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Welcome to Trauma! Trauma surgery is an exciting specialty within surgery that requires quick thinking, procedural excellence, a good fund of knowledge of physiology and anatomy, and complex decision-making capability. Many aspects of the trauma rotation can be applied to multiple other specialties, and overall, if good competence of the skills necessary in trauma is achieved, then one will be a stronger physician in whatever specialty one chooses.

Trauma is a term that applies to injury that occurs from external sources. This may range from falls from standing or sitting, to motor vehicle collisions, to penetrating injuries such as knife stab wounds or gunshot wounds. One must be able to rapidly assess a patient and gain control of life-threatening injuries. However, one must also be able to manage a patient throughout the resuscitation and ongoing process of definitive management of injuries.

The patients that are seen on the trauma service are not managed solely based on the injuries that have occurred, because these injuries are in addition to the chronic medical conditions that the patients already have. These chronic medical conditions add to the complexity of the patients, and therefore require knowledge and ability to manage these issues as well as the acute injuries that have been sustained. Many times, we do not have the luxury of optimization of the medical conditions prior to operations or procedures, because much of what we do is emergent. So, management during and after any required operations or procedures is equally of high importance.

Acute interventions may include chest tubes for pneumothorax or hemothorax, IV access or IO access for active resuscitation, placement of REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta), or resuscitative thoracotomy. However, for the rest of the hospitalization, management of fluid balance, glucose control, electrolyte management, infectious management, renal management, respiratory management, and cardiac management, as well as others are the focus of the providers.

Coordination of care with consultants is also a key component of management of trauma patients. A significant majority of patients seen by the trauma service require multiple specialties to be involved in the care of the patient. It is the responsibility of the trauma team to make appropriate and timely consults and to follow up to be sure that the appropriate interventions are occurring.

This manual is designed to provide information that can be referenced so that from day one, one will know how things should happen, appropriate roles and responsibilities, and even some pointers for successful accomplishment of required procedures. The hope is that all who are a part of the trauma team, whether in the trauma bay or seeing patients on the floor, will be able to start a rotation with confidence and have a foundation for growing in skill and knowledge throughout the rotation.
The trauma service has been organized into teams. There are three teams-Gold, Green, and Blue. Each team has a senior resident and a junior resident. There are also advanced practice practitioners (APPs) assigned to each team. An attending will be assigned to round and cover daytime call when team is on-call. The attendings will typically be on-service for 1-2 weeks at a time. Additionally, there are case management, social work, and physical therapy people that will participate in rounds. The underlying goal of the team approach is to keep patient care moving forward without delays as much as possible to keep patients efficiently and safely progressing to discharge.

Each team will be on call every third day. So, there will be a pre-call day, an on-call day, and a post-call day. On the pre-call day, rounding will be accomplished. If there are any cases for the day, the pre-call senior may be helping to cover these. The junior resident should be working on tertiary surveys. If the pre-call day falls on Tuesday, Wednesday, or Thursday, then there will be a clinic for that team starting at 12:30 pm. All residents are expected to be present for clinic.

During the on-call day, the team will be covering the trauma bay for 24 hours starting at 7:30 in the morning. All admissions for the day will be admitted to the on-call team. If there are elective burn cases admitted after the operating room, they also will be added to the team’s list for following while in the hospital. Rounding occurs as every other day, but if there are traumas coming into the bay, then the residents will be expected to cover the bay and the APPs will continue to round with the attending.

The post-call day will start with checkout. Rounding will still occur as usual. The residents need to make sure that the work from the on-call day is complete such as history and physicals, list updates, and communication of any issues that need to be addressed to the on-call team. The residents are expected to leave as soon as possible after table rounding to recover from the on-call day.
CHAPTER 3
JUNIOR RESIDENTS

Trauma Bay

The primary responsibility of the junior residents is primary and secondary survey in the trauma bay and documentation. However, junior residents need to be knowledgeable in procedures as there may be times when they may be called on to perform a procedure.

If you recall, we follow the ATLS protocol of evaluation. The alphabet designation of ABCDE is used for the primary survey: A-Airway, B-Breathing, C-Cardiac or Cardiovascular, D-Deficit (neurologic or other), and E-Exposure. So, let’s walk through the primary survey.

Airway- Many times the junior resident (or surveying physician) will meet the patient in the hallway and begin the assessment with a question- What is your name? or Can you tell me your name? If the patient responds and can talk, then the airway is intact (air can move through the trachea and vocal cord in order to phonate). If the patient cannot or does not respond, then the airway is either obstructed (not intact) or not protected (the patient has diminished consciousness and cannot protect the airway). The findings are conveyed firmly and loudly enough to be heard to the trauma team. An airway that is not intact or not protected may require intubation.

Breathing- If the patient is able to verbalize, then enough air is moving to enable phonation. However, this does not ensure adequate breathing. Auscultation of the lung fields is imperative to determine if there are breath sounds equally and bilaterally. One must rule out tachypnea or hemothorax with adequate breath sounds before moving on. If a patient shows signs of respiratory distress such as tachypnea, increased work of breathing, decreased oxygen saturation, etc., then the airway and breathing should be reassessed. The findings of the evaluation should be conveyed firmly and loudly enough to be heard to the trauma team. (Re-occurring concept!)

Cardiac- The cardiac evaluation is assessment of adequate blood flow AND control of hemorrhage. When the patient arrives, the nursing staff will be attaching monitors, obtaining IV access, and checking blood pressure. The intern should feel for pulses. A radial pulse should indicate a systolic blood pressure of at least 80. The pedal pulses should also be evaluated to determine adequate flow to the lower extremities. If there is active hemorrhage occurring, this should be immediately addressed. Start with direct pressure. If this is effective, then a dressing may be adequate. If the bleeding is from an extremity, a tourniquet may need to be applied. Trunical bleeding may require REBOA, thoracotomy, or laparotomy in the OR. Scalp bleeding can be profuse and even cause exsanguination. A dressing and wrap should be applied early to control hemorrhage from the head. If there has been difficulty or inability to obtain adequate IV access, there may need to be intervention here, such as a central line or intraosseous (I/O) access to enable adequate resuscitation. As part of this assessment, the pelvis should be palpated to determine stability. An unstable pelvis can be a source of significant blood loss. If a pelvis is found to be unstable, a pelvic binder can be applied to tamponade the bleeding.

Deficit- The deficit evaluation is more of a quick neurological exam. Can the patient move all extremities? Is sensation intact? What is the GCS? If you recall from ATLS, GCS is now

<table>
<thead>
<tr>
<th>Points</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>Does not open</td>
<td>Opens to pressure</td>
<td>Opens to voice</td>
<td>Opens Spontaneously</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Verbal</td>
<td>No sounds</td>
<td>Makes sounds</td>
<td>Words</td>
<td>Confused, disoriented</td>
<td>Oriented, normal</td>
<td>N/A</td>
</tr>
<tr>
<td>Motor</td>
<td>No movement</td>
<td>Extension</td>
<td>Abnormal flexion</td>
<td>Normal flexion</td>
<td>Localizes</td>
<td>Obey commands</td>
</tr>
</tbody>
</table>

The points are added for a maximum score of 15. The minimum score is 3. If the patient is intubated, then the score would be a number with an added ‘T,’ such as 3T. Typically, a GCS score of 8 or less is an indication for intubation, provided that the decreased mental status is not due to medications given by EMS en-route or in the trauma bay. However, in the emergent trauma evaluation, safety of the patient must be a priority, and the patient may require intubation and control of the airway until adequate evaluation is complete.

Exposure- The exposure step is also done very quickly on arrival. Many times this is done prior to some of the primary evaluation, because it may be necessary to adequately assess the patient for bleeding or cause of diminished pulses. The patient’s clothes are removed as rapidly as possible so that the assessment can proceed. It is important to evaluate the patient quickly and to then cover and warm the patient. Also try to keep the patient covered as much as possible from a modesty point of view. However, if evaluation or procedures require exposure, then do what needs to be done to adequately assess and care for the patient.

The patient is then rolled to one side using log roll precautions. The assessing physician will press on the spine going from the cervical spine to the sacrum. The patient is instructed to respond with a verbal response only as to whether there is pain with each press on the spine. The assessing physician should make known the location of any tenderness as well as any palpable step offs along the spine. Rectal tone is assessed by gluteal tone or “squeeze.” If the patient is unconscious or unreliable, a rectal exam is performed. This is a more complete evaluation as this can assess rectal tone, if there is blood in the rectum, and whether there is a high-riding or ballotable prostate in men that could indicate
urethral injury. The transport hard back board is then removed along with any clothing or items that were under the patient, and the patient is then log rolled onto the back. If the mechanism was a penetrating injury, a log roll to the other side is performed as well to look for any other wounds. Also, in a penetrating injury, it is important to evaluate fully the axilla, buttocks, thighs, and perineum for any other wounds.

After the primary survey, the patient will be supine. X-rays of the chest and pelvis are performed. During this time, the assessing physician should be assessing the patient from head to toe and evaluating for any injury. This includes scalp evaluation, extremity evaluation, palpation of face, chest, and abdomen, more thorough neurological evaluation, evaluation of ear canals and oral cavity, as well as obtaining a medical and surgical history from the patient. It is important to get as detailed a history as possible and to document clearly and fully. The patient should also be asked about allergies and tetanus status, so these can be addressed.

Documentation

One of the key functions of the junior resident is the documentation of the initial evaluation and findings of the patient in the Trauma History and Physical note on the computer system. The template should be followed as it contains the key items of the exam. Care should be made to document the time of evaluation, the mechanism and circumstances of the injury, all injuries found, all procedures and interventions that were performed in the trauma bay, imaging study results, lab results, consults, and the plan for disposition. The past medical and surgical history is important to document as thoroughly as possible. In ATLS, the AMPLE acronym is used for obtaining information necessary for preparing to transport the patient to a higher level of care. These letters represent Allergies, Medications, Past medical history, Last meal, and Events surrounding the time of injury. However, when completing a history and physical, the document should follow a standard History and Physical format, not the AMPLE format. Some of the information is the same, but it is typically ordered differently in a SOAP (Subjective, Objective, Assessment, and Plan) format. The history and physical format would look more like Chief Complaint (mechanism of injury), History of Present Illness (events of the accident, patient’s symptoms, locations of pain, etc.), Past Medical History, Past Surgical History, Family History, Social History, Medications, and Allergies. These components are part of the subjective portion. Next, there is the objective portion that includes Vitals, Physical Exam, Lab Results, and Imaging Results. Next follows the Assessment and Plan. It is usually easier to read when these are kept together. This should include a list of the injuries along with the plan for addressing each injury. Included in this section should also be any medical problems that will require ongoing management during the hospitalization. After the H&P is documented, it is forwarded to the senior resident who was running the trauma, so their comments and additions can be made.

Additionally, the trauma list and the team list must be kept up to date in PowerChart. As patients come through the trauma bay, they can be added to the list as their dispositions are determined. They should also be added to the admitting team’s list. Similarly, as patients are discharged from the hospital or go to other services and the trauma team has signed off, they patients should be removed from the list. The list of procedures should also be updated daily as multiple specialties are performing operations on the patients, and these procedures occur throughout the hospitalization. It is important to keep the lists up to date as they are used for multiple purposes and by multiple teams.

Floor Rounding

Junior residents who are assigned to the floor will be expected to round on trauma patients in the ATCU and TBNU. The advanced practice providers (APPs) are now responsible for most of the rounding, but there may be occasions that residents are asked to help or fill in as necessary. The junior residents on each team are also responsible for performing tertiary surveys on patients both on the trauma service and on patients who ended up being admitted to other services. A tertiary survey includes a complete physical exam and re-evaluation of the patient from head to toe, a review of labs, and a review of radiology to ensure that there has not been a missed injury or anything that requires further workup.

If a resident is assigned to round on floor patients, patients will be assigned for daily rounding by the team with which you are rounding. The patient should be seen, evaluated, and a physical exam performed. The previous day’s events, consults, and procedures should be reviewed. A daily progress note (Trauma Progress Note) is then completed and forwarded to the attending physician who is rounding on the patients. There are certain items within the note that must be completed each day. If any of these items such as infectious disease is not complete, the heading will be yellow. All areas should be complete before forwarding to the attending physician. Be careful about using the copy forward function as information from previous days may no longer be accurate! Notes should be completed and forwarded as soon as possible, because the days can get busy quickly.

Didactics

Didactic sessions covering trauma ICU topics take place on Fridays in the 9601 conference room. While these sessions are less about the trauma bay and more about critical care, all residents on the trauma service are welcome and encouraged to attend if there are not active responsibilities in the trauma bay.

The fellows typically have educational sessions on Tuesdays at 11:30 AM. The topics vary, but they are typically quite relevant and include literature reviews. Again, all residents are welcome to attend these sessions.

Trauma Clinic

Currently, trauma clinic takes place on Tuesdays, Wednesdays, and Thursdays at 12:30pm. Each team (Gold, Blue, and Green) has a clinic each week for their patients. The day of the clinic occurs on the team’s pre-call day, and this day will change from week to week. Residents are
expected to be present and see patients in clinic. The patient should be seen and examined. It is helpful to open the patient’s chart and review the admission, injuries, procedures, and discharge plan prior to seeing the patient. The resident will then present the patient to an attending or fellow. After the encounter is done, the note is written and then forwarded to the attending or fellow to whom the presentation was made.
CHAPTER 4

SENIOR RESIDENTS

Trauma Bay and More

The senior surgery resident is responsible for the oversight of the trauma service. They should be aware of ongoing issues with patients who are admitted to the service and actively involved in the resolution of the issues. Many times, if procedures need to be done on floor or ICU patients, the senior resident may be called to perform the procedures. Alternately, they may supervise a junior resident in performing the procedure. The senior should also be up to date on ongoing repeat examinations for floor patients.

In the trauma bay, the senior resident and the ER resident alternate roles in their responsibilities. On odd numbered days, the surgical resident is lead and the ER resident is doing procedures. On even numbered days, the roles are reversed. The trauma lead position is responsible for managing the evaluation, care, and disposition of the patient in the trauma bay. The trauma lead should be directing the evaluation so that roles are clear and well defined. It is important to direct those assisting so that only those necessary are at bedside and the room is not cluttered. This is especially important in critical patient resuscitations where more people show up to help. More people does not necessarily mean more efficiency and may actually impede efficiency, so it is important to give clear direction during these resuscitations. Additionally, it is important that the lead resident is ensuring that there is proper overwatch of patients throughout their evaluation. This may mean assigning one of the residents on the service to stay with the patient while in the CT scanner or staying with the patient themselves in the case that a patient is tenuous or critical. It is easy to allow the tasks of placing orders or computer documentation to take the focus away from the care of the patient, so deliberate decisions and direction must be given when necessary.

The procedure resident is responsible for performing any procedures required during the resuscitation. Procedures may include arterial blood draw for blood gas, venous blood draw via femoral stick, chest tube insertion, laceration repair, intubation (ER resident), or emergency thoracotomy (surgical resident). The procedure resident should also be forming a FAST (Focused Abdominal Sonogram for Trauma) exam during the evaluation. They may also be assisting in the evaluation of the patient as the primary and secondary survey continue. Some guidance as to the technique of the various procedures can be found in the Procedures chapter.

Documentation

When the intern or junior resident is finished with their portion of the Trauma History and Physical document, the senior resident should take the note to complete it prior to forwarding to the trauma attending who oversaw the resuscitation. The note should be evaluated to make sure that the documentation is complete and thorough. The resident should also ensure that all procedures done in the trauma bay are documented in the H&P. If procedures are done in the bay after the initial assessment, they can be documented in the H&P or a separate procedure note may be done. An addendum should be added to the H&P document stating the assessment and plan. The assessment should ideally include a list of all injuries discovered up to the point of admission. The plan should include planned procedures, consultations, and disposition for the patient.

Floor Rounding

Typically, the senior surgical resident does not routinely do daily note writing. The senior resident is responsible for ensuring that all patients are seen including the patients who are off service or on other floors that need tertiary surveys or notes. Many times, the senior will see patients prior to morning check-out, so an update can be given during check-out. The senior is also responsible for assigning junior residents to round on off floor patients that require on-going daily exams. The senior should be particularly familiar with the ICU patients so that plans are conveyed during team rounds.

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CHAPTER 5
A TRAUMA RESUSCITATION EXAMPLE

Scenario: A page is sent out: Trauma Alert 10 min Level 1, 47 yoF MVC rollover, declining mental status, HR 120, BP 90/55, Resp 10, Sats 95%.

The junior resident begins donning PPE and awaiting arrival.

The procedure resident begins donning PPE and ensuring that appropriate equipment is staged and ready. In this case, in addition to the standard blood draw and ABG devices, they may decide to have needle decompression angiocaths available, a chest tube tray on standby, an introducer kit (CVL) available, possibly an IO device available or easily accessible, and ultrasound ready for a quick FAST exam. The procedures will go more smoothly if the resident knows where these things are and can give direction to someone to get them quickly.

The senior resident (lead) will be verifying that the room is set up and ready. A communication with the lead nurse may be helpful to ensure that the right people are in the room as well as limiting the number of people in the room to essential only. They should also ensure that the anesthesia resident is available and ready with all they need in case the patient requires intubation.

As the patient arrives...

The junior resident halts the patient outside the room and verifies COVID screen while also assessing the airway. In this case, let’s assume the findings are voiced as, “Airway intact, but unprotected. COVID screen unknown.” This may mean that the patient is making sounds (airway intact) but her mental status is low enough to not protect the airway or get a reliable answer to questions.

If the COVID screen is positive or unknown, appropriate PPE with enhanced respiratory precautions should be initiated rapidly.

The senior resident then directs the movement of the patient to the bed. He or she will ensure that there is someone at the head to hold c-spine and direct the move to the bed. After the move to the bed, he/she will get the story from the EMS.

The junior resident then begins the ABCs. Airway is done. If the patient is moving air, then auscultate the lung fields and voice the findings, such as, “Breath sounds bilaterally.” He/she will participate in exposing the patient and then rapidly assess pulse and signs of active bleeding. A rapid assessment of GCS is performed, and the findings are called out, “GCS is 8.”

The procedure resident assists with exposing the patient. Then, they perform ABG draw and blood draw if necessary. He/she will ensure that IV access has been obtained by the nurses, and if not, proceeds to CVL or IO access.

The senior resident then directs anesthesia that the patient needs to be intubated and begins directing the flow of people in the room. While anesthesia is preparing, they should be verifying that the needed medications are being drawn, the number of people in the room is at the minimum required, and the patient is adequately supported while preparations are made.

Anesthesia intubates the patient with a bedside nurse and respiratory tech.

After intubation, the senior resident will direct people back into the room after the patient is connected to the ventilator. Verifies placement of the tube and proper end-tidal CO2 and oxygen saturation. The senior resident will then direct to continue with the primary and secondary surveys. This will include directing the team to position themselves to roll the patient and check the back.

As the patient is rolled with proper support and the RT stabilizing the head, the junior resident will press on the spine. Because the patient is intubated, there will not be a verbal response, so the resident will be palpating for step offs. All findings are voiced so the team can hear. He or she will then perform a rectal exam and state the findings. A mepilex pad is then placed over the sacral area to prevent a decubitus ulcer. The patient is then rolled to the supine position again.

The senior resident will then direct x-rays to come in and complete chest and pelvis x-rays. The x-rays should be examined immediately by the senior resident to determine if any immediate procedures need to be accomplished prior to CT scan. These could be placing a pelvic binder or inserting a chest tube for pneumothorax or hemothorax. If there were any significant findings on the secondary exam such as joint dislocation, significant deformity, etc., then the senior resident may direct interventions like splinting or additional x-rays to be performed prior to going to the CT scanner.

The procedure resident should perform a FAST exam at this time. This is especially important if the patient is or has been hemodynamically unstable. The results of this exam should be voiced so that the findings can be documented, and the senior resident can utilize the information.

The senior resident is now responsible for determining if the patient is stable to go to CT scan. If the patient remains hypotensive after blood products are given, then massive transfusion may be requested with whole blood, if available. Also, if the FAST exam is positive and the patient is hypotensive, the decision may be made to go to the operating room rather than the CT scanner. This should be discussed with the attending.

The senior resident should then direct the team to transport the patient to the CT scanner for all appropriate scans and ensure that the correct scans have been ordered. He or she should also be aware of the patient’s vital signs and stability throughout the process of transport and scanning and be prepared to initiate any needed interventions such as more blood products, pain control, sedation, etc. If the patient requires
close monitoring while in the CT scanner, the senior should either be present or assign a team member to remain with the patient. The scans should be evaluated by the senior resident as soon as possible in order to determine if there are any life-threatening injuries that need to be addressed immediately. He or she should then begin the process of calling, or assigning someone to call, appropriate consultants based on the findings that are seen or the reports by the radiologist.

The junior resident will begin working on the history and physical document.

The senior resident will decide, with discussion with the attending, the disposition of the patient and ensure that the bed request order is entered in the computer. It is a good idea to get the patients out of the trauma bay as soon as possible in order to keep the trauma bays cleared for incoming patients.

If the patient requires an operation, the senior surgical resident will accompany the patient to the operating room and participate in the operation.
APPENDIX A - PROCEDURES

Arterial Blood Gas Draw

Typically, this is done at the femoral artery during a trauma resuscitation, but it may be done at the radial artery.

The pulse should be palpated.

The needle should be inserted about 1 cm distal to the palpated pulse along the direction of the artery. The needle should be pointing cephalad in a straight line parallel to the axis of the body or parallel to the axis of the artery. The needle should be inserted at about a 45 degree. This angle may have to be adjusted based on the location of the site or the body habitus relative to the length of the needle. In a larger body habitus and performing a femoral artery stick, the needle may have to be inserted closer to 60 to 75 degrees. However, one should keep in mind that the steeper the angle, the less blood flow into the needle will occur due to the sharp angle. Conversely, if performing a radial artery stick, a shallower angle may be needed due to the smaller size of the artery and the shallow depth.

The needle is inserted until blood is seen entering the syringe. The blood flow should be pulsatile and easily filling the syringe. If the blood flow is slow, the color is darker red, and the flow is non-pulsatile, it is more likely to be a venous stick. After the syringe is filled, the needle is withdrawn, and pressure held on the insertion site to control any ongoing bleeding. The safety cover for the needle should be applied and the syringe handed off to the lab technician for processing.

An ultrasound may be used to guide the insertion at either location. The artery may be identified by visualizing the pulsations on the ultrasound image. In the first method, the ultrasound probe is placed transversely (or perpendicular to the direction of the artery) so that the artery is in the center of the picture. The artery will be a circle on the screen, and the pulsations will be visible. The needle is then inserted at the center point of the ultrasound probe aiming cephalad and deep to the ultrasound probe. The depth of the artery can be measured with the markings on the ultrasound screen, so that the user knows approximately how far the needle should be inserted before reaching the artery, and this depth should be the aiming point of the needle. When the needle reaches the artery, the needle can be seen as a point depressing the artery. Small adjustments in trajectory are made until the blood flow into the syringe is seen.

Image 1 - Transverse ultrasound guidance for placement of needle in a vessel. Courtesy of Michael Lovelace RN, CCRN, CEN, CFRN, CPEN, CTRN, TCRN, NHDP-BC.

The second method of ultrasound guidance utilizes the ultrasound probe parallel to the direction of the artery. The pulsations of the artery can still be identified. The artery appears on the screen as a dark line across the screen. The needle is inserted at the center point of the end edge of the probe just distal to the probe. The trajectory is along the center line of the probe and at about a 45 degree angle. The needle is seen on the screen as a line, and the tip of the needle can be followed on the screen through its entire course and guided into the artery if the needle is kept in the center line of the probe. This method allows better visualization of the artery and the needle throughout the process, but it requires some practice to control the probe and the needle for proper visualization. Again, the image below shows a needle being placed into a vein, but the technique is the same for arterial placement. When the needle is kept in the center line of the probe which is the plane of the ultrasound wave, the entire needle and the vessel can be seen along its course. There is much more visual information to guide the placement using this technique.
Here are some points to consider.

1) Whether using a finger to palpate the pulse or an ultrasound to visualize the artery, care must be made to not apply too much pressure and restrict the flow of blood distal to the point of the finger or probe.

2) The needle should be inserted at a shallower angle to improve the flow into the syringe. The steeper the angle, the more likely to have less flow, and the more likely that the needle will go through the back wall of the artery.

3) The tip of the needle should be down with the opening in the end of the needle pointed up (toward the ceiling).

4) The trajectory should always be caudad to cephalad. The needle should never be inserted in a lateral to medial trajectory.

5) The position of the radial artery is lateral to the tendon and medial to the radius bone.

6) The femoral artery should be palpated about 1/3 the distance between the pubic tubercle and the ASIS along the inguinal crease.

7) The structures in the femoral canal are remembered by the NAVEL acronym. Moving from lateral to medial, the structures are NERVE, ARTERY, VEIN, EMPTY SPACE, LYMPHACTICS. So, if one is trying to find the artery and the pulse is difficult to find, starting a little lateral and working towards the medial side should get the needle into the artery first and avoid confusion with a possible venous stick.

8) When using ultrasound, the probe must be kept in the center of the probe, either the center of the long edge or the center of the short edge depending on which technique is being utilized.

9) When using ultrasound, the ultrasound gel packs are NOT sterile. The K-Y gel in packets IS sterile. So, in catheter placement, the sterile K-Y gel packets should be used.

**Femoral Venous Blood Draw**

If there is difficulty getting IV access and withdrawing blood through a peripheral stick, a femoral vein blood draw may be required.

The femoral pulse is palpated. If the pulse can be palpated, the needle is inserted about 1-2 cm distal to the inguinal crease and about one centimeter medial to the palpated pulse. The needle is inserted at about a 45 degree angle with a trajectory parallel to the body aiming cephalad. As the needle is inserted the plunger on the syringe is pulled back to provide a negative pressure inside the syringe. The pressure applied to the plunger will immediately release when the needle enters the vein and the blood begins to fill the syringe. If the pulse cannot be palpated, then the point of insertion should be about 1-2 cm medial to the point that is 1/3 the distance between the pubic tubercle and the ASIS, and one will repetitively insert and withdrawal the needle while applying negative pressure to the syringe plunger working from medial to lateral. In this way the needle should enter the vein first as opposed to artery.

Ultrasound can also be used to guide the blood draw. The technique is the same as for an arterial stick. See Images 1 and 2 in the Arterial Blood Gas Draw section. The vein will appear as a round circle if the probe is placed transversely or as a thick line if the probe is placed longitudinally. The user should not see pulsations. If pulsations are seen, then the probe should be moved medially slowly until the venous, non-pulsatile structure is seen. Then, the probe can be used to guide the needle insertion using the same technique as documented in the arterial blood gas section of this manual.

Points to Consider:

1) The vein will always be medial to the palpated artery.
2) The needle should be inserted at a shallower angle to improve the flow into the syringe. The steeper the angle, the more likely to have less flow, and the more likely that the needle will go through the back wall of the artery.

3) The tip of the needle should be down with the opening in the end of the needle pointed up (toward the ceiling).

4) The trajectory should always be caudad to cephalad. The needle should never be inserted in a lateral to medial trajectory.

5) The femoral artery should be palpated about 1/3 the distance between the pubic tubercle and the ASIS along the inguinal crease, and the vein will be located 1-2 cm medial to this.

6) The structures in the femoral canal are remembered by the NAVEL acronym. Moving from lateral to medial, the structures are NERVE, ARTERY, VEIN, EMPTY SPACE, Lymphatics. So, if one is trying to find the vein and the pulse is difficult to find, starting a little medial and working towards the lateral side should get the needle into the vein first and avoid confusion with a possible arterial stick.

7) Adjustments to the trajectory should not be done while the needle is fully inserted. The needle should be withdrawn, the trajectory adjusted, and then re-inserted. If the trajectory is adjusted with the needle inserted, the tip of the needle can cause a laceration injury to the vascular structures.

8) When using ultrasound, the probe must be kept in the center of the probe, either the center of the long edge or the center of the short edge depending on which technique is being utilized.

9) When using ultrasound, the ultrasound gel packs are NOT sterile. The K-Y gel in packets IS sterile. So, in catheter placement, the sterile K-Y gel packets should be used.
Thoracostomy Tube Insertion

A chest tube insertion is required for pneumothorax or significant hemothorax. There are times that this procedure must be done rapidly such as when there is tension physiology. Because of this, the technique must be familiar to all residents prior to the time the procedure is required.

The location of the insertion should be at the 4th to 5th intercostal space. This is approximately at the location of the nipple. On females, one should be sure the nipple is in a neutral location and not displaced inferiorly in the case that the patient has pendulant breasts.

The chest tube size should be selected appropriately. In the event there is pneumothorax only, a smaller tube may be selected such as 24 French. If there is a significant hemothorax, a larger tube may be selected (32-36 French). However, there have been some studies that show that smaller tubes are comparable to larger tubes even in the treatment of hemothorax.

Lidocaine should be used for the procedure to provide local anesthesia if possible. In the event of a truly emergent procedure, this unfortunately may have to be left off. The incision should be made between the anterior and mid axillary line in the horizontal or transverse direction. The length of the incision should be as small as possible, but large enough to accommodate the size of the tube plus the index finger of the person inserting the tube. If the incision is too narrow, there is more likelihood of air leaking around the tube into the chest and causing an ongoing leak or recurrent pneumothorax upon the removal of the chest tube.

A rapid dissection of the tissues is then accomplished with a Kelly clamp or Mayo scissors. The dissection should go above the rib just superior to the incision. The instrument is then rotated so that it is almost perpendicular to the chest wall, keeping the tip of the instrument adjacent to the top of the rib. The instrument is then inserted until the physician feels the “pop” of the instrument through the pleura. This can require a significant amount of force and care must be taken to ensure that the instrument is not inserted too far and cause more damage to the lung. A finger should be placed on the instrument to provide a stop point. In other words, the finger will catch on the chest wall and prevent the instrument from going too far. This can also be done by using the other hand on the instrument, and the second hand will serve as the stop point.

After the tip breaks through the pleura, the instrument is then opened to spread the opening wider. The instrument is then withdrawn and a sterile gloved finger is inserted into the pleural cavity to ensure that the opening actually goes into the pleural cavity. The finger is swept circumferentially in the pleural cavity around the opening to ensure that there are no significant adhesions. Also, one should verify that the lung is palpable thereby ensuring that it is the pleural cavity and not the peritoneal cavity. (You shouldn’t be able to palpate the liver or spleen.)

The chest tube should be inserted through the opening, and it is typically directed posteriorly and superiorly. There are several methods of using the Kelly clamp to assist in this process. The end of the tube can be compressed in the clamp. The clamp can be inserted through the hole closest to the end of the chest tube and one edge of the chest tube clamped in the Kelly clamp. The other method places the tip of the Kelly clamp through the most distal hole so that the tip is extending about 1 cm beyond the end of the tube. The tip can be used to re-find the opening, pushed into the pleural cavity, and then the tube can be slid over the clamp into the pleural cavity. The curve of the Kelly clamp should be used in order to direct the chest tube in the proper trajectory. The chest tube should have another Kelly clamp clamped onto the other end of tube transversely in order to prevent fluid from shooting out of the tube and onto those around the patient. As the tube is inserted, this Kelly clamp may be used as a handle to “spin” the tube as it is advanced. If the tube is spinning freely, then one can reasonably assume that the tube is not kinked. The tube should be inserted far enough that the last hole in the tube is well into the pleural cavity. Typically, this is between 10 and 12 cm at the skin. I like to use the 12 cm mark at the skin as my minimum insertion distance.

After the tube is inserted, a gloved finger should be inserted, sliding it along the tube up to the opening through the rib cage to verify that the tube is entering the pleural cavity. One of the common mistakes in inserting a chest tube is the lack of verification of the placement, and the tube ends up tracking along the rib cage posteriorly but external to the rib cage. The x-ray for placement will look like a good placement, but the pneumothorax or hemothorax will not be resolved.

Once the tube is in proper position, it needs to be secured. A sturdy suture, typically a 0-silk suture, is used. There are multiple ways of doing this. If the incision is larger than the hole, then additional sutures may need to be placed to close the incision, so it is tight around the chest tube. In the method that I use, I place a horizontal mattress suture around the tube and tie this down so that the skin is slightly puckered around the tube. The two tails of the suture are left at approximately equal lengths. Each tail is then secured with a single throw or loop around the chest tube. This is done by holding the end of the tail with one hand while the other hand forms a “C” with the index finger and thumb. The “C” is used to press the mid-portion of the suture toward the chest wall. The tail of the suture is then passed around the tube and grasped by the “C” fingers behind the chest tube and pulled around the tube. This is done for both tails. The two tails are then tied together tightening the sutures until a slight indentation in the chest tube wall can be seen. The remaining throws are then applied to the sutures.

Another common mistake that is made is wrapping the suture around and around the chest tube thinking that if one is good, many must be better. However, more wraps around the tube just increase the surface area, essentially making a sleeve. The tube is more likely to slide through this sleeve and become dislodged. So, the number of wraps around the tube should be minimal, but the size of the suture should be sturdy enough to bear the load.

After the tube is secured, the tube should be connected to a Pleuri-Vac or equivalent drainage system and the system is typically connected to suction. The device should be set on -20 cm of water suction. Also, the connection between the chest tube and the drainage system hose
should be reinforced and secured with tape. The chest tube should also be secured to the chest/abdominal wall with tape so that an inadvertent pull on the tube will not dislodge it. A sterile dressing should then be applied to the insertion site.

Points to Consider:

1) Be sure the incision site is not too low on the chest.
2) Be sure the incision is not too large in order prevent ambient air from leaking into the pleural cavity.
3) Hold the Kelly clamp or scissors with a “stop point” when inserting into the pleural cavity so that the instrument does not go too deep and cause injury to the lung.
4) Use the curve of the Kelly clamp to direct the chest tube in the direction it needs to go for proper placement.
5) If there is significant resistant on insertion of the chest tube, re-insert a finger and verify the tube is in the right place. Do not force a tube!
6) Always verify placement of the tube by sliding a finger down the tube to the opening through the rib cage.
7) Ensure the tube is properly secured with sutures as well as secured to the chest/abdominal wall with tape.

Central Venous Cather (Central Line)

A central line may be required in the event peripheral access can not be obtained, high volume rapid infusion is required, or certain medications are required intravenously the must be given centrally. One must first ensure that the line is required as there are potential complications and morbidities associated with central lines. If the line is required, then the next question to be answered is where to put the line.

There are three locations for common placement of central lines. These are the internal jugular vein, the subclavian vein, and the femoral vein. The recommended placements are in the order of the subclavian vein, the internal jugular vein, and the femoral vein. The recommendations have to do with the associated complications, infection rate, and patient comfort.

In the trauma bay, most of the time there is a flurry of activity around a patient with more of the activity around the upper body. Additionally, most of the trauma patients have cervical collars, so the internal jugular approach is less than optimal. So, many times a femoral approach is chosen.

Ultrasound can be used to guide the needle access into the vein in all of the approaches. Ultrasound should be used if possible, but in emergent placements, this may not be possible. The subclavian approach is the most difficult to use ultrasound, but the axillary artery can be followed with ultrasound up to the point is passes under the clavicle at which point the axillary artery becomes the subclavian artery. So, the ultrasound can still give depth and trajectory for the needle guidance.

The area should be prepped and draped in sterile fashion. The catheter should be flushed in all ports to get the air out of the lines. All the necessary equipment should be prepared and placed for easy access during the procedure. Lidocaine may be injected at the insertion site if the patient is awake and time allows.

If not using ultrasound, then landmarks are utilized. In the femoral approach, the same technique for venous blood draw is utilized to access the vein. If the femoral artery pulse can be palpated, then the needle is inserted about 1-2 cm medial to the palpated pulse at about a 45 degree angle while aspirating with the plunger. The trajectory is gradually brought from medial to lateral until the vein is entered. However, the trajectory should not be adjusted while the needle is inserted to avoid lacerating the artery. The location of the needle entry site should be at least a couple centimeters inferior to the inguinal ligament. If the location is too high, pressure cannot be applied to control bleeding in the event of a laceration or at the removal of the catheter.

There are multiple approaches to the subclavian access, and some of this is how one was taught initially. Some people place the needle very close to the clavicular bend, but this forces a steeper angle of the needle which is more likely to hit the lung if the vein is missed or to have wire threading issues due to the angle. There is also a supraclavicular approach, but this is less common and is also impeded by cervical collars.

The approach that I prefer uses placement of the needle about one centimeter lateral to the edge of the pectoralis in the delta-pectoral groove and about 1.5 to 2 cm inferior to the clavicle. If one places a thumb in the delta-pectoral groove with the tip of the thumb on the clavicle, then the needle insertion site would be approximately at the interphalangeal joint on the lateral aspect of the thumb placement. The needle is inserted and directed at the clavicular bend with the tip of the needle touching the clavicle. The needle is withdrawn slightly, and the free hand is used to press the needle down until it just clears the deep edge of the catheter. The needle should be aimed at the sternal notch. One trick is to put the index finger of the free hand in the sternal notch and the thumb of the free hand presses down on the needle. The needle is then aimed in the direction of the index finger. The needle is then slowly advanced while aspirating with the plunger until the needle enters the vein and the syringe fills with blood.
The internal jugular approach uses the two heads of the sternocleidomastoid muscle (SCM) as landmarks. The needle is inserted at the superior (cranial) aspect of the SCM at the apex of the triangle formed by the two heads of the SCM and the clavicle. The trajectory is toward the ipsilateral nipple. The free hand may be used to palpate the carotid artery. The needle should be aimed just lateral to the palpated artery. The needle is then advanced while aspirating until the vein is entered.

After the vein has been entered, the wire is inserted into the vein. The wire should pass easily. If there is resistance, withdraw the wire, aspirate to ensure the needle is still in the vein, and then re-insert the wire. Once the wire is in the vein, the needle is removed leaving the wire in place. From this point on, a hand must have control of the wire at all times in order to prevent the wire from disappearing into the vein. Hence, having the equipment within easy reach is very important prior to beginning the procedure. An 11-blade scalpel is then used to make a small incision at the insertion site. A dilator is passed over the wire until it is deep enough to be within the vein. The dilator is removed, and the catheter is placed over the wire into the vein. The wire must be pulled back until the end of the wire is protruding out of the end of the catheter (the brown port if a triple lumen) and can be grasped. The catheter is then advanced over the wire until the tip is far enough in to be in the superior vena cava. The wire is withdrawn, and an IV port is attached to the catheter. All ports on the catheter should be aspirated and then flushed with saline. The catheter is then secured with sutures, and a sterile dressing is applied. A CXR is ordered after placement with an IJ or subclavian placement to ensure proper tip positioning and no pneumothorax. A femoral placement does not require a chest x-ray, and the catheter is inserted all the way.

If an introducer is used rather than a triple lumen catheter, then the catheter and the dilator are all connected. The whole device is inserted all the way, and then the dilator is withdrawn leaving the catheter in place. An introducer has significantly more diameter, so flow is much better. In the event of massive transfusion, an introducer may be a more appropriate choice if central access is needed.

Arterial Line Placement

Placement of an arterial line is similar to the central venous catheter placement. It is typically placed in the radial artery or the femoral artery. One should be sure that there is flow through the ulnar artery and into the hand before placing a radial artery to prevent ischemia of the hand or digits. A needle is inserted into the artery. When pulsatile blood is seen, a wire is inserted into the artery through the needle. The needle is withdrawn. Then, the line is placed over the wire into the artery. Some arterial lines have everything as one unit, while others have a separate wire, needle, and catheter. However, the principles of placement are the same. After placement of the catheter, the wire is removed, and the arterial line tubing is connected to the catheter and calibrated. The catheter is again secured with sutures, and a clean sterile dressing is applied.
FAST Exam and e-FAST Exam

Focused Abdominal Sonography for Trauma (FAST) is utilized in the trauma bay to rapidly assess if there is free fluid in the abdomen or a pericardial effusion. This is important in the scenario of hemodynamic instability where the information may be used to make a decision of whether or not to go emergently to the operating room. The extended FAST, or e-FAST, exam additionally visualizes the lung fields to evaluate for pneumothorax, and the diaphragmatic angle can be evaluated for hemothorax or pleural effusion. The FAST exam is performed using the curvilinear or abdominal probe. The marker on the probe is oriented cranially or to the patient’s right side. This does not change the information, but it does make the interpretation easier, and the information is more consistent to the viewer.

The probe is placed in the right flank and aimed medially. The probe is moved until the kidney is visualized. The view is then shifted superiorly until the liver-kidney interface is visualized. A black stripe in this area indicates free fluid in the abdomen. The probe is then used to visualize the left spleen-kidney interface looking for a black stripe that indicates fluid. The next placement is just caudal to the xyphoid process with the probe aimed cranially at the heart. The probe must be pressed down so the ultrasound beam is directed deep to the sternum. When the heart is visualized, the user is looking for a black stripe around the heart and contained by a brighter white line (the pericardium). The black stripe around the heart indicates a pericardial effusion. The probe is then positioned in the suprapubic area aimed caudally and posteriorly. The bladder will be visualized as a black circular or oblong form. The probe is used to visualize to the left and right of the bladder looking for fluid (black) adjacent to the bladder indicating free fluid in the pelvis.

When an e-FAST exam is performed, the probe is additionally rotated cranially when in the flank positions to visualize the diaphragmatic angles assessing whether there is fluid (black) above the diaphragm that would indicate a hemothorax. The probe should be then be changed to the linear probe. The probe is placed on the chest wall. The pleura is seen as a bright line. The sliding of the lung can be seen just deep and adjacent to the pleura. If this sliding is not visualized, then a pneumothorax is present. The exam should be performed on both sides of the chest wall.
Intubation of a patient may be required in the trauma bay in the event of respiratory distress, hypoxia, or inability of a patient to protect the airway. All residents should be familiar and adept at intubation. However, typically in the trauma bay, the ER residents and the anesthesia residents perform this task.

The patient should be positioned appropriately in the supine position with the head easily accessible. The patient should be oxygenated to hyper-oxygenate prior to intubation if possible. However, this may not be possible in an emergency. The patient should be oxygenated as much as possible. Medications should be drawn up and ready including a sedative and paralytic. Typically, etomidate and succinylcholine are utilized. Suction with a yankauer tip should be set up and ready. A bag mask should be available as well as a ventilator. There should also be a CO2 color change indicator or end-tidal CO2 setup to verify placement.

The medications are given with the sedation first followed by the paralytic. An assistant should hold the head in line while the cervical collar is not in place. The best positioning of the assistant is at the patient’s side with hands on the sides of the patient’s head and elbows in the midline of the chest. This allows full access to the face by the person intubating. An additional assistant may apply cricoid pressure while the airway is unprotected. The patient should be bagged with 100% oxygen while the drugs are getting on board. Once the paralytic is in effect, the intubation can proceed.

The laryngoscope is held in the left hand. A Macintosh blade technique is described here. Usually, a Mac 3 or Mac 4 blade is selected. The blade is inserted into the mouth keeping the tip on the tongue. The tip is gently advanced into the posterior oropharynx keeping the tip of the blade on the tongue. The advancement in this way will place the tip of the blade at the base of the epiglottis. The blade can be slid slightly to the patient’s right keeping the tip at the base of the epiglottis. The entire blade is then lifted toward the ceiling and inferiorly. Care must be taken not to pivot the laryngoscope, because this will cause the body of the blade to contact the teeth and cause damage. As the laryngoscope is lifted, the tongue is pulled forward and the epiglottis opens. As the epiglottis opens, the vocal cords are visualized anteriorly as an upside down “V” structure. Suctioning is performed as needed to aid visualization. Once the vocal cords are visualized, the laryngoscope is maintained in position, and the endotracheal tube is placed through the vocal cords with the right hand. The tube should be visualized going through the vocal cords. The laryngoscope is withdrawn, and the endotracheal tube balloon is inflated. The tube is then secured with an appropriate device to prevent inadvertent dislodgement.

Alternatively, a Glidescope or C-MAC video laryngoscope may be used. This usually gives better visualization particularly in difficult airways. The technique of placement of the laryngoscope is the same, but the user watches the video screen rather than directly visualizing the oropharynx.
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- 6-4205 (Trauma Lead RN)
- 6-2097 (Bay Workroom)
- 6-9856 (Trauma Sr)
- 6-9855 (Trauma Jr)
- 5-1234 (All Nurse Managers-Vocera)

ATCU:
- 6-9225 (unit)

TBNU:
- 4-7250 (unit)

TBICU:
- 4-0006 (unit)
- 4-0262 (PA’s/NP’s)
- 6-5067 (resident)
- 6-3407 (high side)
- 6-3406 (low side)
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  - 4022 (pager)
  - 6-7991 (APP phone)
- Green:
  - 6-1435 (Sr)
  - 4023 (pager)
  - 6-7990 (APP phone)
- Blue:
  - 6-0907 (Sr)
  - 4021 (pager)
  - 6-3190 (APP phone)
- 6-3190 (Night Shift APP)

- TRAUMA INTERN:
  - 6-8955 (phone), 9137 (pager)

ORTHOS:
- 4-6582 (workroom)
- 2777 (rotating pager)

Neurosurgery:
- 9228 (rotating pager)

Burn Dressing Team:
- 6-4632 (portable phone)
- 9367 (pager)

Pharmacy:
- 4-2167
- 7285 (pager-ATCU/TBNU)
- 2132 (pager TBI)

Radiology/Diagnostics:
- 5-9999 (x-ray)
- 4-1382 (US)
- 4-1541 (Film library)
- 4-4831 (CT)
- 5-7528 (UED CT)
- 4-1796 (MRI)
- 4-4072 (Echo), 7022 (pager)
- 4-5135, 4-4431 (UED radiology)
- 4-0152 (IR)
- 6-6029 (IR coordinator)
- 4-2140 (Nuclear Medicine)
- 5-1281 (Audiology)
- 4-6515 (Telemetry)

Lab:
- 4-6440 (Hospital Lab)
- 4-6390 (Blood Bank)
- 5-6384 (UED)
- 6-8911 (Massive Transfusion)

Orthotics:
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- 1559 (Keaton Berrien, pgr)

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