Tourniquets for Massive Hemorrhage

Kathy Schrank, MD, FACEP
City of Miami Fire Rescue
University of Miami Miller School of Medicine
Jackson Memorial Hospital
Bleeding out ...

- Potential for rapid death underestimated
- Once in cardiac arrest, rarely survive
- Even with initial save, high M & M:
  - Respiratory, multi-organ failure
  - Sepsis, thromboembolism, etc
- **SO STOP BLEEDING A.S.A.P.!!**
Tourniquets & EMS: 2010

- Safe and effective when used correctly
- # EMS providers carrying TQs
- “HOW to” is easy. Gotta teach “WHEN”
  - Training sessions = good time for Basics
  - TQ usually but not only as a last resort
- Rarely used in ED, staff not familiar
Long history...especially military

- Ancient Greeks and Romans
- European 1500s, 1600s
- Civil War:
  - TQ commonly used & saved lives, but limited medical care
- Later, especially WWs
  - Lots of unnecessary use, prolonged use
  - Delays to definitive care
  - Fell out of military favor due to limb loss
- Civilian use ↓↓ also, except for amputations
- Impressions: Lose a limb, save a life
  Primum nul nocere
But then...

- Vietnam
  - Helicopters, faster times to definitive care
  - KIAs: 67% die in <10 min, but 1/3 > 10 min
  - Hindsight: TQ might have saved up to 5,000

- Middle East
  - TQ easy, safe, effective
  - Time to OR < 70 min
Several recent military studies

- **Israeli Defense Force**
  - Reviewed 91 TQ uses in 4 yrs; 47% not indicated
  - But complications rare
- **Baghdad 2006**: 232 pts with TQ: 87% survival
  - If TQ BEFORE shock ensued, 96% survival
  - If TQ AFTER shock ensued, 10% survival
  - Complication of transient nerve palsy 1.7%
  - Amputations caused by TQ: ZERO
  - Case match study of 5 with wounds deemed treatable by TQ but not used, with 13 with TQ: Survival 0% vs. 77%
  - Field witnesses: *underestimated the speedy lethality of uncontrolled limb hemorrhage*
    - (Kragh, et al, J Trauma 08, Annals of Surgery 09)
TQ in Orthopedic OR Procedures

- Used for bloodless surgical field
- TQ safe on warm extremity for 2 hours (warm ischemia time in OR), longer if limb is cool
- > 6 hrs, limb loss from TQ likely
- From 2-6 hrs, variable risk
- < 2 hrs, most common complication is transient nerve palsy with NO later problem
Combat = Care under Fire

- Return fire and take cover
- Move casualty to cover
- Apply self aid
- Stop life-threatening limb bleeds with TQ:
  - Trauma Combat Casualty Care Guidelines 2008
- CAN use TQ easily, NOT direct pressure
- Combat wounds (GSWs, IEDs) often arterial

- Similar to civilian tactical EMS/SWAT or disaster situations
Military PHTLS: from ABC to M Massive hemorrhage
   A Airway
   R Respirations
   C Circulation
   H Head injury
Civilian EMS Applications

- Amputations
- Tactical (SWAT) EMS
- Mass Casualty Incidents
- Industrial & farm machinery trauma
- Watercraft propeller trauma
- Entrapment / extrication

- But what about other penetrating limb wounds?
Debates: Civilian EMS TQ Use

Considerations:

- Rapid transport – but do WE recognize how fast people die from uncontrolled bleeding?
- Civilian weapons usually lower force than in combat – but not always!
- Enough hands for direct pressure – but not always!
- *Is there data?* Pending!
What, when, where, how, who?

No: WW2 style

Yes:

Wide band, rounded edges, uniform material, ratchet
Don’t make your own
Procedure

- Use **wide** band, **not** cord or surgical tubing
- Leave at least **2 inches** of uninjured tissue between wound and TQ
  - *Thigh GSW or mangled*: place more proximal
- Tighten until bleeding stops and/or distal pulse gone (if too loose, venous bleeding ↑)
- Needs a lot of force: **ratchet** or **windlass** to do final tightening & secure it
- Leave limb uncovered

Comments:
- Belt or BP cuff won’t hold for long
- Military study: CAT, SOFT, EMT all excellent
Civilian EMS Use

- Generally try **direct pressure** first:
  - review technique + correct use of pressure drsg (& put direct pressure on top of drsg)
- Can try elevation & pressure points but hard to maintain, less effective, and **no evidence**
- Use for amputation, and for any other life-threatening rapid hemorrhage in extremity—doesn’t have to be spurting!
Myth: Only for amputations

- Although that was the NAEMSP guideline in 2006…
- TQ is safe and effective for short use in massive hemorrhage from penetrating limb trauma when combined with rapid transport to definitive care
- Most Trauma Surgeons now agree with TQ—Florida COT is pushing strongly to adopt as civilian EMS standard of care
Myth: Always try direct pressure first

- **Direct pressure**
  - may delay txp, miss deep bleeding site, or be done poorly
  - takes 10-15 min to stop bleeding!
- **Can use TQ as first choice if:**
  - Entrapment/extrication
  - Multiple bleeding sites
  - Injury not amenable to direct pressure
  - High risk scene—must move victim out fast
  - Need EMS hands for airway, breathing, etc.
  - Multiple victims/MCI
  - Total darkness or other bad environment
Myth: Never release prior to arrival at ED

- Usually NOT, but YES, IF:
  - placed as 1° care due to lack of resources, extrication, etc
  - transport time > 60 minutes (>30?)
  - extreme pain (pain med!)
  - bleeding stopped, pt not in shock, & can watch closely

- Procedure:
  - Apply direct pressure prior to release & maintain after
  - Leave TQ loosely on limb in case need to reapply fast
  - Serial reassessments of limb and patient

- If bleeding resumes or VS deteriorate, re-tighten and leave on until arrival

- Don’t release if used for amputated limb
Civilian EMS use – SAFETY

- Document time applied
- Do not cover up the TQ
- Mark patient and triage tag
- Safe hand-offs!!! Clearly inform receiving EMS medic, RN, MD of TQ presence and TT
- ED: Physician must see patient stat
- Never overestimate what the next provider knows
TQ risks

- Distal ischemia
  - Compartment syndrome
  - Gangrene
  - Limb loss
  - Rhabdomyolysis
  - Bone necrosis
- Local pressure injury to soft tissues
- Vascular spasm
- Nerve damage
- ↑ bleeding
- ↑ limb edema
- SIRS

- Venous thromboembolism
- Excessive limb edema
- Circulatory overload in CHF patient
- Plaque fracture
- Problems with release
  - Acidosis, ↑ K+
  - Arrhythmia
  - Brief coagulopathy
  - Transient ↓
TQ: Bottom Lines

- Saves lives, also limbs
- Fast, easy to train & use
- Safe when used appropriately as one component of quality trauma care
- Belongs in BLS & ALS bag of tricks
- Needs data collection in civilian EMS
  - Case studies in publication
Want more info?

Great article:

Additional info & references in 2009 & 2010 slides posted at gatheringofeagles.us
- Dr. Fabbri 2009 – more science, references
- Dr. Schrank 2010 – implementation and training, references
TQ implementation in your EMS system

- Local decisions:
  - Selection of specific TQ
  - Indications for use
  - Indications for removal
  - Documentation requirements

- Protocol: above items; technique for application, removal; monitoring of patient and limb; transfer of care

- Notify receiving hospitals

- QM tracking for safety, efficacy
TQ Training for EMS

- In addition to TQ info, module should briefly re-teach the basics
  - Recognition and management of shock
  - How to do direct pressure and pressure dressing correctly
  - General approach to trauma

- Skill Training:
  - Scenarios re when to use, remove
  - Each learner should apply TQ to self & partner (briefly!), with skill and knowledge checked by instructor
TQ training

- Location 2” above wound for arms or lower legs, consider most proximal site for thigh wounds
- If bleeding continues, tighten more
- If bleeding resumes, tighten more
- If VS worsen, recheck site for bleeding, look for other injuries
BACK TO BASICS: SHOCK

• Prevention: STOP THE BLEEDING
• Recognition: Initial stages often missed
• Management:
  • Airway, Breathing
  • STOP THE BLEEDING
  • Role of IV fluids?
  • GET TO DEFINITIVE TREATMENT:
    • Blood products
    • Surgeon
# Recognition: Hemorrhage

<table>
<thead>
<tr>
<th>Class</th>
<th>Bld loss</th>
<th>Pulse</th>
<th>BP</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>&lt;15%</td>
<td>&lt;100</td>
<td>NI</td>
<td>NI</td>
</tr>
<tr>
<td>Class 2</td>
<td>15-30%</td>
<td>&gt;100</td>
<td>NI</td>
<td>20-30</td>
</tr>
<tr>
<td>Class 3</td>
<td>30-40%</td>
<td>&gt;120</td>
<td>↓</td>
<td>30-40</td>
</tr>
<tr>
<td>Class 4</td>
<td>&gt;40%</td>
<td>&gt;140</td>
<td>↓↓</td>
<td>&gt;35</td>
</tr>
</tbody>
</table>

- Any idiot can recognize Class 3 Bleeds (Trauma Center criteria)—but shock starts way before that!
- Elderly, pedi, folks on beta blockers don’t get tachy before they crash
- Persistent pulse > 100 is not just anxiety!
- Don’t assume agitation + smell of EtOH is “just drunk”
- Anxiety and agitation are early signs of shock
Back to Basics: A’s & B’s

- **Airway:** Keep it open
  - Snoring ("he’s just drunk") is not a patent airway

- **Breathing:**
  - **Oxygenation:** High flow O2 even if nl O2 sat
  - **Ventilation:**
    - Positive pressure breathing drops preload & BP
    - **Ventilate at 8-10 breaths/minute in shock MAX**
    - If assisted ventilation, End tidal CO2 goal 30-35
Hemorrhage Control

BACK TO BASICS:

• Direct pressure
  • Don’t stop too soon
  • Bleeds thru—add gauze & press harder
  • Pressure dressing + direct pressure

• Elevate limb

• Pressure points

• Fractures: immobilize (pelvis, too)
EMS Concern: Scene Time

- Must keep track of time!!
- “Scoop and run” vs. “stay and play”
- Goal: MAX of 10 minutes on scene for major trauma
- Reminder that if mechanism of injury is high risk, then patient who looks like “minor” injury may crash as a surprise—so still not good to “stay and play”
- Common preventable delays: trying to get IV access on scene vs in route or not at all, or to intubate when BVM is good enough
Fluids: Access and Delivery

- **IV access:** yes if fast but don’t delay transport by more than 1-2 minutes; personal safety is important if trying to start in a moving ambulance
- **IO in adults:**
  - Proximal tibia, distal femur, humerus, sternum
  - Must flush with 10 ml saline to get good flow
  - Use pressure bag
  - Fine for any fluid, drug, blood transfusion
  - Awake patient: push lidocaine (3 ml of 1:10,000), wait 2-3 min, then flush and use
Fluid Resuscitation: Goals

- General goal; how much is enough?
  - Restore and maintain adequate tissue perfusion
  - But is hemorrhage controlled or uncontrolled???
  - Clinical parameters: vital signs
- Reassessment of response to IV bolus:
  - Rapid and maintained—great!
  - Transient—still bleeding somewhere; re-bolus and get to ED
  - Non-responder—still bleeding and/or has more problems; re-bolus and get to ED & surgeon ASAP
Permissive hypotension

- Controlled hemorrhage: Aggressive IVF to normal systolic BP is the goal
- But lower BP goal used for years in UGI bleeds, elective surgery, aortic aneurysms
- Potentially uncontrollable hemorrhage:
  - Deep torso injury, penetrating or blunt
  - Borderline BP is best goal in animal studies & randomized controlled trials in human trauma:
    - Houston (1980s) penetrating torso wounds
    - Baltimore (1990s) penetrating and blunt
Permissive hypotension

- Wound forms initial “soft clot” until fibrin added (takes 1/2 hr); until then, easy for clot to break apart
- Increased systolic BP risky before hemostasis:
  - Dislodges soft clot
  - Accelerates bleeding
  - IVF dilution of RBC mass and clotting factors
    - Limits oxygen delivery to tissue
    - Inhibits clot formation
- **Protocol for uncontrolled hemorrhage:**
  - IVF non-responder → permissive hypotension with goal SBP ~80 mmHg, palpable radial pulse, conscious
More food for thought: What’s next for prehospital trauma care?

- Better monitors of tissue perfusion?
  - Sublingual capnometry
  - Tissue spectroscopy
- Blood substitutes/HBOCs?
- Estrogens/progesterone dose for shock?
- ITDs?
Another Device: ITDs & Trauma

- Impedance Threshold Device
- Creates greater negative intrathoracic pressure during patient’s own breaths

- BUYS TIME in hypovolemic shock
ITD and hypovolemic shock

- Hemodynamic effects:
  - ↑ Preload
  - ↑ Coronary perfusion
  - ↑ Cardiac output, MAP, stroke volume
  - ↓ Intracranial pressure so ↑ cerebral blood flow

- Successful use by military in conscious patients with hemorrhagic shock

- Useful for nontraumatic hypovolemic states
Tourniquet References

- Beekley AC et al, military use. J Trauma 08; 64(2S) S28
- Bellamy RF, deaths in land warfare. Mil Med 84; 140 (2):55
- Mabry R, battlefield use, Middle East. Mil Med 06; 171(5): 55
- Rasmussen TE et al, military study, Iraq. Perspect Vasc Surg Endovasc Ther 06; 18:91
- Swan K, study re TQ site, type. J Trauma 09; 66(3):672
- Walters TJ, Mabry RL, military use. Mil Med 05; 170:770