Welcome to the DCMC Emergency Department Radiology Case of the Month!

In conjunction with our Pediatric Radiology specialists from ARA, we hope you enjoy these monthly radiological highlights from the case files of the Emergency Department at DCMC. These cases are meant to highlight important chief complaints, cases, and radiology findings that we all encounter every day.

If you enjoy these reviews, we invite you to check out Pediatric Emergency Medicine Fellowship Radiology rounds, which are offered quarterly and are held with the outstanding support of the Pediatric Radiology specialists at Austin Radiologic Association.

If you have any questions or feedback regarding the Case of the Month, feel free to email Robert Vezzetti, MD at rmvezzetti@ascension.org.

This Month: Let’s fall in love with learning from a very interesting patient. His story, though, is pretty amazing. Thanks to PEM Fellow Shyam Sivisankar, MD for this case.
Case History

Kind of a slow New Years night. A few fireworks injuries, the usual wintertime viral stuff, some abdominal pain, until a patient is brought back, quickly, you note, by the Emergency Department Triage nurse. The chief complaint is not too surprising: gunshot wound to the back. It’s New Years, this happens not uncommonly, but still, such injuries are not frequent in the pediatric population.

You enter the exam room to see the patient. Exam room? Normally, a gunshot wound is brought back to the trauma bay - more room, more equipment, easy to intubate a patient quickly, the rapid transfuser is there - but this child is not in the trauma bay. What gives?

You read the chart quickly and take a look at your patient. You note that he is ambulatory, speaking, and does not appear to be in any obvious distress. So far, so good. You get the story: The patient is a 17 year old male who, four days ago, was at a wedding celebration in Mexico with his family. He states that he heard gunfire (he also states this is not unusual to have celebratory gunfire at parties) and then felt a pain to his right back. His family noted that he had what appeared to be a gunshot wound to his back, underneath his right shoulder blade. He was taken to a hospital in Mexico and had serial imaging; on hospital day 4 he and his family were told that “there was nothing else to be done”. This prompted his family to remove him from the hospital and drive 16 hours back home to Austin. And now here he is...in your department...on New Years. Wow.

He’s conversing - that’s good. Overall, he appears perfectly fine. You scan his vital signs: T - 100 HR - 114 RR - 20 BP - 131/76 Sats - 93% (RA). Hmm. Low normal sats and a temp of 100. You begin to examine the patient and get more history. The family tells you there were no other injuries. The patient tells you that he had a fever yesterday to 102 and has been having right sided chest pain and right sided abdominal pain. He states he has had progressive difficulty breathing. You note that he does indeed have what appears to be an entrance wound from a small caliber firearm (presumably); there does not appear to be an exit wound. He has no other injuries. His breath sounds on the right are diminished; there are no retractions; he has no obvious crackles or rhonchi. You palpate his chest; while there are no wounds, he complains of rib pain laterally near his right lower ribs. He complains of pain on palpation of his right upper quadrant. There is no guarding or rebound and he is not distended.

OK. A 17 year old male with a gunshot wound entering through the back that is 4 days old. He has tachycardia, chest and abdominal pain (all on the right), and lowish oxygen saturations. Yet, he is speaking and looks comfortable. The patient’s father would like to keep the bullet when you remove it. Right. Happy New Year!

Pediatric Chest Trauma

Chest trauma in children is typically a result of blunt trauma. The mechanism of this trauma is usually motor vehicle crashes. Injuries include pulmonary contusions (especially in young patients due to the pliability of the chest wall), pneumothorax, and hemothorax. Rib fractures are usually found in older children. Cardiac injuries (pericardial effusions and blunt cardiac injury) also occur. Penetrating trauma is commonly the result of either knife injuries or gunshot wounds. Luckily, these mechanisms are not often seen in the pediatric population. Mortality is related to associated injuries which rise with the presence of head injury or multiple rib fractures. Always consider NAT in any pediatric trauma patient as well.

DCMC Trauma Categories

Like all trauma centers, DCMC uses categories to triage trauma patients, indicating injury severity as well as what resources are needed to properly care for the pediatric trauma patient. They are:

- Cat I - Amputations, penetrating wounds, intubated patients, hypotension, cord injuries, GCS < 9, arrest.
- Cat II - Fall > 10 feet, MVC/ATV w/ ejection/death, burn > 20% BSA, significant auto vs ped, hanging.
- Cat III - MVC > 60 PMH, snake bite, degloving injuries, suspected pelvic fractures. Patients can be upgraded or downgraded as the clinical situation dictates/evolves.

Penicillin was introduced to the world on February 14, 1929.

The phrase “Sweets for the sweet” is a line from Shakespeare’s Hamlet, Act 5, Scene 1.
Given the history and physical examination, you decide to obtain a chest x-ray. This makes sense. The images are noted to the left. The most striking finding is the moderate pleural effusion on the right (red arrow) and a retained foreign body, presumed to be a bullet fragment (blue arrow); this appears to be posteriorly located. There is (oddly enough) no obvious pneumothorax. So, what is the fluid collection? Blood? Pneumonia (he did have a fever and cough)? Atelectasis? How do you find out?

While you are thinking this over, you had obtained some labwork (CBC, CMP). The CBC looks normal (that would make pneumonia less likely, given the images) and the CMP looks ok except for the LFT's; they are elevated. A CT of the chest would get a better idea of what the patient's thoracic injuries. Why are the LFT's elevated? Maybe a CT of the abdomen with reconstruction of the lumbar and thoracic spine is also indicated. Selected images are to the right. Well, there's our bullet again (blue arrow) and the fluid collection which looks like a hemothorax (red arrow) and there is also a fracture of the 8th rib (blue arrow).

Take a look at the liver; there are foreign objects (blue arrow) as previously noted, which are presumably fragmentation pieces of the bullet. There is also a gas hematoma in the liver (green arrow) that measures 4x7x4 cm. There is no hemoperitoneum. To the immediate right is an image of the thoracic reconstruction obtained from the CT. Note the bullet, lodged within the body of T10 (yellow arrow) and there are tiny comminuted fractures (silver arrow).
Well, the liver hematoma explains the elevated LFT's. It's a good thing that you got the CT of the chest and the abdomen/pelvis. While it is not standard practice to obtain CT imaging in pediatric trauma reflexively, in this case, the studies are indicated to evaluate the extent of the patient's injuries.

Because of the patient's age, he was transferred to Dell Seton Medical Center for ongoing trauma care, after evaluation by the Pediatric Trauma Team at DCMC. This was due to existing Pediatric Trauma Protocols that ensure patients are cared for in appropriate settings. (At DCMC, trauma patients over the age of 14 may be transferred to Dell Seton depending on their injuries and medical history). A chest tube was placed.

**Imaging in Chest Trauma**

**Chest Xray** - In stable patients (no hypotension, no hypoxia, and well-perfused) a chest xray is often employed as the initial imaging modality of choice. Hemothorax, most pneumothoraces, and pulmonary contusions can be detected. However, plain radiography can miss a pneumothorax, due sensitivity (although it is highly specific). The good news that a pneumothorax or pulmonary contusion that is not readily evident on plain radiography is generally not clinically significant and can be managed with observation only.

**CT** - Generally not indicated solely to detect chest injury, unless there is concern for ongoing hemorrhage due to injury to a large vessel or a significant injury that will change management. Remember, this is high radiation exposure.

**Ultrasound** - This is rapidly becoming useful in the detection of chest injuries, especially pneumothorax and hemothorax, without the use of ionizing radiation. This modality is not entirely reliable yet, but is being studied for pediatric trauma evaluation.

**Pediatric Chest Tubes**

Depends on size of the child and what you are draining. A rough guide:
- Infants/young child: 8-12 F
- Children: 16-20 F
- Adults: 24-32 F 36-40 F (large)
- OR 4 x the ET tube size

It can be difficult at times to differentiate between a hemothorax and a pleural effusion. This patient has a pleural effusion and associated empyema. In these patients, an ultrasound or chest CT with IV contrast may be useful. (US is preferred in pediatrics).

**Hemothorax Management**

The most common cause of hemothorax in trauma is lung laceration or laceration of blood vessels, such as intercostal vessels. A small volume hemothorax can be managed with observation; this is especially true if the hemothorax is due to blunt injury. A large volume hemothorax should be treated with a chest tube. There are studies that have looked at the use of pigtail catheters versus traditional chest tubes for hemothorax management, which have yielded mix results in efficacy. Pigtails are great for a pneumothorax, though.
A tension hemothorax is a hemothorax that exerts mass effect. This often is the result of intrathoracic hemorrhage. Lung compression on the ipsilateral side (red arrow) and mediastinal displacement are radiographic findings (blue arrow).

The type of firearm influences projectile velocity, which contributes to wounding capacity. Rifles have the highest velocity injuries; handguns have medium to low velocities; shotguns (due to how they work) are dangerous at close range but largely ineffective at long ranges. Friable tissues (intra-abdominal organs) are prone to more severe injury whereas dense tissues (bone) and loose tissues (fat) are less prone. Bone, by the way, can alter bullet trajectory, sometimes, significantly. Deformation, tumbling, and fragmentation all increase the amount of damage a projectile does. Imaging can identify wound tracks, hemorrhage, gas, isolate the projectile, and assess injuries.

Case Resolution:
A chest tube was placed and this yielded 650 cc of blood. After this was done, he stated it was easier to breathe (makes sense). Neurosurgery evaluated the patient and felt no surgical intervention was indicated and recommended followup in 4 weeks. His hospital course, which lasted for one week, was uncomplicated. The chest tube was removed once output had slowed down (about 100 cc/day). Daily CBCs were obtained and they remained stable; he did not require transfusion. He was discharged with appropriate pain medications and was told to followup with the Trauma Surgery Clinic in 2 weeks. The bullet, you ask? Well, that was left in, much to the patient’s delight; he thought it was kind of neat. Wow.

Teaching Points
1. Pediatric chest trauma is not common, with blunt injury being more common than penetrating injury.
2. Consider the possibility of pneumothorax, hemothorax, pulmonary, and cardiac injuries when evaluating a patient with any manner of chest trauma. Often there will be more than one of these injuries. For example, it is common to have both a pneumothorax and a hemothorax. These injuries can be life-threatening.
3. Physical examination is the most important tool a physician has to detect injury. Common findings include tachypnea, hypoxemia, respiratory distress, chest pain, chest wall crepitus/ecchymoses, and diminished breath sounds on the affected side.
4. Do not delay placing a chest tube in the patient with a chest injury who is unstable and/or decompensating in order to obtain imaging. Place the chest tube first, then obtain appropriate imaging if you (and the patient) are in a position to do so.
5. Plain chest radiography is the initial imaging modality of choice in pediatric patients with chest trauma. Chest ultrasound is being increasingly used first, then obtain appropriate imaging if you do not require immediate intervention.
6. Unstable patients or patients in whom ongoing hemorrhage is suspect or confirmed, need to be seen by a trauma surgeon and will most often need to be taken to the operating room for exploration and repair encountered injuries. Involve the surgical team early!

References