined with intraoperative exploration of the rectum. If the patient is unstable, suspicion of intraperitoneal injury is high and exploratory laparotomy should be performed, checking the intraperitoneal section of the rectum. Then the extraperitoneal section should be evaluated using a rectal speculum or any other rectal retraction device. A straight sigmoidoscope can be used in order to visualize the upper rectum.

**Management:** The repairs consist of distal wound suture repair, distal washout, fecal diversion (colostomy), and presacral drainage. In extraperitoneal rectal injury, the wound may not be visualized and repair is not necessarily needed if washout and diversion are done. When the injury is intraperitoneal, primary repair is done with or without fecal diversion depending on the time and contamination.

**Venous Thromboembolism in Trauma Patients**

**General Considerations:**
- There is evidence to support the presence of risk factors of post-traumatic VTE; these are spinal fracture and spinal cord injuries. Older age also is a factor but is not clear at which specific age the risk increases, some low powered studies have shown >55 y/o to be the starting point. There is inadequate literature/evidence to support other factors such as lung-bone fractures, pelvic fractures or head injuries as increasing the risk of VTE.

**Diagnostic Modalities:**
- Ultrasonography (Duplex of the LE veins) can be used in symptomatic patient to assess for suspected DVT without
confirmatory venogram. It is easy to visualize the CFV, proximal SFV and popliteal veins. It can be difficult to visualize the SFV in Hunter’s canal and also to detect calf DVT’s. An acute DVT is identified by the presence of dilated vein, lack of compressibility and absence of Doppler flow sounds. In symptomatic patients, this mode has a sensitivity and specificity of 96%.

- Hand-held Doppler ultrasound may be used to assess symptomatic trauma patients with suspected DVT. Confirmatory venogram may be needed in patients who screen positive for DVT.
- Serial duplex US imaging of high risk, asymptomatic trauma patients to screen for DVT may be cost-effective and decrease the incidence of PE. Reports are variable in their success rates.
- Venogram. Ascending venogram should be used as a confirmatory study in those patients who have equivocal ultrasound for DVT.
- Ascending venogram should not be used to screen asymptomatic trauma patients at high risk for DVT. There may be a role for ascending venography in research studies on the incidence of DVT in trauma patients (Level II recommendation).
- Magnetic resonance venography may have a role in diagnosing acute DVT in the trauma patient, especially with clots in the calf and pelvis (areas where venography and ultrasound are less reliable). (Level III recommendation).

**Management:**

- **Use of Low Dose Heparin (LDH) for DVT/PE prophylaxis**

LDH significantly decreases the incidence of DVT from 25%, in patients with no prophylaxis, to 8.7% in treated patients; Similarly PE was halved by LDH treatment (0.5% in treated patients compared to 1.2% in controls). Major hemorrhage is higher in treated patients (1.8% vs. 0.8%) but is not statistically significant. Minor bleeding complications are more frequent in LDH treated patients (6.3 vs. 4.1%, P<0.001).

Trauma patients with high risk for VTE are severe closed head injury (GCS<8), pelvic fractures, plus long bone fractures, multiple long bone fractures, and spinal cord injury. There is no strong evidence supporting usage of LDH in any other kind of trauma patients.
Role of Low Molecular Weight Heparin (LMWH) in Venous Thromboembolism (VTE) Prophylaxis in trauma patients.

In trauma patients, LMWH has better efficacy than unfractionated heparin (UH) and similar efficacy to sequential compression, with similar bleeding risk when used for VTE prophylaxis. In addition it is more cost-effective than Standard Heparin taking into account the reduction of DVT and the ability to administer LMWH without following coagulation.

LMWH has a Level II recommendation for VTE prophylaxis in trauma patients with these injuries:

- Pelvic fractures requiring operative fixation or prolonged bed rest (>5 days)
- Complex lower extremity fractures, (defined as open fractures or multiple fractures in one extremity) requiring operative fixation or prolonged bed rest (>5 days)
- Spinal cord injury with complete or incomplete motor paralysis. The use of LMWH is predicated on the fact that these patients do not have other injuries that put them at risk for bleeding.

Level III recommendation for the use of LMWH are:

- Trauma patients with an ISS>9, who can receive anticoagulants, should receive LMWH as their primary mode of VTE prophylaxis.
- The use of LMWH or oral anticoagulants for several weeks post-injury should be considered in patients who remain at risk for VTE (elderly pelvic fracture patients, spinal cord injury patients, patients who remain at prolonged bed rest (>5 days), and patients who require prolonged hospitalization or rehabilitation).LMWH has not been sufficiently studied in the head-injured patient with intracranial bleeding to justify its use at this time.
- LMWH should not be used when epidural catheters are placed or removed.

LMWH should be the standard form of VTE prophylaxis in trauma patients with complex and lower extremity injuries as well as spinal cord injuries.
Role of the Vena Cava Filter in prophylaxis and treatment of PE

Indicated on patients with ongoing bleeding or those with recent brain, spinal cord or ocular injury who will not tolerate even minor amounts of bleeding. Also, these patients often have multiple lower extremity fractures which preclude the use of sequential compression devices.

Level I recommendations supports the usage of vena cava filters for:

- Recurrent PE despite full anticoagulation
- Proximal DVT and contraindications to full anticoagulation
- Proximal DVT and major bleeding while on full anticoagulation
- Progression of iliofemoral clot despite anticoagulation (rare)

Level II recommendations indicate the usage of vena cava filter placement in patients with established DVT or PE:

- Have a large free-floating thrombus in the iliac vein or IVC
- Following massive PE in which recurrent emboli may be prove fatal
- During/after surgical embolectomy.

Level III recommendations for prophylactic vena cava filters are issued in very high risk trauma patients.

- Those who cannot receive anticoagulation because of increased bleeding risk, and have one or more of the following injury patterns:
  - Severe head injury (GCS<8)
  - Incomplete spinal cord injury with para or quadriplegia
  - Complex pelvic fractures with associated long-bone fractures
  - Multiple long-bone fractures.

Patients with high risk for bleeding complications for 5 to 10 days after injury include those with intracranial hemorrhage, ocular injury with associated hemorrhage, solid intra-abdominal organ injury, and/or pelvic or retroperitoneal hematoma requiring transfusion. Also, patients with cirrhosis, active peptic ulcer disease, end-stage
renal disease, and coagulopathy due to injury or medication, or congenital coagulopathies.

Complications with the Greenfield filter indicate that it has a patency rate of about 96%, a recurrent PE rate of 3% to 5%, and a caval penetration rate of about 2%.

There is no data to date to support the liberal usage of retrievable filters, mainly due to technical problems with the retrieval process. Future work may clarify the indications for this relatively new modality.

Role of Sequential Compression Devices (SCD) in the Prevention of DVT/PE

SCD's have been shown to increase the mean and peak femoral venous blood velocities on the lower extremity. Additionally, they have shown to have direct effect on the fibrinolytic pathway, acting to shorten the euglobulin lysis time, increase levels of coagulation cascade inhibitor molecules, as well as affecting the balance of plasminogen activation.

Level III recommendations indicate that SCD's are to be used:

- In the subset of spine-injured head-injured patients, SCD may have some benefit in isolated studies.
- For patients in whom the lower extremity is inaccessible to place SCD's at the calf level, foot pumps may act as an effective alternative to lower the rate of DVT formation.

Role of A-V Foot Pumps in the Prophylaxis of DVT/PE in the Trauma Patient

The A-V pump was designed to mimic the venous pump on the sole of the foot that consists of a plexus of veins that fills by gravity and empties upon weight bearing, increasing femoral blood flow without muscular assistance. The major advantage of this system is that it only requires access to the foot which enables the use in patients with casts, external fixators, etc.

Level III recommendations have been issued for A-V foot pumps for the usage as a substitute for SCD's in those high risk patients who cannot wear SCD's due to external fixators or casts.

Small clinical series in elective orthopaedic patients support the use of A-V foot pumps to prevent DVTs. A non-randomized trial of 184 patients who could not received SCD because of lower extremity
injuries were placed in A-V foot pumps. Overall there was no significant difference in DVT rates between the two groups with SCD at 7% and A-V foot pumps at 3%. Therefore A-V foot pumps are a reasonable alternative for SCD’s.

**Burn Resuscitation: End Points**

**Goal** – maintain vital organ perfusion including the skin

As in any trauma resuscitation the “ABC’s” need immediate attention:

**Airway**
- Ensure airway is protected and supplemental oxygen supplied
- Mechanism or sign of inhalational injury: monitor carefully for stridor and/or neck and airway swelling, consider intubation if being transferred and has signs of airway compromise
- Remember: inhalational injury increases fluids necessary for resuscitation
- Chest wall burns: may make breathing difficult or necessitate higher airway pressures to adequately ventilate: Escharotomy may be needed.
- NG tube: decompress the stomach to prevent vomiting, aspiration

**Breathing**
- Chest x-ray
- Ensure adequate/appropriate ventilation
- ABG: unexplained acidosis: think of carbon monoxide/cyanide poisoning

**Circulation**
- Ensure adequate, large bore IV access early
- Avoid placing IV catheters through burn sites if at all possible
- Chart fluid losses/IV fluids given early and accurately
- Try to avoid femoral and brachial lines, especially in children

**Depth of Burns**
- Calculate, using Lund & Browder chart, total body surface area (TBSA) burned, including only second and third degree burned areas
- Protection/restoration of adequate circulation is key to preventing burn wound extension and deepening
Extent of Injuries

- Consider the mechanism of injury: Concurrent blunt/penetrating trauma may be possible, perform appropriate exams/imaging
- Consider co-morbidities in establishing monitoring necessary to safely and adequately resuscitate the patient

Determining Fluid Administration for Burns

- Fluids are given in the first 24 hours to replace the intravascular leak
- Burns >20% TBSA require fluid resuscitation more than maintenance based on calculated amounts (see below) while monitoring urine output and other signs of resuscitation
- Adult Burns <20% TBSA can be managed with oral or maintenance IV fluids. (<10% TBSA in pediatric burns) if airway is not involved
- Lactated Ringer with/without normal saline is the fluid of choice due to the extracellular losses (Na)
- D5LR at maintenance rates is used for pediatric burn patients, with “losses” replaced by NS, LR or ½ NS as necessary.
- Estimate the TBSA of burn injury by using the Lund and Browder method. This method is fairly accurate for burn wound size, estimate both adult and pediatric (see chart in the Trauma Room)
- Only second degree (partial thickness) and third degree (full thickness) burns are estimated for the TBSA
- The Parkland formula is used as a guide to fluid resuscitation (4ml LR/kg weight/TBSA in adults. For the pediatric burn: 2-3ml/kg/%TBSA for the burn + D5%LR maintenance rate)
- Give ½ of the calculated value over the first 8 hours (from the time of injury) and give the second half over the next 16 hours.
- This formula is a guide only; fluids are titrated to patient’s response of urine output and other signs of adequate resuscitation: base deficit, pulse rate, lack of acidosis, lactate clearance. Urine output should be 0.5-1.0 ml/kg/hr.
- This formula should be modified with additional fluid for patients with inhalation injury, electrical injury or delayed fluid resuscitation
- Elderly patients and pediatric patients should be 1.0 – 1.5ml/kg/hr
- Electrical burn patients with myoglobinuria should have a urine output of 1 cc/kg/hour.
Colloids, including fresh frozen plasma and albumin, are sometimes used after 12 to 18 hours.

Mannitol can be considered, especially in electrical burns, but if used, adequate resuscitation cannot be measured by urine output.

The 2nd 24 hours:
- 5 or 25% albumen (colloid) is added to maintain intravascular volume and tonicity. DO NOT USE HESPAN.

**Modify resuscitation** if the patient is requiring much more than the calculated amount to avoid overwhelming the patient’s heart, lungs and abdominal compartment syndromes. Patients for whom one must particularly avoid too much fluid are elderly and infants. Hypertonic solutions may be used. The most common is Lactated Ringers with 2 amps of sodium bicarbonate. Closely monitor urine output, electrolytes and signs of tissue acidosis. Invasive monitoring may be required if the patient is not responding as expected. Discuss with Trauma Attending for approval.

**Inhalation Injury**
Suspect inhalation burns when there is a history of smoke exposure, victim of closed space fire, burns to the face, singed nasal hairs, singed eye lashes, and/or carbonaceous sputum.

**Goal** – Maintain patent airway

1. Upper airway burns
   - direct thermal injury
   - risk for obstruction due to edema of the tongue and mucosa
   - onset of signs and symptoms is usually delayed as resuscitation and edema progresses

2. Lower airway burns
   - toxic chemicals
   - impaired gas exchanged
   - onset may be delayed: progressive hypoxia, loss of compliance

3. Carbon monoxide
   - carbon monoxide binds with the Hgb which decreases O2 delivery to the tissues
   - Suspect if:
     - closed space fire/smoke
     - unexplained blunted mental status
     - unexplained tissue acidosis
     - ischemic EKG
O₂ saturations are not reliable as they will be normal despite high levels of COHgb.

must be specifically measured from a blood sample or through a transcutaneous CO-Oximeter.

carboxyhemoglobin clinical
level (%) manifestations
<10 none
15-25 nausea, headache
30-40 confusion, stupor, weakness
40-60 coma
>60 death

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Treatment
- 100% oxygen
- early intubation (if unable to protect airway)
- hyperbaric oxygen: if mental status changes, pregnancy, tissue acidosis (transfer to a hyperbaric program)

Thermal Burns
- TBSA estimated by using the Rule of 9s (in the field) the
- Lund and Browder method (in the Trauma Room)
- Depth of the burn wound is rarely accurate on admission due to the progression and deepening of the wound over the next 24-48 hours

Burn depth:
1. Superficial (first degree)
   - epidermis
   - sunburn
   - mild pain
   - heals within 48-72 hours

2. Partial thickness (second degree) epidermis and partial dermis
   - superficial partial thickness, painful blister, healing within 14 days
   - deep partial thickness red, white appearance +/- blisters, diminished pain. Healing time long and may require surgery

3. Full thickness (third degree) epidermis and dermis involvement
   - painless
- no signs of bleeding
- shiny, leathery, charred appearance
  requires excision and grafting for healing

4. Fourth degree through skin and subcutaneous fat and into underlying muscle, bone or organs

Treatment of Thermal Burns:
1. Remove all clothing, jewelry, contact lenses
2. Wash with “Shur Clens” and rinse with NS
   (or water if using the spray table)
3. Remove all loose skin; leave blisters intact if firm,
   debride only if function and ROM are compromised
4. Irrigate the eyes as needed with copious amounts of NS
5. Cover with a dry sterile sheet or dressings if transferring the patient
6. Dressings for treatment: topical agents
   a. Aloe – used in conjunction with other topicals in the first 24 hours on superficial burns
   b. Bacitracin used on superficial burns, usually the face
      May need frequent reapplications due to dryness
   c. Silver Sulfadiazine (Silvadene)
      - Use for partial and full thickness burns
      - Applied daily or twice a day
      - Avoid use in the oral area due to potential for staining of mucosa
   d. Mafenide Acetate (Sulfamylon)
      - Use on deep partial or full thickness burns
      - Use on nose and ears
      - Penetrates eschar
      - Painful
      - Can cause a metabolic acidosis
      - used on small areas only or diluted with sterile water
   e. Other burn wound coverings
      - Acticoat (silver impregnated and remains on for several days)
      - Biobrane: use on clean second degree burns.

- Compartment syndrome:
  - monitor pulses in areas with circumferential burns
  - full thickness eschar on the trunk can lead to impaired ventilation
  - increase in airway pressures: lowers compliance
- if on pressure controlled ventilation, and TV’s falling on same pressure consider compartment syndrome

- If on volume controlled ventilation: rising airway pressures to deliver the same volume
- Non intubated patient: increase in difficulty breathing;
- Tachypnea, “air hunger”
- Treatment: escharotomy
- Do not wrap burn skin to burn skin
- Wrap hands lightly with net dressing to promote range of motion
- Elevate all burned extremities
- Adhere to gowns, masks, hats and glove precautions for burns >20% TBSA
- All wounds must be washed and cleaned, removing all old topicals and loose skin before new topicals are reapplied
- NO prophylactic antibiotics

Chemical Burns
- Two types: acidic or alkalis extent depends on concentration of chemical and the duration of exposure
- Chemical solids/powders should be brushed off, not irrigated
- Irrigate all other chemicals with warm water until pain diminishes
- For eye involvement, irrigate well with NS
- Special consideration – Hydrofluric acid
  - HFA burns are very painful irrigate well
  - chemical with an antidote – Calcium Gluconate
  - topically apply 2.5% Calcium Gluconate gel to wound
  - Sub Q - ½ ml/10% sol Calcium Gluconate/square cm TBSA
  - IV – 10mls/10% sol Calcium Gluconate + 5,000 units of Heparin in 40mls of D5W
  - Intra arterial (radial or brachial artery) – 10% Calcium Gluconate in 40mls of 5% Dextrose
    - can cause hypocalcemia
    - draw serial calcium levels
    - treat EKG changes consistent with hypocalcemia
    - (prolonged QT interval) with IV calcium treated in an ICU
Electrical Burns

- Most of the injury is beneath the skin surface
- Current generates intense heat and electromagnetic field which cases muscle, nerve, blood vessel and bone damage. The path is unpredictable
- Arc causes flame burn, energy has dissipated. Associated trauma is common
- Low voltage injury <1000 vol
  - cardiac dysrhythmias
  - skeletal muscle contractions
- High voltage injury >1000 volts
  - extent of tissue and muscle damage can be underestimated

Treatment of Electrical Burns

- EKG monitoring
- Telemetry for 24hrs
- Serial CPKs
- Wound care
- Myoglobinuria (muscle breakdown excreted in urine)
  - Increase fluids to maintain urine output >1cc/kg/
  - if unable to maintain urine output consider use of
  - Mannitol or Bicarb (check with the Trauma Attending first)
  - Entrance wound – point of contact with the electrical source
  Exit wound – point of contact at the ground site, current comes to the surface
- Monitor pulses in the extremities for possible Compartment Syndrome
- Early debridement and excision

Special considerations in Burn Treatment

- No prophylactic antibiotics are given
- Burn wound sepsis >48 hrs, diagnosed by quantitative wound culture >105 organisms/gm of tissue
- Suspicion of airway burn – intubate
- Early enteral nutrition (ie., within first 24 hrs); burn patients are extremely hypermetabolic
- Pain control
- Positioning and splinting of affected limbs, early OT/PT
- Specialty bed may be considered
• Tetanus prophylaxis
• Stress ulcer prophylaxis
• DVT prophylaxis (sub Q Heparin unless contraindicated)
• Consider beta blockade in resuscitated pediatric burns
• Check with the Trauma Attending first

Special considerations in Burn Treatment

• No prophylactic antibiotics are given
• Burn wound sepsis >48 hrs, diagnosed by quantitative wound culture >10^5 organisms/gm of tissue
• Suspicion of airway burn – intubate
• Early **enteral nutrition (ie. within first 24 hrs);** burn patients are extremely hypermetabolic
• Pain control
• Positioning and splinting of affected limbs, early OT/PT
• Specialty bed may be considered
• Tetanus prophylaxis
• Stress ulcer prophylaxis
• DVT prophylaxis (sub Q Heparin unless contraindicated)
• Consider beta blockade in resuscitated pediatric burns
• Check with the Trauma Attending first
7. PEDIATRIC TRAUMA CARE AT UMASS MEMORIAL TRAUMA CENTER

The appropriate management of traumatically injured children requires a sound knowledge of developmental norms and age appropriate clinical parameters and responses, as well as how these responses are altered in the face of trauma. This knowledge, tempered with experience, good clinical judgment, compassion, and sensitivity best serves the pediatric trauma patient. The Trauma Team is encouraged to utilize the knowledge and experience of our Pediatric EM and Critical Care physician and nursing colleagues in dealing with injured children.

Pediatric trauma care at the University Campus is the responsibility of pediatric surgeons who deal exclusively in the surgery of children. Pediatric patients are not admitted to the Memorial Campus. The Trauma Team, under the direction of the Attending Pediatric surgeon, provides the initial resuscitation and ongoing management of pediatric trauma patients. Pediatric trauma patients requiring critical care management are admitted to the Pediatric ICU under the direction of an Attending Pediatric Surgeon with close collaboration of the Pediatric Critical Care team.

The current definition of a “pediatric” trauma patient is one who is less than age 18 years of age (including infants).

The operational protocol for the resuscitation and admission of pediatric burns is the same as for adult burn patients. In general, an isolated pediatric burn patient may be admitted to the Plastic Surgery Burn/Wound Service with on-going consultation by the Trauma Team as necessary. Burn injuries with associated traumatic injuries are admitted to the Trauma Service with Plastics/Burn consultation. Burns encompassing body surface area of >20% are stabilized and transferred to a dedicated burn center.

The operational protocol for the resuscitation and admission of pediatric spinal cord and head injuries is the same as on the adult service. Initial stabilization and clinical management occurs in the trauma bay, under the direction of a Pediatric Surgeon, Neurosurgical and/or Orthopedic consultants, with eventual transfer to a pediatric rehabilitation facility specializing in spinal cord and/or traumatic brain injuries.
A. ROLES & RESPONSIBILITIES FOR THE PEDIATRIC TRAUMA SERVICE

Trauma Chief Resident:

- Holds responsibility for the overall management of pediatric trauma patient from initial resuscitation through transfer to the Pediatric Surgery Service. Responds immediately to pediatric traumas and “trauma alerts” (consults) in ED, serving as Team Leader under the direction of the Attending Pediatric Surgeon.
- Facilitates any inter-service transfers by speaking with the accepting Attending physician.

Pediatric Surgery Chief Resident:

- Makes daily AM rounds with the attending Pediatric Surgeon and PICU team to formulate a plan of care for the day for pediatric trauma patients. Transfers out of the PICU must be cleared with the Attending Pediatric Surgeon. Daily progress notes in the PICU will be written, outlining plan of care.
- Makes daily AM rounds with the Pediatric Surgeon on the pediatric trauma floor patients. Directs daily plan of care and delegates tasks to specific individuals to follow up and report back to him/her.
- Makes himself/herself available to communicate plan of care with patient’s family on a daily basis.
- Ensures that all x-rays, CT’s, labs, etc. are performed and reviewed in a timely manner. Ensures that appropriate consults (i.e. PT, OT, speech, nutrition, subspecialties etc.) are written and results reviewed.
- Completes, or delegated completion of discharge documents. Should coordinate follow-up visits.
- Can be called upon to perform as the Trauma Chief Resident whenever the Trauma Chief Resident is otherwise occupied or unavailable.
Other Trauma Team Member Responsibilities:

- These team members include other residents rotating from the Emergency Medicine department, other surgery residents on the Trauma Service, other residents on the Pediatric Surgery Service, and the Pediatric Trauma Program Manager.

Residents on the Trauma Service respond to all pediatric trauma resuscitations immediately. Patient care responsibility is then assumed by the residents on the Pediatric Surgery Service. Collectively, these individuals perform tasks as outlined in previous sections and/or delegated by the Trauma Chief Resident, which include but are not limited to:

1. Review all x-rays and CT’s with pediatric radiologist in AM on day after admission.

2. Coordinate and document clearance of C-spines and all other x-rays as per protocols.

3. Initiate and follow up on all consults including PT, OT, SS, nutrition, subspecialties, etc. on all patients.

4. Complete discharge summary and discharge attestation forms.

5. Coordinate transfers to rehabs units, or follow up visits with Case Manager.

Any changes in the plan of care must be cleared through the Trauma Chief Resident or Pediatric Surgery Chief Resident.

Residents on the Pediatric Surgery Service attend daily patient rounds on the pediatric trauma floor (5East).

Pediatric Trauma Program Manager:

- Coordinate all aspects of discharge planning for pediatric trauma patients.

- May respond to pediatric trauma resuscitations as able

- Communicates with patients’ pediatricians.

- Coordinates communication between families, patients and other providers.
- Facilitates regularly scheduled Pediatric Trauma Quality Assurance (QA) meetings.

- Represents the Pediatric Trauma Service at monthly combined Pediatric and Adult Performance Improvement (PI) meetings.

- Facilitates quarterly Multidisciplinary Pediatric Trauma (Multi-D) meeting.

**Trauma Service Alcohol and Drug Referral Program (>14 Years)**

Any Trauma Service patient with a positive serum ETOH/drug toxicology screen should be referred to the Trauma Case Manager and/ or Social Worker for evaluation and possible referral for treatment. Remember: information concerning ETOH/Toxicology screen results is strictly confidential and may not be shared with anyone without the patient’s consent.

The treatment of individuals involved in traumatic injuries carries with it many social, psychological and medico-legal implications which require knowledge of (and sensitivity to) patient’s rights, confidentiality and informed consent, by anyone involved in this treatment. Despite one’s personal opinions on whether information (i.e. ETOH results in a driver; HIV status) should be divulged, the law protects individual’s rights to privacy, and you will place yourself, other providers and the hospital at risk by inappropriately divulging information. (See “Release of Patient’s Medical Record to ...Other Than Patient”). Patient information should be released to the media ONLY by the Office of Public Affairs or the Nursing Supervisor, (See “Release of Patient Information”) especially for “VIP’s” or celebrities. If you are contacted for information, please defer to those listed above. Please be aware of the procedure for “OPT OUT” patients.

Inquiries from police concerning patient injuries may be answered using very general terms (i.e. head injury, a broken leg, internal injuries, etc.) or simply a patient condition (i.e. good, fair, serious, critical). The circumstances surrounding the injury (i.e. GSW), intoxication status, statements made by the patient and prognosis may not be given. Do not be intimidated into answering questions. Refer questions to the Trauma Program Manager or Nursing Supervisor if in doubt.
Patients may be interviewed by police if they are medically and psychologically stable enough (in the opinion of medical and psychiatric providers) to undergo questioning and the patient gives permission to be interviewed. Refer requests from police to the UMass police and the Nurse Manager/Supervisor before consenting. Patients should be able to talk with their doctor, nurses or health professionals in private and know that the information supplied will not be given to others not involved in their care without their knowledge. Specific considerations:

- **Pregnancy:** If the patient is a minor (under age 18) and is, or even believes herself to be pregnant, she may consent to her own care. Therefore, consent for treatment when considered emergent is not necessary from parents, and disclosing information about the pregnancy to anyone is not necessary (or advised). Only if the minor patient is married, widowed or divorced can she obtain an abortion or sterilization without parental consent or court order. Contact the social worker to coordinate/facilitate discussion of this issue with parents, or for questions.

- **Alcohol (ETOH) / Toxicology Screen Results:** Results from the serum ETOH and urine toxicology screens drawn for medical purposes (see Policies on ETOH Levels Legal, Medical) may not be shared with ANYONE (i.e. police, media, family, etc.) not involved in the medical care of the patient, and without the patient’s permission. In patients who are unable to give permission to medical personnel to divulge results to family members, extreme discretion is advised. Otherwise, as with any other medical information, patient consent must be given. Be sensitive to, and wary of any possible legal proceedings that the patient may be involved in for which inappropriate disclosure of this information may have a negative effect.

For all Pediatric trauma patients who are immobilized:

1) AP and lateral c-spine x-rays in Trauma Bay. If positive findings, consult spine team.

2) If head injured, specify CT of head should extend down to c2 to evaluate the odontoid.

3) If patient cooperative, open-mouth views in trauma bay can be obtained.

4) If patient complains of neck pain or has neurologic deficit in trauma bay, CT c-spine should be obtained. If CT positive, consult spine team.
5) If patient has persistent neck pain, altered sensorium or distracting injuries so that clearance cannot be achieved despite normal imaging, admit patient for 24 hrs and re-examine. If findings persist, consult Spine Team.

6) MRI of spine should be obtained if SCIWORA is suspected or if there is a neurologic deficit after injury.

7) Once imaging documents no injury and physical exam is normal, the Pediatric Surgery Service or Trauma Service will be responsible for removing the collar, writing a note documenting a normal exam, and writing an order to discontinue precautions.

B. PEDIATRIC TRAUMA POLICIES AND PROTOCOLS

Criteria For Trauma Team Activation: Pediatric

Introduction: 
Appropriate field triage of the 20% of trauma victims that require treatment in a trauma center is the critical first step in a well organized system of trauma care. Inadequate identification of injuries and/or delayed resuscitation after arrival at a trauma center is often the cause of early in-hospital deaths. This concept is even more significant in injured children, in whom assessment of respiratory failure and/or shock, and interpretation of vital signs may be more difficult than in adults. Therefore, the immediate involvement of the Trauma Team in those patients who have the highest likelihood of serious injury is the second critical step. There is no perfect system of triage. An over triage rate of 30 - 50% is necessary to capture those patients who do require emergent, comprehensive trauma care. The UMass Memorial Level 1 Adult & Pediatric Trauma Center has therefore adopted the field/ED triage guidelines suggested by the American College of Surgeons Committee on Trauma.

Purpose:
To immediately identify those pediatric trauma patients with actual or potentially serious injuries based on mechanism of injury, physiologic data and pre-hospital provider report. To activate the Trauma Team for immediate and expeditious resuscitation and management of injured children.

TRAUMA TEAM ACTIVATION:

• An Emergency Department RN and/or Pediatric Emergency Medicine Attending physician may make the decision to activate the Trauma Team prior to patient
arrival based on the pre-hospital CMED radio report and the following criteria guidelines.

- Pediatric trauma patients who meet Trauma Team activation criteria by pre-hospital report should not routinely be evaluated (even briefly on arrival) by the Pediatric EM Attending or resident before activating the Trauma Team.

- Trauma patients transferred from a referring hospital who have been discussed and accepted by a Pediatric Trauma Attending surgeon (or other surgical sub-specialist) should always generate a Trauma Team activation rather than initial evaluation by a Pediatric EM Attending/resident. The accepting surgeon must contact the Pediatric EM Attending or Resource Nurse to communicate that:
  1. The referred patient is expected and
  2. That the Trauma Team should be activated.

- If a patient is initially triaged to EM for evaluation and immediately meets the criteria below, and / or a patient's clinical condition changes such that the criteria are now met, the Trauma Team beepers should be activated with a “STAT” code.

- Any patient who clinically may appear well, but will require a significant diagnostic workup (i.e. head and / or abd CT scans; multiple plain films, etc.), procedures (i.e. chest tube placement, etc.), and probable admission should be considered for Trauma Team activation or early consultation.

**PEDIATRIC ACTIVATION CRITERIA:**

**PHYSIOLOGIC: (one or more):**

1. Pediatric GCS < 13; + LOC and/or significantly altered mental status (including amnesia, irritability, combativeness, inappropriate responses or affect per family)
2. Cardiac arrest or hemodynamic instability (i.e. abnormal vital signs for age; especially hypotension & tachycardia)
3. Respiratory arrest or distress; compromised airway (including abnormal respiratory effort and / or rate for age; low O2 saturation)
4. Paralysis; extremity weakness and/or paresthesias
5. Head (see #1) and/or neck injury (including complaints of neck pain and an abnormal peripheral nerve exam)
6. Actual or potential multi-system (two or >) injury (i.e. head, chest, fractures, spine, abdominal, etc.)
7. Two or more long bone fractures only (include femur, tib/fib, humerus, radius)
8. Flail chest (multiple fx ribs; “floating rib segments”)
9. Pelvic Fracture (any type)
10. Amputation of extremity
11. **BURNS:** > 20% TBSA; any burn with h/o associated trauma (i.e. falls, MVA, explosion). *Does not include clearly isolated inhalation injury.
12. **All penetrating** injuries of: head, neck, chest, abdomen, groin, extremities adjacent to major vascular structures
13. **Any pregnant** patient with associated injuries (even minor) should at least have a trauma consult; those who meet any other criteria should generate a Trauma Team activation (*see Pregnant Trauma Protocol).

**MECHANISMS OF INJURY:** (alone or with physiologic criteria above)
14. Any patient requiring aeromedical evacuation
15. Ejection from a vehicle
16. Falls from > 10 - 15 ft. height
17. Vehicle rollover without safety restraints (i.e. safety belts, booster seats, car seats)
18. Any motorized vehicle versus pedestrian at speed > 20 mph and / or with significant impact (including striking windshield, “thrown”, “run over”).
19. Drowning / immersion **WITH associated trauma** or unclear mechanism. Trauma Team may be asked to participate in drownings without associated trauma but **WITH** hypothermia (core temp < 95 F) to assist in line placement, procedures and re-warming bypass preparations.
20. **Child Abuse (suspected /actual):** Children with significant head injury without a clear mechanism of injury (i.e. “MVA”, “fall onto hard surface”) are at high risk (especially age < 6 mos) for other inflicted injuries including chest, abdominal and skeletal. Therefore, the multi-disciplinary approach (i.e. Pedi EM, Trauma Surgery, Pediatric Medicine, CAT Team) to suspected child abuse will best serve the patient's medical and psychosocial needs.

The Trauma Team must be activated or consulted for patients who meet one or more of the above criteria
APPENDIX

PEDIATRIC VITAL SIGNS

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Weight (kg)</th>
<th>Heart Rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 mos</td>
<td>3-6</td>
<td>160-180</td>
</tr>
<tr>
<td>6 mos – 3 yrs</td>
<td>7-12</td>
<td>120-160</td>
</tr>
<tr>
<td>3 – 11 yrs</td>
<td>12-35</td>
<td>100-120</td>
</tr>
<tr>
<td>11-17 yrs</td>
<td>35-70</td>
<td>60-100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SBP (mmHg)</th>
<th>Resp Rate (breaths/min)</th>
<th>Urine Output (mL/kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-80</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>1.5</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>20</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Adapted from Advanced Trauma Life Support Program for Doctors, American College of Surgeons, Chicago, IL.
### PEDIATRIC GLASGOW COMA SCALE

<table>
<thead>
<tr>
<th></th>
<th>&gt; 1 year</th>
<th>&lt; 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eye</strong></td>
<td>Spontaneous</td>
<td>Spontaneously</td>
</tr>
<tr>
<td><strong>Opening</strong></td>
<td>To verbal command</td>
<td>To shout</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>To pain</td>
<td>To pain</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>No response</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>&gt; 5 yrs.</th>
<th>2-5 yrs.</th>
<th>0-23 mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best</strong></td>
<td>Oriented,</td>
<td>Appropriate</td>
<td>Smiles, coos</td>
</tr>
<tr>
<td><strong>Verbal</strong></td>
<td>Appropriate</td>
<td>Smiles, coos</td>
<td></td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>Inappropriate</td>
<td>Appropriate</td>
<td>Smiles, coos</td>
</tr>
<tr>
<td></td>
<td>Cries, consolable</td>
<td>Cries, consolable</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL SCORE = 3 – 15**

Note: Add “T” (for intubated) and/or “P” for (paralytic drugs given) to total score.

ADULT GLASGOW COMA SCALE

Motor

6: Obeys commands
5: Localizes to pain
4: Flexion withdrawal
3: Flexion: decorticate
2: Extension

Verbal

5: Oriented
4: Confused words
3: Inappropriate words
2: Incomprehensible
1: None

Eye Opening

4: Spontaneous
3: To speech
2: To Pain
1: None

CGS – M + V + E

13-15: Mild head injury
90-12: Moderate head injury
3-8: Severe (coma)
### AAST SOLID ORGAN INJURY SCALE

#### SPLEEN

**Table 1**

AAST Splenic Injury Scale (1994 Revision)

<table>
<thead>
<tr>
<th>Grade*</th>
<th>Type</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular, &lt;10% surface area</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, &lt;1 cm parenchymal depth</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular, 10-50% surface area; intraparenchymal, &lt;5 cm in diameter</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>1-3cm parenchymal depth; does not involve a trabecular vessel</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Subcapsular, &lt;50% surface area or expanding; ruptured subcapsular or parenchymal hematoma</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&lt;3cm parenchymal depth or involved trabecular vessels</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Laceration involving segmental or hilar vessels and producing major devascularization (&lt;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 that devascularizes spleen</td>
</tr>
</tbody>
</table>
**LIVER**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Capsular avulsion, superficial lacerations(s) &lt;1cm deep, subcapsular hematoma &lt;1cm</td>
</tr>
<tr>
<td>II</td>
<td>Laceration(s) 1-3cm deep, central/ Subcapsular hematoma(s) 1-3cm</td>
</tr>
<tr>
<td>III</td>
<td>Laceration(s) &lt;3cm deep, central/ Subcapsular hematoma(s) &lt;3cm</td>
</tr>
<tr>
<td>IV</td>
<td>Massive central/subcapsular hematoma &gt;10 cm</td>
</tr>
<tr>
<td>V</td>
<td>Bilobar tissue destruction or devascularization</td>
</tr>
</tbody>
</table>
## CRANIAL NERVES

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olfactory</td>
<td>Smell: identification of odors</td>
</tr>
<tr>
<td>Optic</td>
<td>Visual acuity; visual fields</td>
</tr>
<tr>
<td>Oculomotor</td>
<td>EOM: except SO and LR</td>
</tr>
<tr>
<td>Trochlear</td>
<td>SO EOM: out and down</td>
</tr>
<tr>
<td>Trigeminal sensation</td>
<td>Masseter/temporalis; facial</td>
</tr>
<tr>
<td>Abducens</td>
<td>LR EOM: outward movement</td>
</tr>
<tr>
<td>Facial tongue</td>
<td>Facial expression; anterior 2/3</td>
</tr>
<tr>
<td>Vestibulocochlear from lesion</td>
<td>Nystagmus: fast phase away</td>
</tr>
<tr>
<td>Glossopharyngeal</td>
<td>Taste: posterior 1/3 tongue</td>
</tr>
<tr>
<td>Vagus</td>
<td>Oropharynx: gag reflex; uvula</td>
</tr>
<tr>
<td>Accessory</td>
<td>SCM, trapezius: shoulder shrug</td>
</tr>
<tr>
<td>Hypoglossal lesion</td>
<td>Tongue (motor): deviates toward (lower motor neuron)</td>
</tr>
</tbody>
</table>
FIGURE 35. THE RULE OF NINES
# BURNS

## TABLE 28. MODIFIED LUND AND BROWDER CHART

<table>
<thead>
<tr>
<th>Burned Area</th>
<th>1</th>
<th>1 to 4</th>
<th>5 to 9</th>
<th>10 to 14</th>
<th>15</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Body Surface (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>19</td>
<td>17</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Neck</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Anterior trunk</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Posterior trunk</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Right buttock</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Left buttock</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Genitalia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Right upper arm</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Left upper arm</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Right lower arm</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Left lower arm</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Right hand</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Left hand</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Right thigh</td>
<td>5.5</td>
<td>6.5</td>
<td>8</td>
<td>8.5</td>
<td>9</td>
<td>9.5</td>
</tr>
<tr>
<td>Left thigh</td>
<td>5.5</td>
<td>6.5</td>
<td>8</td>
<td>8.5</td>
<td>9</td>
<td>9.5</td>
</tr>
<tr>
<td>Right leg</td>
<td>6</td>
<td>5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
</tr>
<tr>
<td>Left leg</td>
<td>5</td>
<td>5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
</tr>
<tr>
<td>Right foot</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Left foot</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>
DERMATONES
NUTRITIONAL CALCULATIONS

Calculate Caloric Goals

**Ideal Body Weight** = 48 Kg for women at 5 ft tall
50 Kg for men at 5 ft tall

For each inch over 5 ft ADD 2.2 Kg

**Feeding weight** = (actual wt – IBW) / 4 + IBW

**Caloric Goal** = Feeding weight X 25 kcal

**Goal TF rate/hr** = caloric goal / 24 hrs

TPN

Caloric needs: based on Feeding weight (see above)

Note: for serious burns (.20% BSA) and Severe CHI/posturing: add 25%-50%

**Protein needs**: 0.8 – 1.0 g/kg: renal failure not on HD
1.2 g/kg: renal failure on HD
1.5 – 2.5 g/kg: all other patients

• Protein calories: # grams total x 4kcal/g

**Lipid needs** (ensure triglycerides < 350)

• (Total calories – Protein calories) X 1/3 = Total lipid calories

• 1 gram lipid = 9 kcal
• Total lipid calories/9 = grams lipid needed
Carbohydrate (CHO) needs

- Total caloric need – (Protein calories + Lipid calories) = CHO calories
- CHO calories / 3.4 kcal = CHO grams needed
- CHO total should not exceed 2-4 mg CHO/kg/min
## WOUND CLASSIFICATIONS

### Tetanus Prophylaxis

<table>
<thead>
<tr>
<th>Tetanus Immune history</th>
<th>Clean Wound</th>
<th>Dirty Wound</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5 Yrs</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>&lt;5-10 Yrs</td>
<td>None</td>
<td>Toxoid booster</td>
</tr>
<tr>
<td>&gt;10 Yrs</td>
<td>Toxoid booster</td>
<td>Toxoid booster + TIG-human</td>
</tr>
<tr>
<td>Incompletely Immunized</td>
<td>Toxoid + and Completion of Immunization</td>
<td>Toxoid + TIG-human Completion of immunization</td>
</tr>
<tr>
<td>+/or uncertain History</td>
<td></td>
<td></td>
</tr>
<tr>
<td>immunization</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Conversion Factors

<table>
<thead>
<tr>
<th>IF YOU KNOW:</th>
<th>MULTIPLY BY:</th>
<th>TO GET:</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>2.54</td>
<td>centimeters</td>
</tr>
<tr>
<td>centimeters</td>
<td>.04</td>
<td>inches</td>
</tr>
<tr>
<td>ounces (wt)</td>
<td>28</td>
<td>grams</td>
</tr>
<tr>
<td>pounds</td>
<td>.45</td>
<td>kilograms</td>
</tr>
<tr>
<td>grams</td>
<td>.035</td>
<td>ounces</td>
</tr>
<tr>
<td>kilograms</td>
<td>2.2</td>
<td>pounds</td>
</tr>
<tr>
<td>fluid ounces</td>
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<td>milliliters</td>
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<td>milliliters</td>
<td>.03</td>
<td>fluid ounces</td>
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<tr>
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<td>pints</td>
</tr>
<tr>
<td>liters</td>
<td>1.06</td>
<td>quarts</td>
</tr>
<tr>
<td>temp (f)</td>
<td>F-32/1.8</td>
<td>celcius</td>
</tr>
<tr>
<td>temp (c)</td>
<td>1.8C + 32</td>
<td>Fahrenheit</td>
</tr>
</tbody>
</table>

110
<table>
<thead>
<tr>
<th>C</th>
<th>°F</th>
<th>C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>80.6</td>
<td>34</td>
<td>93.2</td>
</tr>
<tr>
<td>28</td>
<td>82.4</td>
<td>35</td>
<td>95</td>
</tr>
<tr>
<td>29</td>
<td>84.2</td>
<td>36</td>
<td>96.8</td>
</tr>
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<td>30</td>
<td>86</td>
<td>37</td>
<td>98.6</td>
</tr>
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<td>31</td>
<td>87.8</td>
<td>38</td>
<td>100.4</td>
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<td>89.6</td>
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<td>102.2</td>
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<td>33</td>
<td>91.4</td>
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<td>104</td>
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