A Tale of Two Livers:

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In a two week period, two similar stab wounds to the liver presented at UVA to the same on call surgeon.

The techniques used and the lessons learned exemplify what it is to be a Level I trauma center, and what trauma centers can do to lead the rest of medicine.

They also demonstrate the serious problems injured patients face in our rural area, and how these problems have been resistant to 20 years of interventions.
Liver 1

- 36 year old black male shopping at Sheetz in Orange, Va
- Man walks up behind him and stabs in RUQ with unknown size knife
- Patient awake and oriented
- On EMS arrival, hemodynamically quasi-stable, BP 95-105 systolic with omentum and bowel extruding from wound
- Aeromedical not activated though available
- Patient transported by ground, 35 minute transport time
ED

- Initially called beta alert
  - Upgraded to Alpha by attending by radio prior to arrival once report given
  - Radio check with OR that room available
- On arrival, BP 100/50, P 105
- Examination of wound – omentum and bowel through stab wound (not relayed by EMS)
- Immediately taken to OR
OR

- Patient transferred to OR within 15 minutes
- OR prepared with trauma cart and nursing/anesthesia team
- Blood alert not activated – patient hemodynamically stable
OR

- On opening abdomen, massive amount of bleeding from right upper quadrant
- 3 cm laceration over dome of right lobe with massive audible bleeding
- Significant bleeding seen from lesser sac around porta
OR

- Largest Foley catheter obtained and placed as deep as possible in liver wound and inflated
- Bleeding slowed
With bleeding slowed, Pringle maneuver performed which slowed bleeding around porta, examination of porta revealed no injury to visible vascular structures, with release of Pringle bleeding appeared to be coming from superior portion of Porta

- Pringle could not be released without massive bleeding, and packing did not control bleeding
- Hepatobiliary/liver transplant and vascular asked to respond (Adams, Zaydfudim and Upchurch)
- Patient severely unstable at this point with systolic BP 40 receiving massive blood and blood product transfusions
OR

- With 2 attendings and Chief resident, were able to expose injury to main portal vein and right hepatic artery high in porta controlled (slowed) with suture
- At this point Pringle could be released but deflation of Foley caused massive bleeding from liver wound
- Umbilical tape and Rumel left in place, Foley left inflated, temporary closure and transfer to ICU
ICU

- Patient resuscitated with blood and blood products with Rotem directed product transfusions
- Dr Angle in IR consulted
- After 24 hours patient returned to OR to attempt to release Foley balloon
  - Deflation of balloon resulted in massive hemorrhage
  - No bleeding from Porta
  - Patients Bilirubin tripled
Planning

- IR felt that right portal vein was either transected, or had significant injury
- Plan to bring patient to hybrid room, gain access to portal vein and assess
- Place stent if needed
Hybrid

- Patient brought to hybrid room after optimization
  - Off pressors, Bilirubin stabilized, coagulation values normalized
Post-Op

- Feared that right lobe of liver would die
- Follow up CT showed necrotic lateral right lobe
- Patient returned to OR for partial right hepatic lobectomy
Earlier Hepatic Lobectomy?

- We thought the wound was in a position that control would be difficult, and where injury to the main portal vein was an issue. Therefore we wanted to get control of the blood flow in the portal vein first.

- We always expected he would need a some form of hepatic lobectomy, but wanted to do it in as controlled a situation as possible.
Course

- Patient extubated and discharged to home
- Has had continued drainage from drains left around resection
- Admission for drain impaction and fever/WBC. Drain cleared, patient defervesced
- Patient eating and doing well but continues to have persistent drain output. Bilirubin in drain is <0.1.
Liver #2

- Patient stabbed under disputed circumstances
- Patient hemodynamically stable in field
- Helicopter available but refused by ground crew (30 minute transport time)
- Ground transport
Liver #2

- Patient hemodynamically stable
- Initial FAST negative
- Between initial Fast and prep for transport HR increased and BP more labile
- Patient about to go to CT, when Chief and Attending wanted to repeat FAST
- FAST now grossly positive
- Patient taken to OR
OR

- Stab wound slightly medial to previous patient with significant (but relatively less bleeding from liver wound) than previous case
- Significant bleeding from underside of liver at Porta (more velocity and brighter red than previous case)
- Foley catheter placed in liver wound and inflated but did not control bleeding
OR

- Palpating underside of liver, could feel Foley balloon
- Pringle performed at same time with control of bleeding
- Foley removed, liver wound packed with NuGauze, Thrombin, and Avitene
- Pringle left in place, but not tightened
- Temporary abdominal closure
Consulted IR who wanted CT before angiogram (?!?) Could not be dissuaded

Patient was hemodynamically stable at this point

Patient overall required 30% of blood products of first case
IR

- Patient thankfully taken to IR
Course

- Taken back to OR at 60 hours
- Packs removed, wound filled with surgical-avitene-thrombin
- Washed out and drained
- Patient discharged on PTD 10
- Follow-up minimal issues
So..

- Sounds great, everyone did a great job, adapted and overcame....
- But.....
Start from the beginning

- Incidents occurred 26 and 30 miles from UVA
- Both incidents had helicopters on standby
- Both incidents refused helicopter transport
  - One in a patient with omentum and bowel hanging out of wound
Transport

- Both patients were quasistable in transport, crashed in OR
- Conservatively, both patients were bleeding at approximately 50 cc/minute
- Had aeromedical process been allowed to occur (with Engine company at landing zone), flight time would have been 8 minutes and patients taken from helipad to OR
Transport

- EMS ALWAYS thinks that drive time is shorter than it actually is. In these cases time from leaving scene to ED was 30 minutes (due to nature of roads)
- Aeromedical could have saved 15 minutes or 750-1000cc of blood loss
- In addition, TXA would have been available on chopper and flow to OR would have been faster
Relative Mortality Metric

- We examined aeromedical scene, vs ground/hospital-aeromedical for 2 of our busier counties
- Our survival performance across all severities of injury was better in the aeromedical scene group
- Though not significant, no question that ground is NOT superior nor is taking patient to hospital and then flying
Corrective Action

- We continually try to convince surrounding counties to
  - Pre-alert aeromedical based on nature of call
  - Dispatch sufficient resources to allow for landing zone
  - Launch on first EMS provider arrival
  - Rockingham county is a great example of how this works well
  - Augusta and Orange county are great examples of where it doesn’t work
Albemarle

- Even in our own county, we have tremendous difficulty getting smooth helicopter operations.
- Aeromedical delay is a self-fulfilling prophecy, if you wait to call until you are sure you need them, then you will be waiting for them on scene.
- Unfortunately, you are going to have to overtriage some to make the system work.
Self Fulfilling

- If you wait to activate air, you will end up waiting for them
- If you activate early, you will have unnecessary flights
- From one AirCare medic: “I think patients get in your trauma bay faster from Pendleton County, WV than Augusta County because they know they are not driving a sick patient here and they call us immediately”
Specialty Services

- Our system, where fellows are in the middle sometimes fails.
- There was no question patient #2 required angiography, the delay for CT probably did not cause harm, but why do it?
- Our system where fellows that are not familiar with protocols often give “stock” answers to consults without thinking can cause problems. Also they attempt to protect the attendings, sometime putting the attending at more risk.
- There are many examples, and we are guilty as well.
Secondary Effects

- Plans are created based on expectations of people carrying out their jobs correctly
- When those people do not do this, the plan falls apart and secondary options need to be considered
  - However, these options may be more dangerous and can lead to cascading problems
- The key to optimal care is to make sure the most effective plan is carried out smoothly
Undertriage

- Case initially beta alert
  - ACS criteria does not mandate highest level activation for stab wounds
  - Because the attending was in the radio loop they were able to upgrade case immediately, thus OR made ready and attending at bedside on arrival
- Stab wounds to chest, neck and abdomen added to Alpha criteria
  - We’re not in LA or Chicago, we don’t get 10 of these a day
Undertriage

- In multiple analyses of cases, we’ve found that undertriage is a key cause of adverse events.
- When we are present, briefed, and ready for the patient, things tend to go smoother than when we realize the patient is sicker than advertised and need to gather forces after the fact.
- If we are “overprepared” we can de-escalate quickly. While we can escalate quickly, it often feels we are reacting rather than acting.
Undertriage

- In trauma, you must accept an overtriage rate of at least 20%, preferably higher.
- A common excuse is that the trauma team is “disruptive” to the ED flow. But our data has shown consistently that undertriage adds to complications and mortality.
- In addition, Alpha alerts have the lowest ED dwell times of any of our patients.
Initial Negative FAST

- In patient #2, he looked pretty good, and initial FAST appeared negative
- In ED, patient had increase in pulse, and labile BP
- FAST repeated before leaving bay and was positive, then taken immediately to OR
Lesson

- Whether first FAST was negative or not, the concept that it can be repeated is important.
- Once you leave the bay for CT a lot of inertia is created.
- Vital to assure yourself that status of patient has not changed before moving to radiology.
Corrective Actions

- Try to work with leadership of areas to create guidelines that will be adhered to so things are not improvised in the middle of the night.
- In these cases, the same specialty service flat out saved one patient, and potentially endangered another, due to variability in practice.
- Undertriage and possible false negative FAST were dealt with by attending and chief at bedside (escalation of alert, repeat FAST).
Lessons

- When you need help, call help
  - It tends to be the inexperienced who don’t call for help, not the experienced
- Innovative solutions can be life saving, but have the most experienced people at the helm when they’re deployed
- Decrease inertia as much as possible
  - Field
  - Diagnostics
  - Interventions
Philosophy

- Expect complications in complex cases
- Run toward problems, not away from them
  - Extremely high risk of abscess
  - Extreme risk for sepsis
  - Extreme risk for DVT/PE
- A high reliability system handles the simple things well, so when the complex comes along, the basics are intuitive and you can spend your time on the more complex decisions