



Case Studies: Opportunities For Improvement in Rural Trauma Care

Kevin T Collopy, BA, FP-C, CCEMT-P, NREMT-P
Performance Improvement & Education Coordinator
AirLink & VitaLink
Wilmington, NC



Disclosure

I receive no relevant financial support for speaking as a representative of any institution, medical group, agency, or company.

Photographs

Out of Respect for privacy and HIPPA, no photographs of the actual patients have been used

X-rays and CT scans are from the actual patients

Objectives

Discuss the significance of rural trauma

Identify reasons behind the increased morbidity and mortality from rural trauma

Explore three rural trauma cases with unique patient presentations

Highlight opportunities for improvement in rural trauma care

Why Rural Trauma



60% of all injury deaths
20% US Population

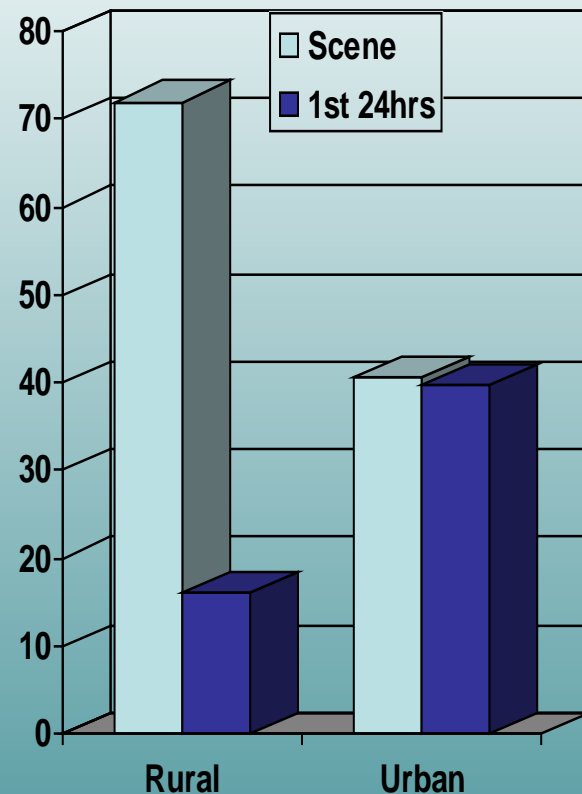
Rural Trauma Mortality

Frederick B Rogers MD et al, *Trauma Deaths in a Mature Urban vs Rural Trauma system* (Arch Surg. 1997; 132(4): 376-382)

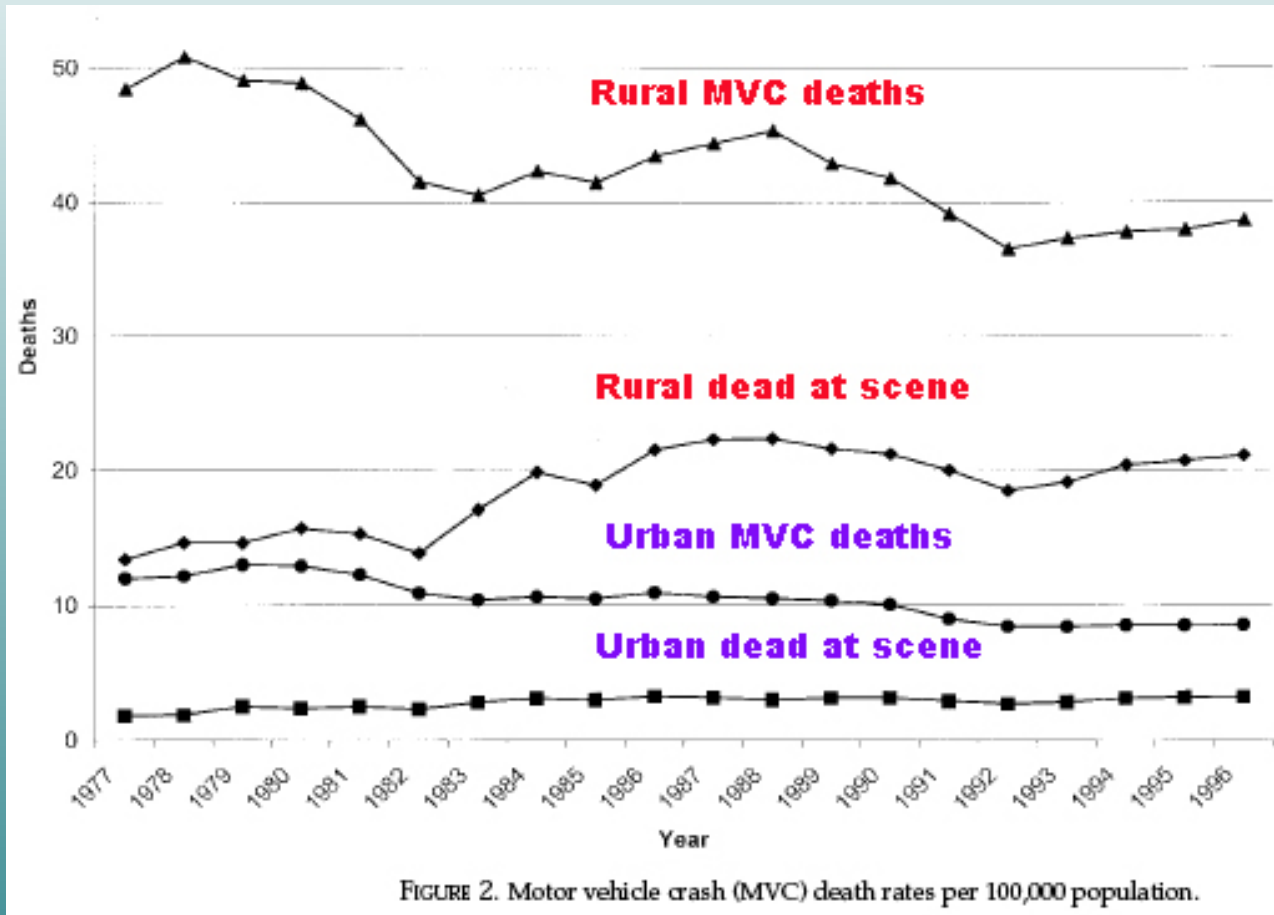
Evaluated death rates in rural and urban settings

Conclusions:

- Fatalities likely to occur prior to hospital arrival
- Rural patients older, more co-morbidities, less severely injured, increased multi-system organ dysfunction
- Increased deaths likely due to
 - Extended discovery & transport time



Rural vs Urban MVC Death Rates



Brown *et al*, Rural vs Urban Motor vehicle Crash
Death Rates

Why a Higher Mortality?

- Gonzalez Richard P MD, et al, ***Increased Mortality in Rural Vehicular Trauma: Identifying Contributing Factors Through Data Linkage***, Journal of Trauma-Injury Infection & Critical Care 2006 61(2): 404-409
- Seeking reasons for increased rural MVC related deaths

Determined
mortality
affected by:

Increased EMS Response
time

Increased scene time

Increased distance to
trauma center

Why a Higher Mortality?

Table 2 Type of Vehicle by Location and Mortality

Vehicle	Rural			Urban		
	Survivors	Mortalities	Total	Survivors	Mortalities	Total
ATV	8	1	9	1	0	1
Bicycle	10	1	11	18	0	18
MVC	2,865	113	2,978	1,548	27	1,575
Motorcycle	52	3	55	17	2	19
Pedestrian	4	11	15	7	6	13

Why a Higher Mortality?

Table 3 Response Times and Location versus Mortality

Location	Number of Patients	Mean Response Time (min)	<i>p</i> Value (t test)
Rural			0.0002
No mortality	2,939	11.2	
Mortality	129	13.9	
Urban			0.691
No mortality	1,591	7.1	
Mortality	35	6.8	

Table 4 Response Times and Mortality versus Location

Location	Number of Patients	Time on Scene (min)	<i>p</i> Value (t test)
Rural			0.420
No mortality	2,939	14.8	
Mortality	38	16.1	
Urban			0.60
No mortality	1,591	10.9	
Mortality	15	11.6	

Table 7 EMS Transport Times and Location versus Mortality

Location	Number of Patients	Mean Transport Time (min)	<i>p</i> Value (t test)
Rural			0.0156
No mortality	2,939	14.0	
Mortality	38	10.3	
Urban			0.469
No mortality	1,591	9.6	
Mortality	15	8.9	

The Impact of Variation in Trauma Care Times: Urban Versus Rural

- Esposito, TJ, et al, *The Impact of Variation in Trauma Care Times: Urban vs Rural*, Prehospital Disaster Medicine, 1995 July-Sept; 10(3): 161-6
- Washington state study on MVC fatalities
- Conclusions on transport times and mortality
 - Prehospital transport times 2x longer in rural areas
 - Death rate 3 times higher in rural areas
 - Preventable death rates in rural incidents is double that of urban rates



The Patients are Different Too

A Comparison of Rural and Urban Trauma Patient Care, North Coast EMS Agency and Harbor-UCLA Research and Education Institute

1,123 trauma transports reviewed

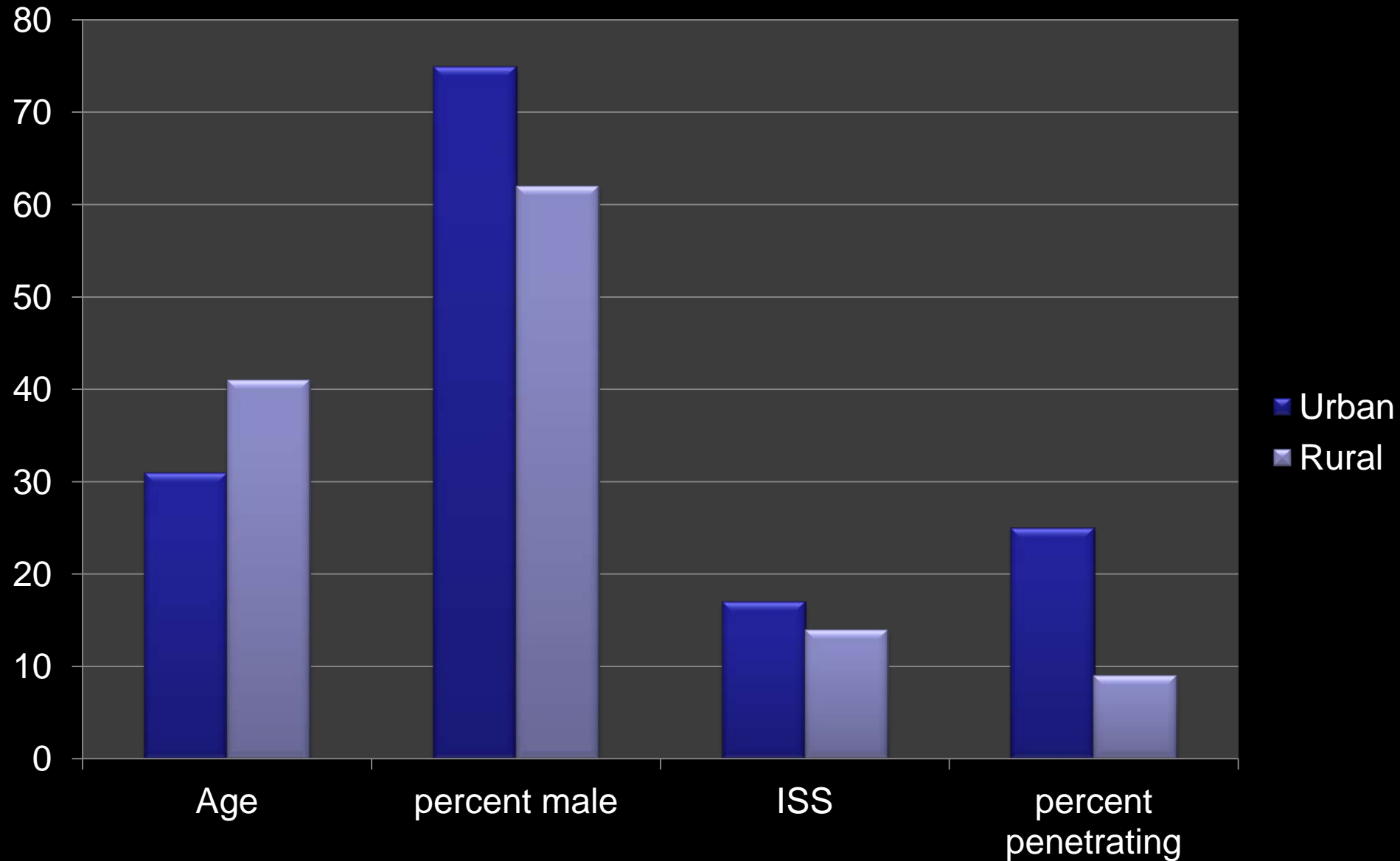
Conclusions:

Rural and urban trauma patients “fundamentally different”

Urban patients

- younger
- more seriously injured
- more penetrating trauma

The Patients



We Can Get Better

*Analysis of Preventable
Trauma Deaths and
Trauma Care
Improvement in Utah*

- Journal of Trauma-Injury Infection & Critical Care April 2011 70(4): 970-977
- Sanddal Terri, BS, REMT-B, et al

Goal

- Determine the nature of preventable trauma deaths
- Identify opportunities for improvement

Conclusion:

51% of preventable deaths had opportunities for prehospital care improvement

We Can Get Better

TABLE 3. Additional Criteria Warranting Consideration for OFI

Quality of Care Filters	Elapsed Time
Patient pronounced dead at scene	
Prehospital on-scene time	≥20 min
Prehospital transport time	≥20 min
Total prehospital time	≥30 min
Patient in ED	≥2 h
Patient died in ED	
Patient seen by initial physician	≥15 min
Patient experienced unplanned return to operating room	
Patient died	Within 24 h of admission
Patient in first hospital	≥90 min before transfer

OFI specifically related to documentation in the pre-hospital phase of care ranged from absence of vital sign recording, missing time elements (i.e., dispatch, scene, departure, and so on), pertinent narrative notes, and so on.

TABLE 6. Opportunities for Improvement of Care—by Phase of Care

Phase of Care (Patient Contacts)	Inappropriate Care Related to	Number of Occurrences*	Patient Contacts (%)	
Prehospital (n = 254)	Airway management	58	45	
	C-spine	10	8	
	Documentation	13	10	
	Fluid resuscitation	31	24	
	Medication	18	14	
Total prehospital		130		
ED (n = 248)	Airway management	28	17	
	Documentation	24	15	
	Fluid resuscitation	18	11	
	Evaluation of abdomen or chest	14	8	
	Inappropriate imaging/diagnostics	16	10	
	Management of chest injury	17	10	
	Other	39	24	
	Recognition of injury severity	9	5	
	Total ED		165	
	Post-ED (n = 141)	Documentation	4	7
Fluid resuscitation		2	4	
Inappropriate operation		17	30	
Management or monitoring of head injury		4	7	
Other		21	38	
Treatment of rebleeding		4	7	
Ventilator care		4	7	
Total post-ED		56		
Total all phases		351		

* Some patients were noted to have multiple errors in a single phase of care.

4 Ways to Improve Our Care Today

Performing thorough assessments to develop a complete problem list

Monitoring how patients change over time

Thinking “fix the small problem now, or deal with a big problem later”

Recognizing the additional consequences of delayed discovery and access



Today's Cases

Case 1: 11yr female water skiing incident

Case 2: 19yr male, snowmobile vs tree

Case 3: 25yr male, tree stand fall/hanging from tree

Today's Cases



Summer Camp Water Skiing Incident

Background

- Late July
- Ambient temp $>80^{\circ}\text{F}$
- Water temp $\sim 70^{\circ}\text{F}$

Dispatch time: **1530**

- Initial information: child injured in water skiing crash, arm amputation
- Local BLS ambulance dispatched



Elapsed time: 15min

BLS Gets the Story

11yr old Hispanic female on 3rd tier of waterskiing pyramid

Boat traveling ~35mph

Patient fell onto ropes, arm became entangled tearing lower left arm off

Patient pulled onto speedboat and brought to shore, still on boat

Elapsed time: 22min

Initial Actions

Assessment findings

- A&Ox4, anxious
- Denies LOC
- Complains of arm pain (10/10) and cold
- Minimal arm bleeding
- Degloving injury 2" distal from elbow becoming deeper distally until amputation 4.5" from elbow

Initial Actions

- ALS intercept requested
- Tourniquet applied and trauma dressing
- Ice packs to residual limb
- Oxygen via NRB
- HEMS requested (40min ETA)



Elapsed time: 35min

ALS Intercept Arrival

- Patient's chief complaint: "Am I going to die?"
- Assessment is same, documented "no active bleeding."
- Interventions:
 - Cut off wet clothing
 - Heat in ambulance "to prevent shock"
 - Intravenous access, 20ga, NS 75mL/hr
 - Cardiac monitoring

Baseline vitals: 1546

pulse: 117

resp: 22

blood pressure 119/74

GCS: 15

Skin: pale cold dry

Pain: 10/10



Elapsed time: 40min

A Decision to Make

20min to local ED
via ground

3 hours to peds
trauma center via
ground

Wait 25min for
HEMS arrival



Decided to drive to local ED to meet HEMS
on their helipad

Elapsed time: 65min

HEMS Arrival

Patient is found on stretcher, seated 45° angle, crying, obviously scared and anxious

Arm is covered in bandage, tourniquet has been removed, no bleeding

Remaining clothing removed

Report given to flight team

Elapsed time: 68min

But Wait a Moment...

What happened to our patient?

Fell how far?

Traveling how fast?

Was she run over?

What is really wrong
with our patient?

Working Problem List



Elapsed time: 70min

Initial HEMS Actions

Spine stabilization
(regular longboard)

25mcg Fentanyl

Full physical exam

Complete history

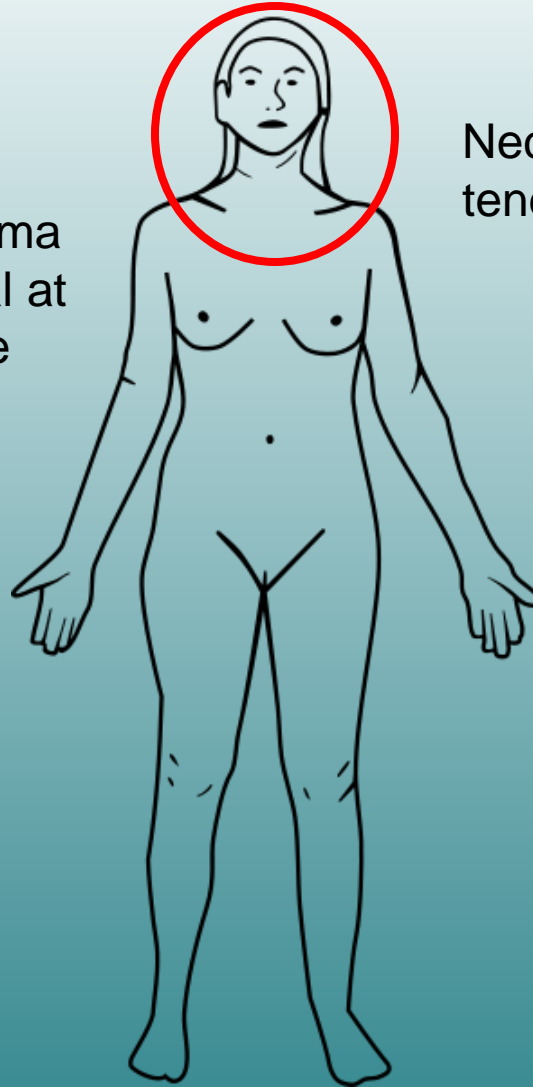


Past Medical History

- S/Sx: as noted previously
- A: No known drug allergies
- M: No home medications
- P: Plate glass injury, age 8
 - 6 hours reconstructive surgery
 - Several scars remain
 - Required in-patient psych counseling
- L: last meal at noon, urinating and defecating normally
- E: As previously stated

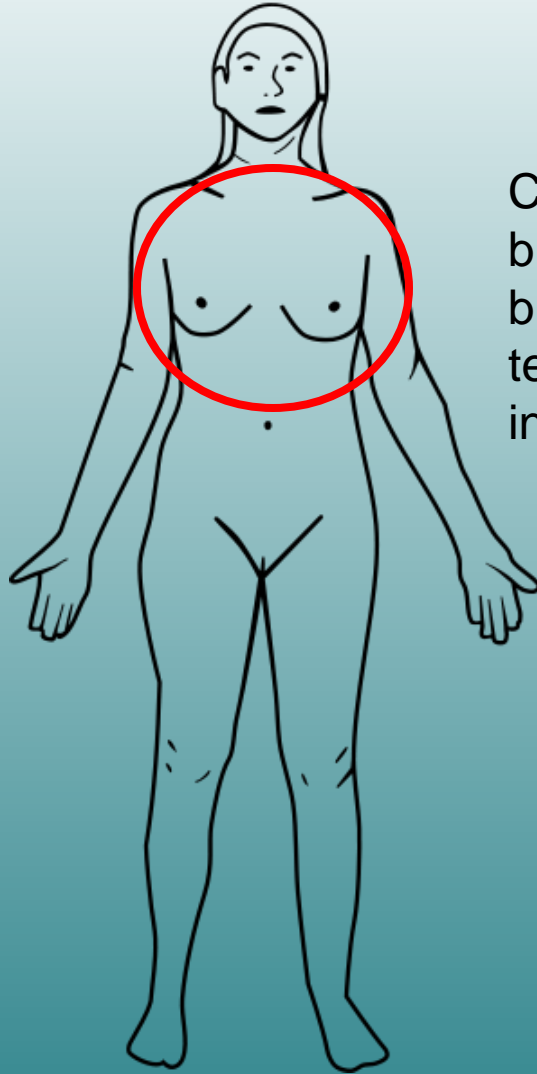
Head to Toe Exam

HEENT: airway self-maintained, no recent trauma noted to head, pupils equal at 4mm and reactive, multiple healed scars



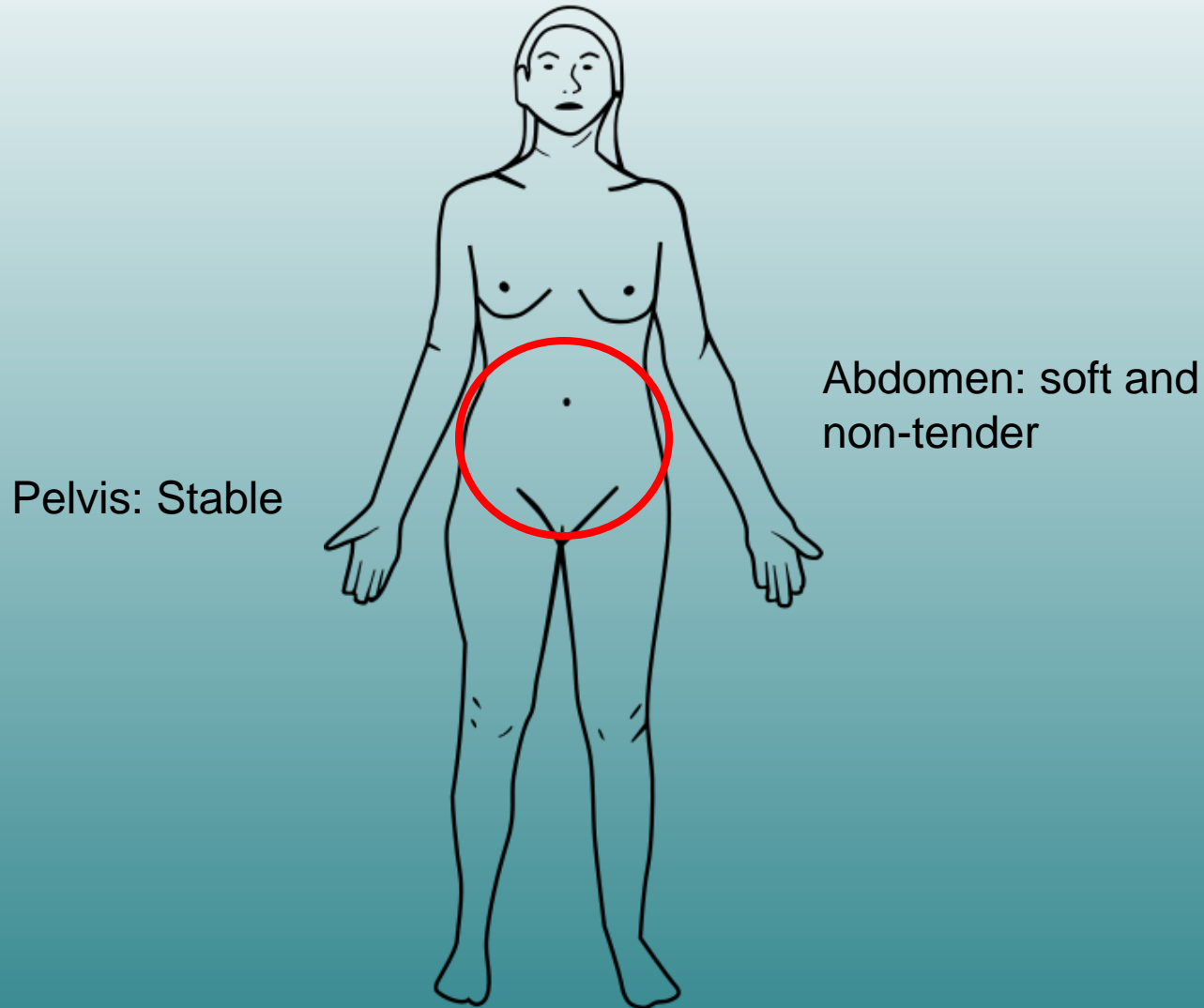
Neck: trachea midline, no tenderness, no JVD

Head to Toe Exam



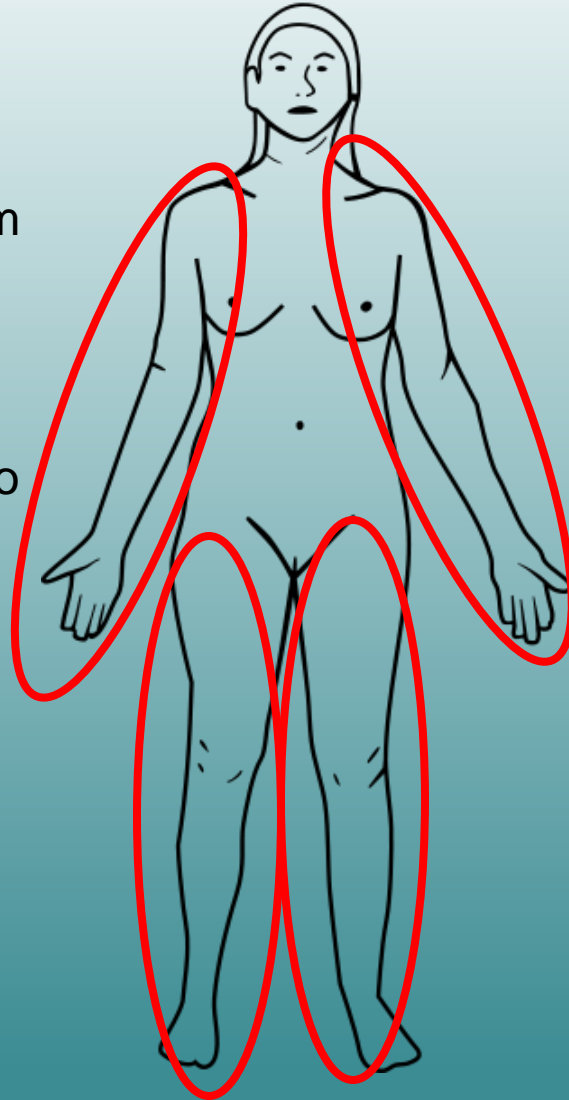
Chest: multiple healed scars,
breath sounds equal
bilaterally, right lateral chest
tenderness, no pain on deep
inspiration

Head to Toe Exam



Head to Toe Exam

- Extremities: left lower arm has circumferential degloving injury with complete amputation, remaining extremities have strong pulses with no evidence of injury and intact motor and sensory response



Skin: now pink warm and dry

Back: no signs of injury other than a rope mark across the lower back, no spine tenderness

Vital Signs

TIME	Pulse	B/P	Resp	Pain level	SpO₂
<u>1545</u>	117	119/74	22	10	99%
<u>1600</u>	107	127/99	20	10	100%
<u>1625</u>	104	132/94	20	8	100%

Problem List

EMS Assessed

Amputated Arm

Shock

Possible severe bleeding

HEMS Assessed

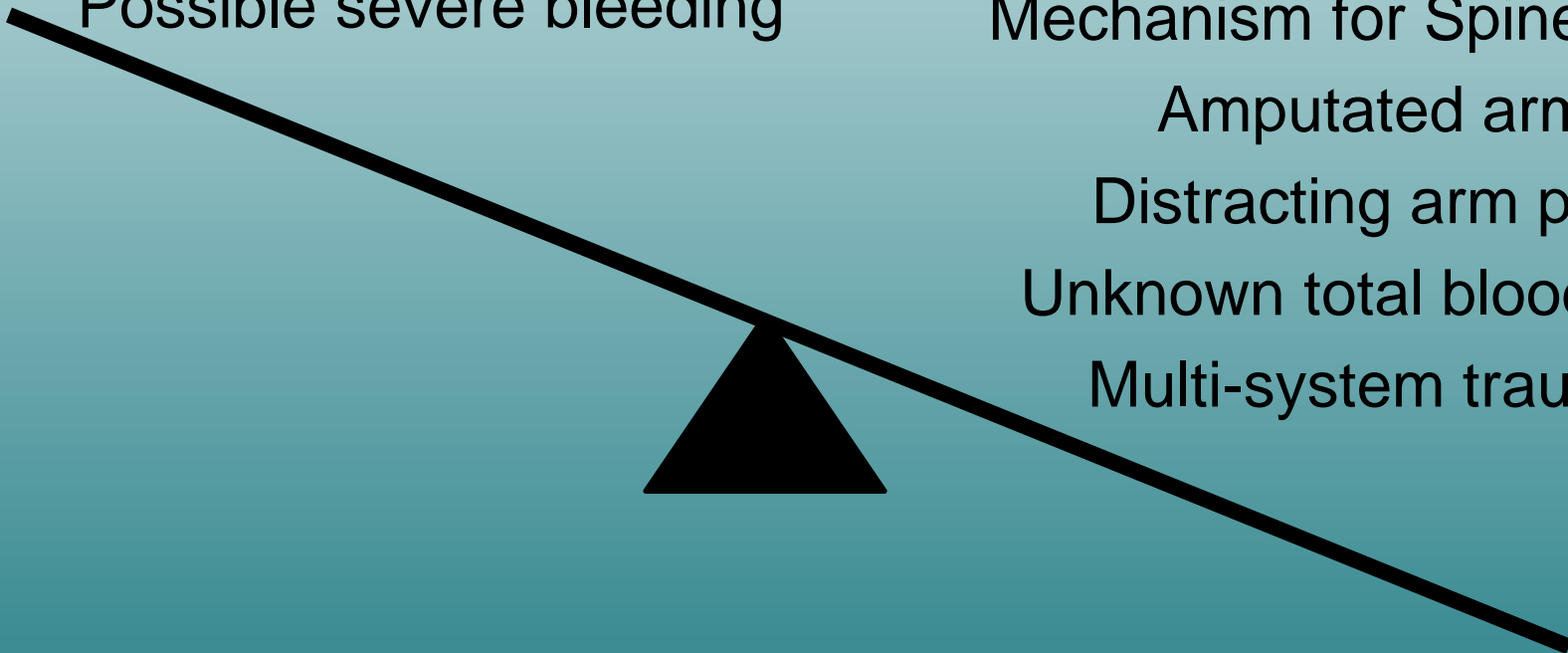
Mechanism for Spine Injury

Amputated arm

Distracting arm pain

Unknown total blood loss

Multi-system trauma



Why the Disconnect?

Injured
children
heighten
rescuer
anxiety

Very
distracting
injury

Patient
brought to
shore by
counselors

EMS
classroom
teachings



What are the Real Problems?

Mechanism for Spine Injury

Arm amputation with degloving injury

Distracting injury

High risk for infection

Multi-system trauma

Significant blood loss

Shock

Multi System Trauma?



- Pt moving >35mph
- Fell from height
- Run over by skiers

Systems affected:

- Musculoskeletal system
- Nervous system (spine)
- Circulatory system
- Integumentary system
- Immune system

Shock?

Shock

- A clinical syndrome where the body's organs are not receiving adequate oxygenation and nutrients resulting in life threatening cellular dysfunction
- Types
 - Hypovolemic
 - distributive
 - obstructive
 - cardiogenic

Acute Stress Reaction

- A transient condition mediated by a stressful event that triggers a release of chemical mediators, that can mimic shock, but resolves once the stress is removed
- Types
 - Sympathetic
 - parasympathetic

Shock?

- Evidence for shock?
 - Hypovolemic
 - Pale skin
 - Mental status changes
 - Spinal shock?

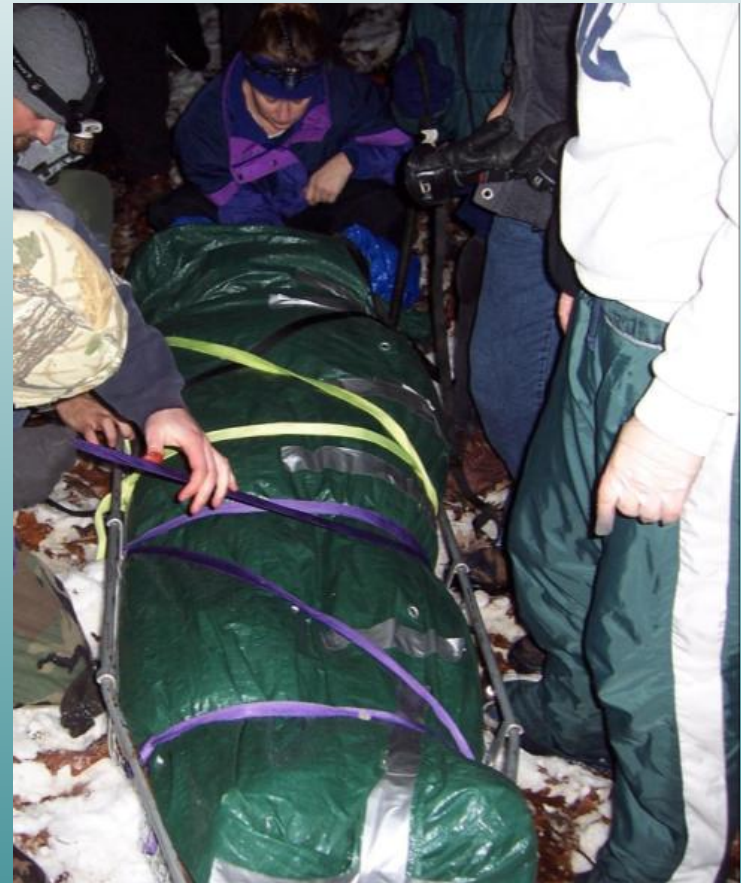


No
evidence

Does temperature influence
shock?

They Turned Up the Heat

- Preventing cold is important because....
 - Hypothermia slows coagulation by up to 40%
 - Hypothermia slows healing
 - Hypothermia decreases neuron activity
 - Hypothermia causes cardiac irritability
 - Hypothermia depletes energy stores
 - Hypothermia slows metabolism



Elapsed time: 76min

In Flight

- Pain management
 - Fentanyl 25mcg every 20min
- Fluid management
 - Normal Saline KVO
 - No symptoms of shock

Elapsed time: 95min

In Flight

Psychological management

- Considerations
 - From Mexico
 - English second language
 - Second traumatic injury
- Actions
 - Requested translator
 - Constant comforting/reassurance

Elapsed time: 100min

In Flight

With 10min remaining in the flight, patient asks,
“When are they going to put my arm back on?”



How does one respond?

Elapsed time: 110min

Trauma Center Arrival

- Negative CT of
 - Head
 - Neck
 - Chest
 - Abdomen/pelvis
- Full trauma lab panel
hematocrit 41,
hemoglobin 11.8
- Arm was never
recovered



Trauma Center Management

6 day admission to Pediatric Trauma Center

Operative repair of residual limb

Skin graft from thigh

Wound-V.A.C. application

Psychology consultation



Take Away Points

Low volume high intensity events

- Leads to increased potential for missing more serious problems

Go back to, and trust your assessment for identifying problems

As anxiety wears off, be prepared to manage psychological concerns

Elapsed time: 0min

Case 2: Snowmobile vs Tree

Background

- Late December
- Dark by 1700
- Ambient temperatures 25°F

Dispatch time: 1912

- Snowmobile crash in national forest
- Snowmobile rescue also responding



Elapsed time: 64min

Patient Access



EMS at trailhead
by 1933

- Several miles from trailhead
- Mature, non harvested forest
- 45 min of searching to access patient
- HEMS requested during search at 2000

Elapsed time: 65min

Initial Assessment



- Presentation: 2016
 - 19yr old male seated upright
 - Chest pain 10/10
 - Difficulty breathing (pursed lips)
 - Blood around mouth
 - Slightly combative
 - >2min period of unresponsiveness
 - Thrown >10'
 - Major damage to snowmobile

Elapsed time: 80min

Scene Management



Attempted
oxygen

Attempted
cervical collar

Placed seated
on long board

- Lying down
increases pain

Manual
stabilization
maintained

Transported
via rescue
sled to closest
trail head

Elapsed time: 95min

Ambulance Care

- Loaded into heated ambulance: 2035
 - Oxygen 15LPM
 - Clothing removed
 - Assessment performed
 - IV access x2
 - Medications
 - Fentanyl
 - Zofran
 - Cardiac monitor

Baseline vitals: 2042

pulse: 100

resp: 28

blood pressure 139/98

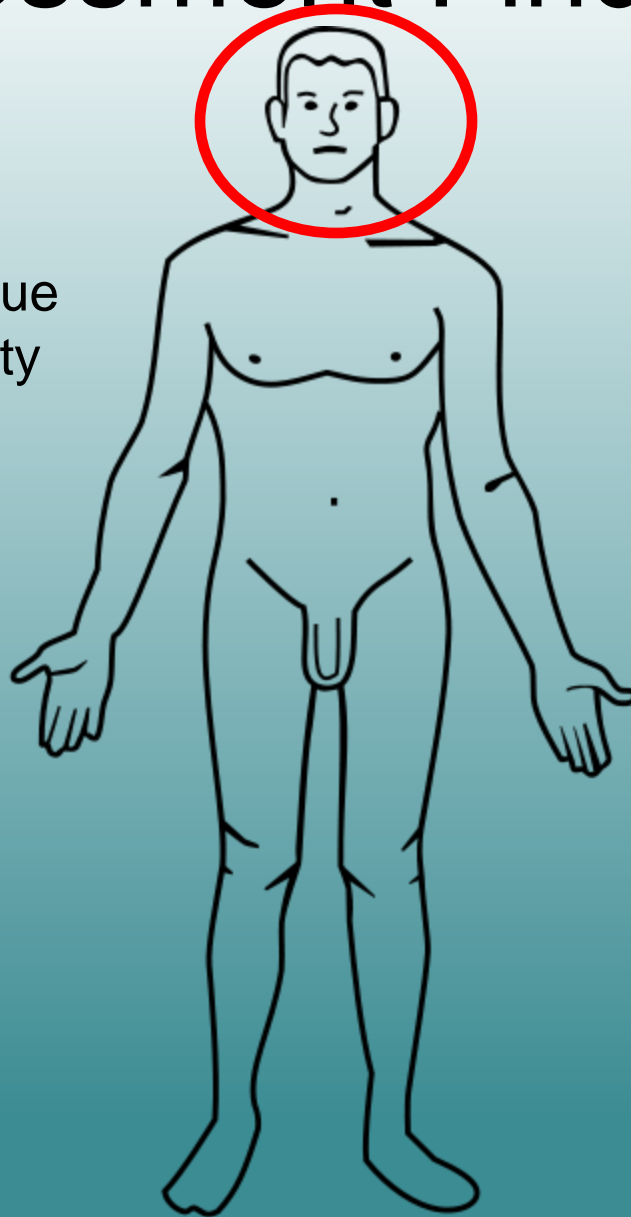
GCS: 15

Skin: pale cold dry

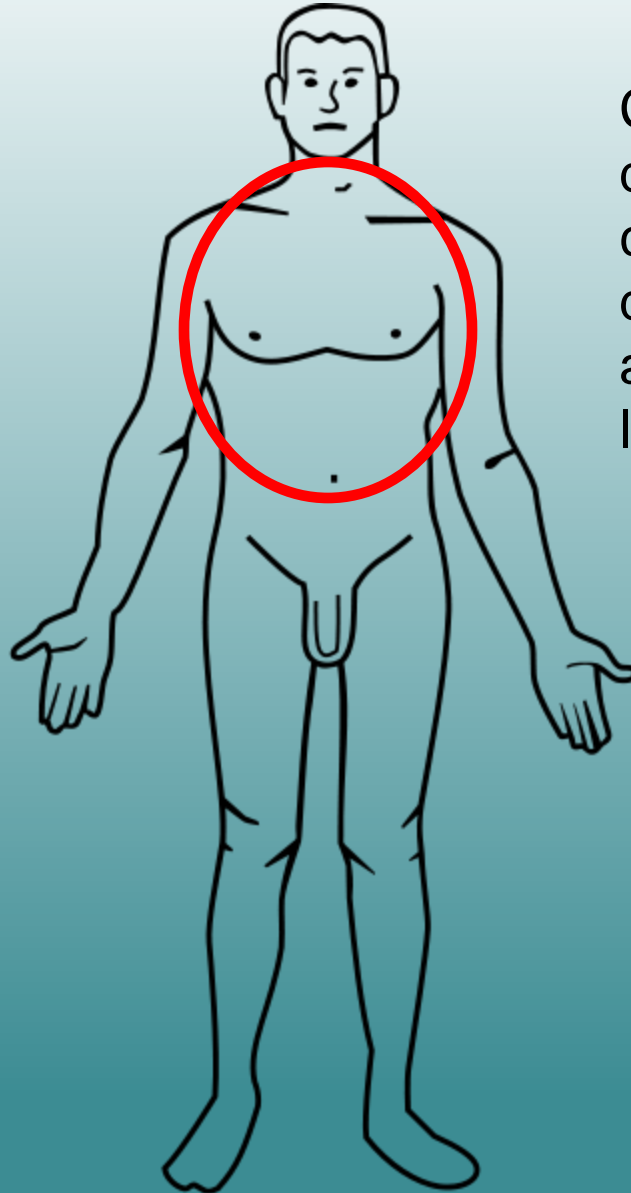
SpO₂: 94% (on oxygen)

Assessment Findings

Pupils PERRL, no blood or deformity in ears or nose; dried blood on mouth, tongue lacerated, no deformity or tenderness in the head

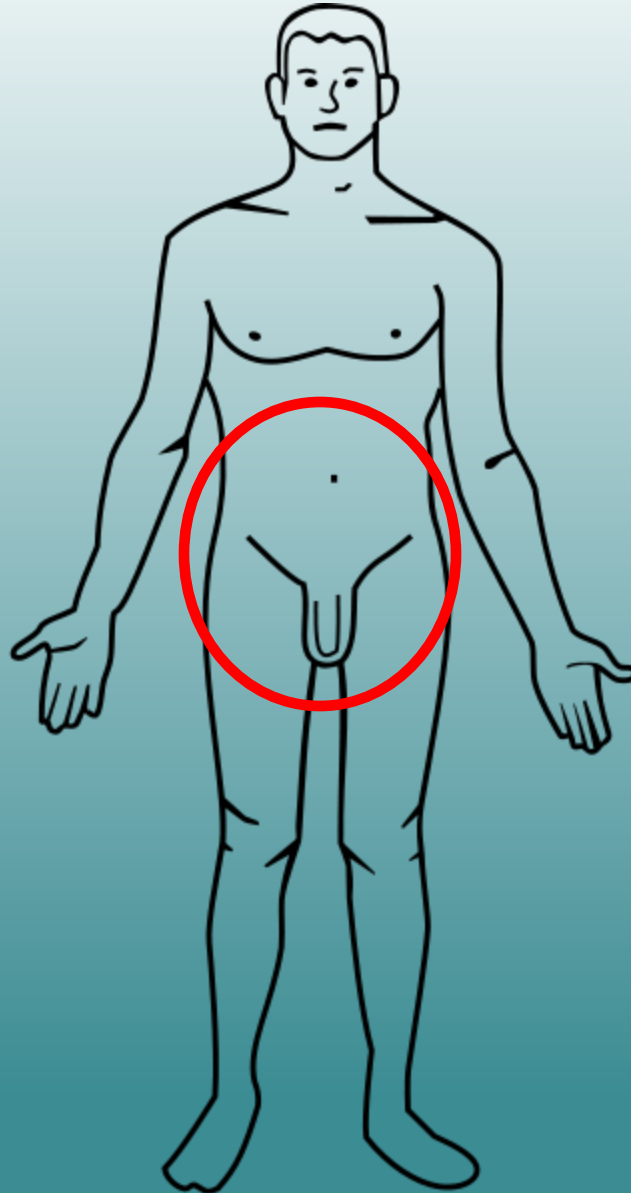


Assessment Findings



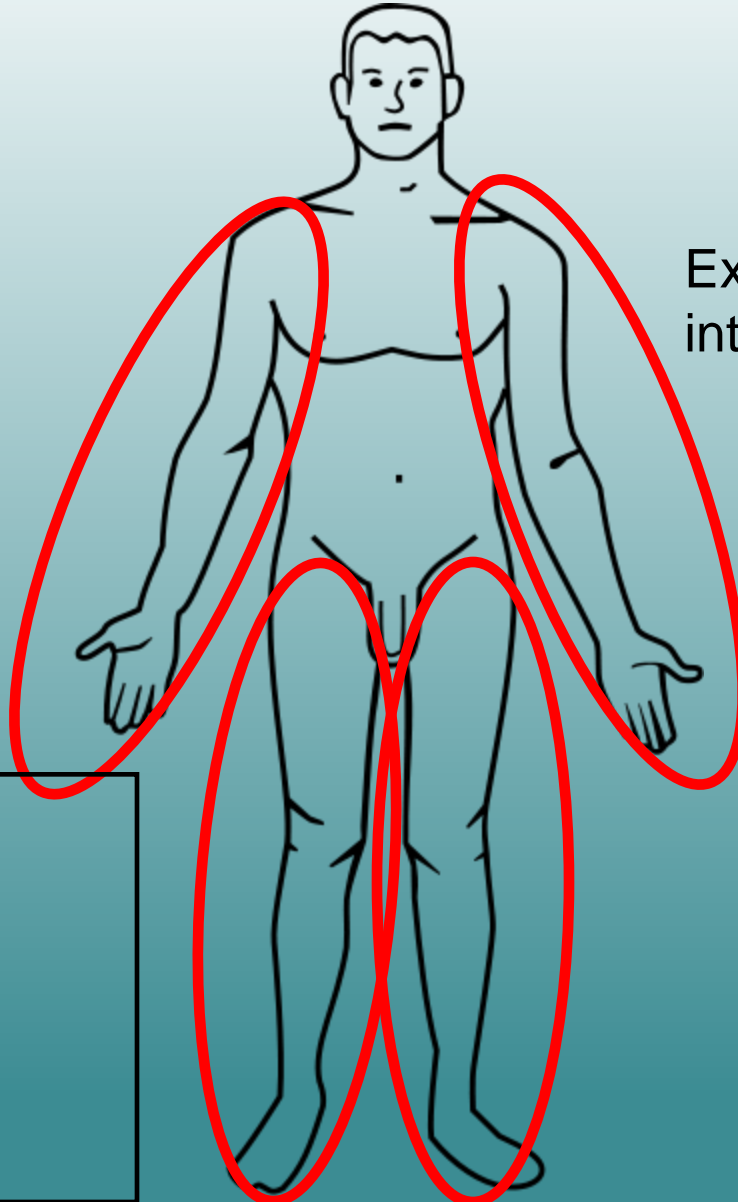
Chest: no bruising, deformity, or uneven chest rise. Lungs are diminished upper left and bilateral lower lobes

Assessment Findings



Abdomen: soft, no
tenderness, pelvis is
stable

Assessment Findings



Extremities atraumatic,
intact CSMx4

Repeat vitals: 2055

pulse: 85

resp: 26

blood pressure 152/93

GCS: 15

Skin: pale cold dry

SpO₂: 94% (on oxygen)

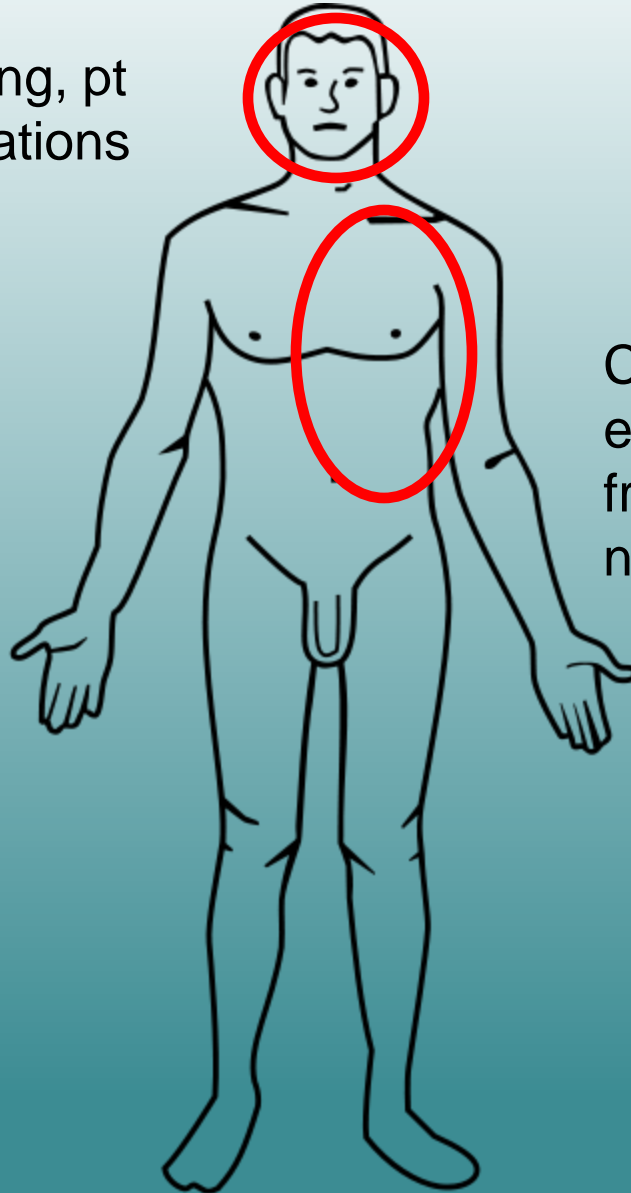
Elapsed time: 120min

HEMS Arrival

- Patient contact made 2100
 - Pt upright on cot
 - Manual stabilization (no c-collar)
 - Complaints
 - Respiratory distress becoming worse
 - Chest pain (no relief)

New Assessment Findings

Pursed lip breathing, pt
focused on respirations



Chest: subcutaneous
emphysema left chest
from collarbone to
nipple

Decision Time

Don't RSI

GCS 15

Airway maintained

SpO₂ OK on O₂

RSI

Pursed lip breathing

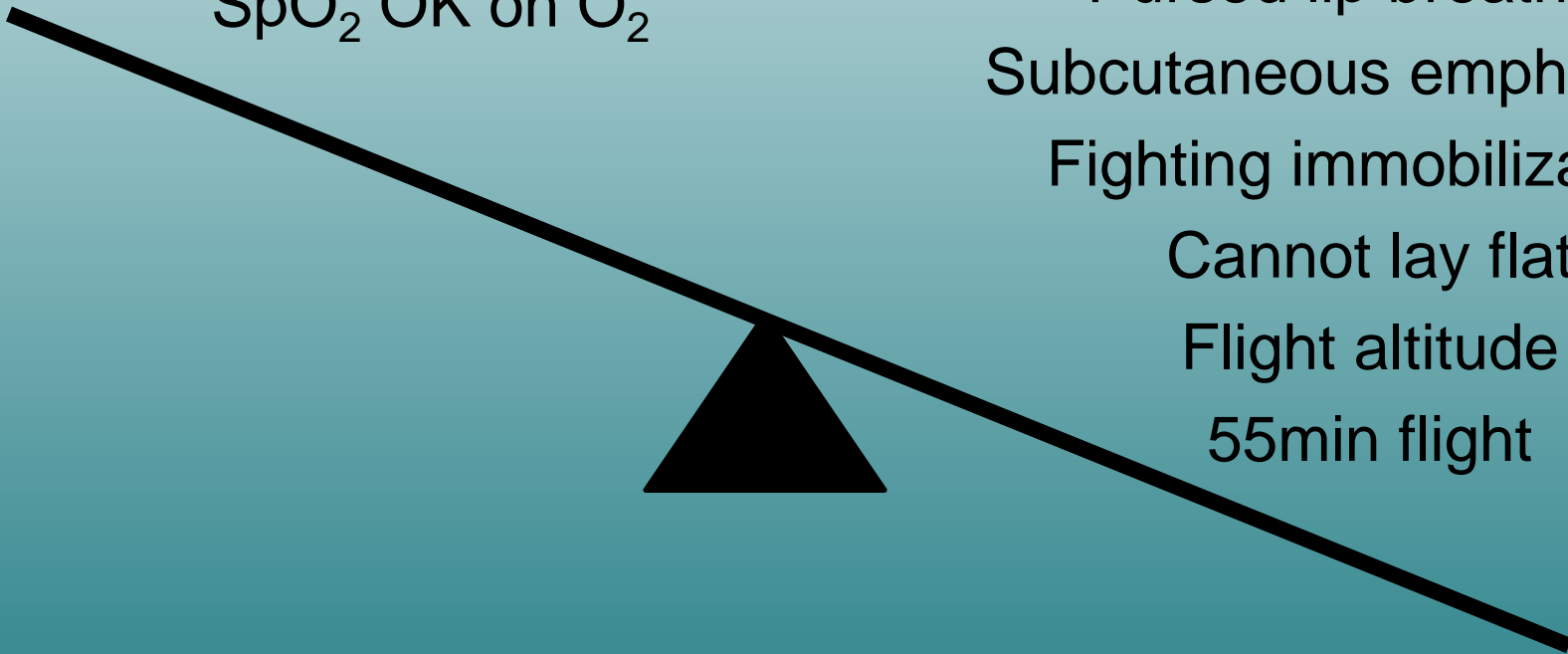
Subcutaneous emphysema

Fighting immobilization

Cannot lay flat

Flight altitude

55min flight



Rapid Sequence Intubation

- Medications
 - Fentanyl
 - Etomidate
 - Succinylcholine
- Oral tracheal intubation 8.0 ID
 - EtCO₂
 - Bilateral breath sounds
 - Cord visualization



Elapsed time: 140min

Post Intubation

Full immobilization

Continued sedation
and paralytics

EMT reports at 2117

- Difficult to ventilate
- Increased subcutaneous emphysema noted left chest
- Breath sounds now absent on left

Chest decompression
via Turkle needle

- Positive airflow return
- Increased compliance noted
- Breath sounds return



Elapsed time: 157min

HEMS Transport

- Airborne: 2137
- Medications
 - Fentanyl 300mcg total
 - Midazolam 5mg initial, 2mg x3
 - Vecuronium 10mg total

Vitals: 2130

pulse: 88

resp: 12

blood pressure 147/92

GCS: 1,1,1: 3

Skin: pale cold dry

SpO₂: 98%

EtCO₂: 36mmHg

Repeat vitals: 2200

pulse: 91

resp: 12

blood pressure 148/92

GCS: 3

Skin: pale cold dry

SpO₂: 85%

EtCO₂: 30mmHg

Repeat vitals: 2115

pulse: 85

resp: 12

blood pressure 153/98

GCS: 3

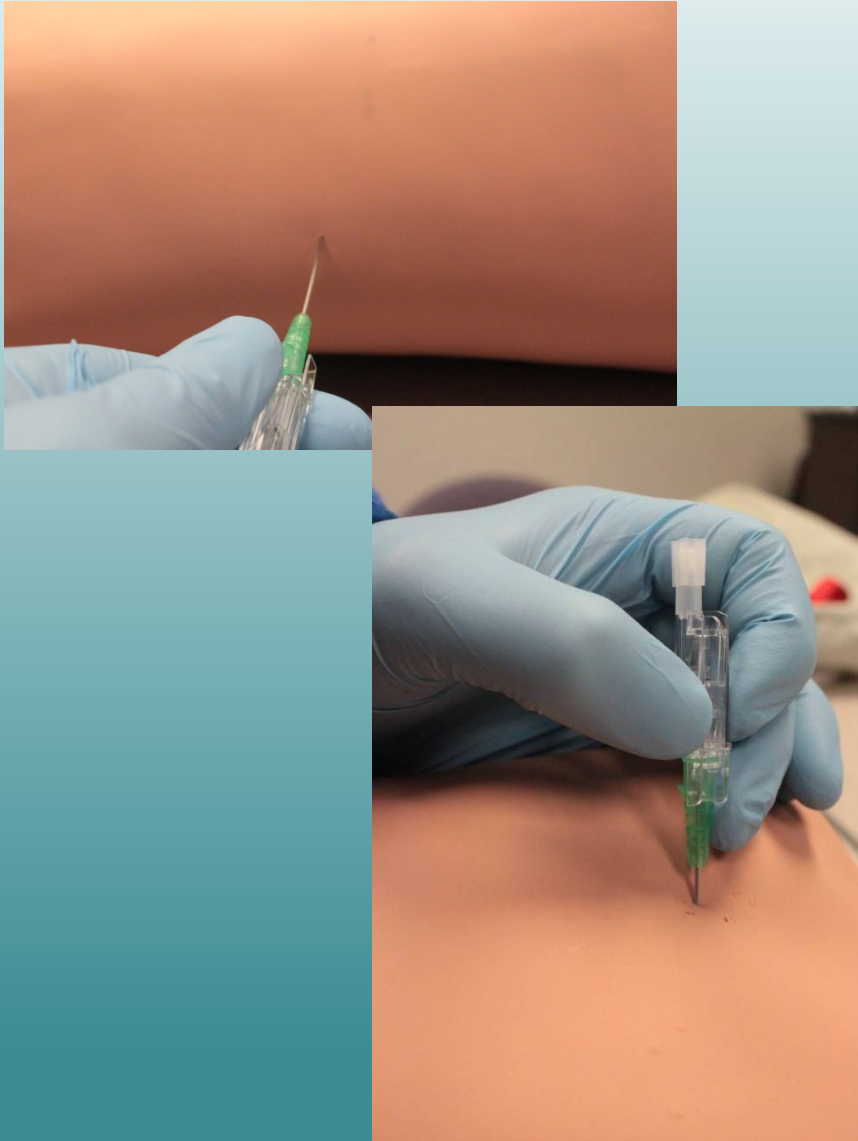
Skin: pale cold dry

SpO₂: 99%

EtCO₂: 34mmHg

Elapsed time: 180min

Challenges Arise



- 2150-2215 progressive...
 - Increasing difficulty ventilating
 - Subcutaneous emphysema right chest
 - Decreasing SpO₂ levels
- Needle chest decompressions
 - Right anterior chest 18ga needle
 - Left mid-axillary line 18ga needle
- Improved SpO₂ levels, continued poor compliance

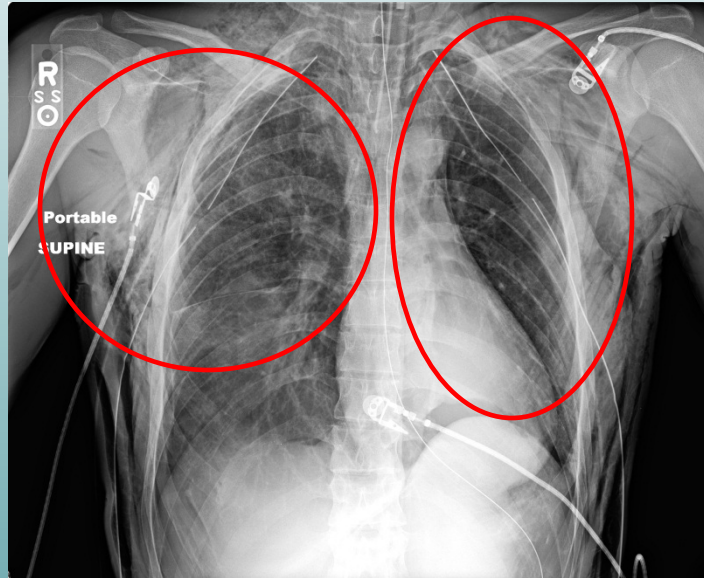
Elapsed time: 210min

Trauma Center Arrival

- SpO₂ stable remainder of flight
- Despite exposure, core temperature 98.2°F
- Subcutaneous emphysema
 - Abdomen
 - Pelvis
 - groin



Trauma Center Findings



Chest x-ray

Right hemopneumothorax
worse than left



Head CT

Intracranial hemorrhage and
swelling

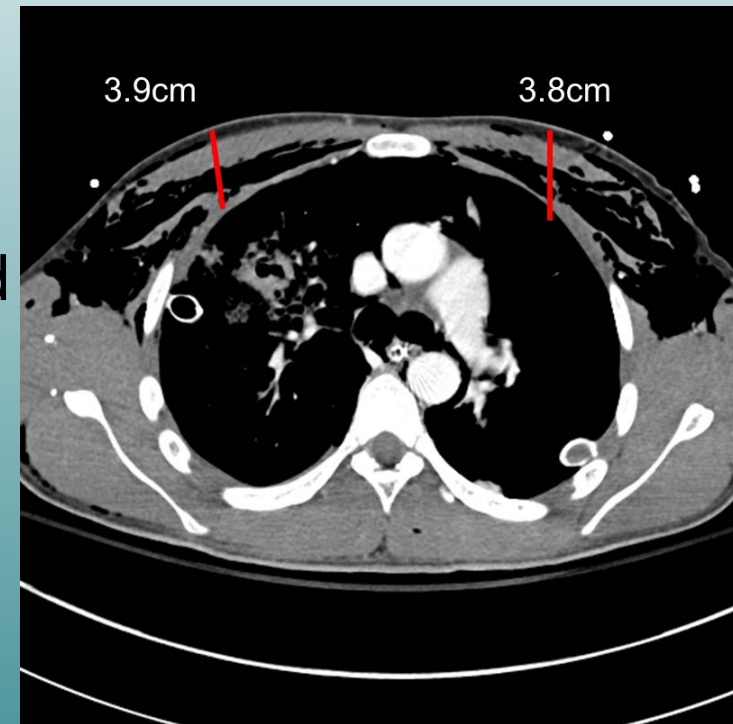
Additional Findings

- T1 fracture
- Right clavicle fracture
- Right first rib fracture
- Sternum fracture
- Initial labs:
 - pH 7.25
 - pCO₂ 53
 - pO₂ 130
 - Hgb 14.5



Diffuse Subcutaneous Emphysema?

- Present from clavicles to groin
- Not typical of lung injury
- Exploratory surgery performed
 - Fascia ruptured along chest and abdomen wall
 - Requires stretching forces
 - Allowed air to leak down abdomen
 - Exacerbated by flight?



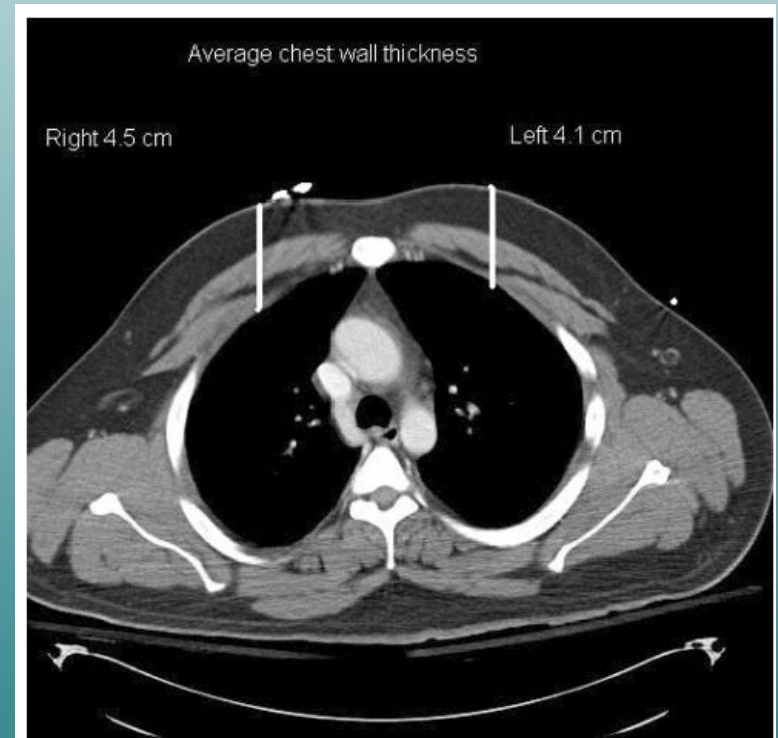
Trauma Center Management

- Admitted to the trauma/surgical intensive care unit for 2 weeks
 - Previously mentioned exploratory surgery
 - Surgical sternum repair
 - Surgical clavicle repair
 - Chest tubes in place for 10 days (L) and 21 days (R)
 - Intracranial hemorrhage non-surgical
 - T-1 fracture did not require surgery
- Discharged after 22d to rehab facility

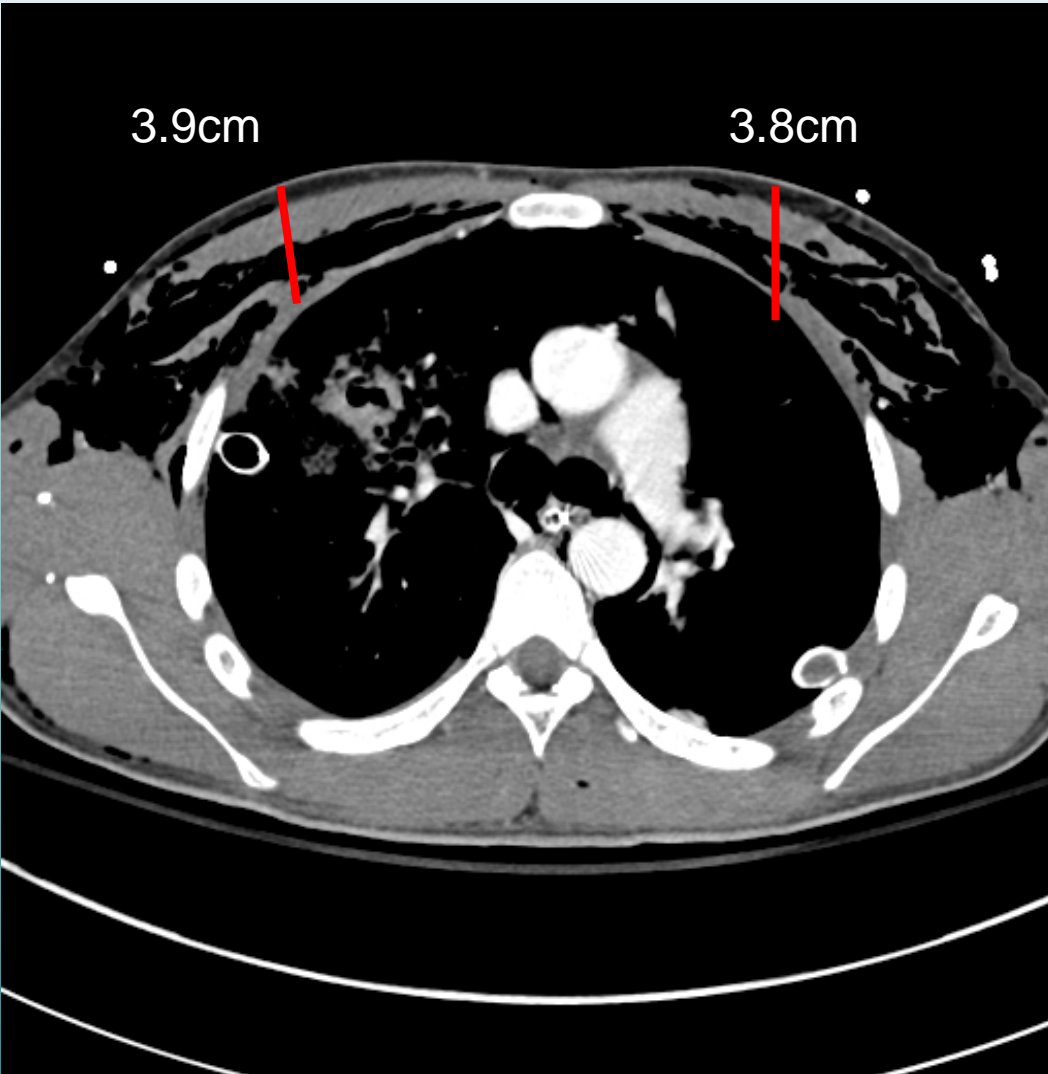
Chest Depth and Needle Chest Decompression

- Robert L. Stevens, et al, ***Needle Thoracostomy for Tension Pneumothorax: Failure Predicted by Chest Computed Tomography***, Prehospital Emergency Care Jan/March 2009, vol 13(1)14-17
- 110 cases
- Standard needle 4.4cm, <2in

Standard angiocath needle is unsuccessful in 50% of needle chest decompressions



Needle Chest Decompression



Take Away Points

Consequences of delayed access

- Would RSI have been needed?
- Would chest decompression have been needed?

Decision to delay assessment to ambulance

Patients change over time, >3hrs from accident to trauma team

- Slow spread of subcutaneous emphysema

Case 3: Fall From Tree Stand

Background

- Early December
- Light snow cover
- Hunting season
- Ambient temperature
15°F

Dispatch at 1725

- Man found hanging from
tree
- HEMS Auto launch



Elapsed time: 15min

EMS & Rescue Arrival

Accessed <1/2mile into forest

Patient found ~15' above ground

- ~4-5' below tree stand
- Pelvis harness
- Uncontrollably shivering
- Awake and lethargic
- Chief complaint
 - Cannot feel legs
- Hanging >3hours



Elapsed time: 25min

Removal

- Extrication took 20min
- Rope rescue system used
- Moved via ATV to ambulance
 - 8min drive



Elapsed time: 35min

BLS Assessment

- Removed clothing
- Placed cardiac monitor
- “in and out of consciousness”
- “complains of no feeling in both legs”
- On physical exam
 - Intact weak motor skills in all extremities
 - No sensation lower extremities

Baseline vitals: 1800

pulse: 90

resp: “fatigued”

blood pressure: N/D

GCS: 3,2,1 = 6

Skin: pale and cold

SpO₂: not documented

Elapsed time: 42min

HEMS Arrival

- Documented: 20' above ground
- Primary assessment
 - A&Ox0
 - Violent shivering
 - “pt does not respond”
 - Cold to the touch

repeat vitals: 1806

pulse: 67

resp: 6 and shallow

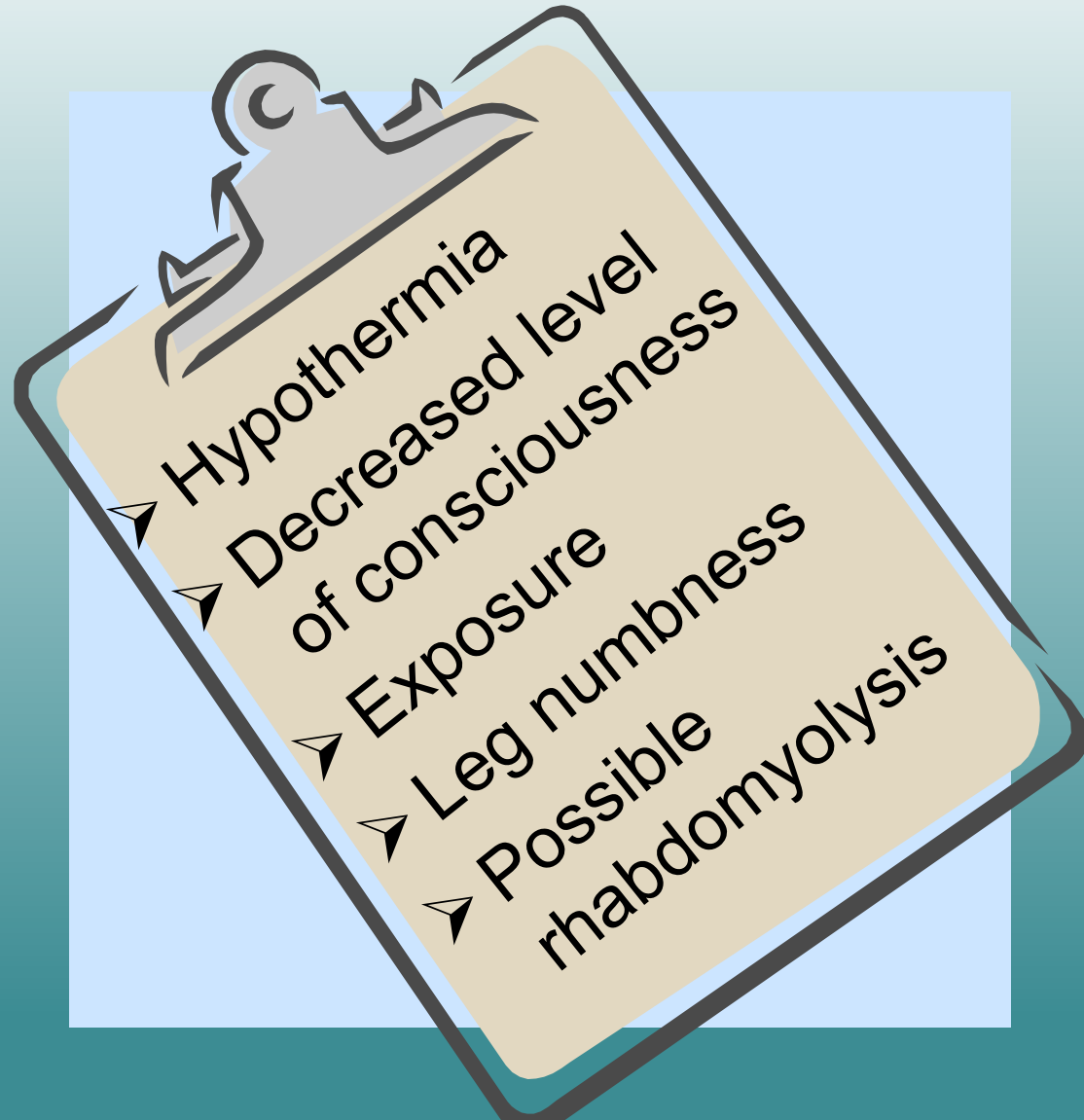
blood pressure: 114/83

GCS: 1,1,2 = 4

Skin: pale and cold

SpO₂: not documented

Problem List



▶ Hypothermia

▶ Decreased level
of consciousness

▶ Exposure

▶ Leg numbness

▶ Possible
rhabdomyolysis

Interventions

- IV Access
 - One IV placed
 - Warmed IV fluids
 - Rapid Sequence Intubation
 - Routine medications
 - 8.0 ID ETT on first attempt
 - Atropine at 1808
 - Unclear reason

repeat vitals: 1813

pulse: 108

resp: 12 assisted

blood pressure: 174/109

GCS: 1,1,1=3

Skin: pale and cold

SpO₂: 100

EtCO₂: 41mmHg

Elapsed time: 60min

HEMS Transport

- Continuous warmed IV Fluids
- Medications
 - Fentanyl
 - Midazolam
 - Vecuronium
- Hot environment provided
- Physical exam
 - No other evidence of trauma
- Vital signs remained stable



Elapsed time: 60min

Trauma Center Arrival

- Remained intubated
- All CT scans negative for injury
- Pertinent Labs
 - CK 205 (50-400)
 - pH 7.42 (3.5-7.45)
 - pCO₂ 35 (34-45)
 - Lactate 1.2 (<2)

arrival vitals: 1840

pulse: 186

resp: 12 assisted

blood pressure: 141/85

GCS: 1,1,1=3

Skin: pale and cold

SpO₂: 100

EtCO₂: 41mmHg

Temp: 98.6°F oral, 96.6°F (bl)

Trauma Center Care

Admitted to SICU

Extubated after 6 hours

Lower extremity sensory
loss continued

- Associated with nerve compression
- Returned within 36 hours



Did you Catch it?

Differences in mental status
documented

SpO₂ prior to
intubation?

Why was atropine
given?

Temperature in the
field?

Difference in height above the ground
documented

Mental Status

BLS Documentation

- “in and out of consciousness”
- “complains of no feeling in both legs”
- GCS: 3,2,1=6

HEMS Documentation

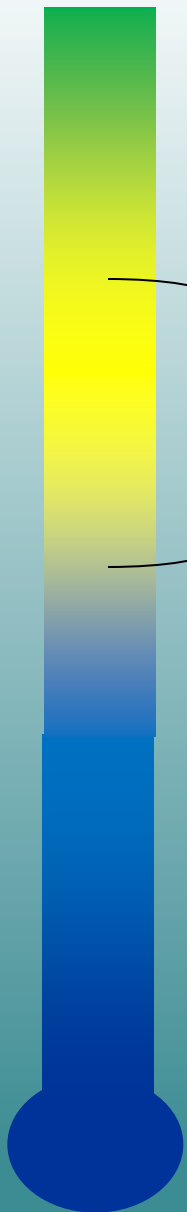
- “A&Ox0
- “does not respond”
- GCS: 1,1,2=4

Hypothermia?



Bladder temperature on
ED Arrival 96.6°F

Mild Hypothermia



← 98.6°F

90-95°F

- Awake with mental status changes
 - Agitated
 - Confused
 - Lethargy
- Uncontrollable shivering
- Increased urine output
- Fully active
- Maintains muscle control
- Skin is pale, cool, clammy

Moderate Hypothermia

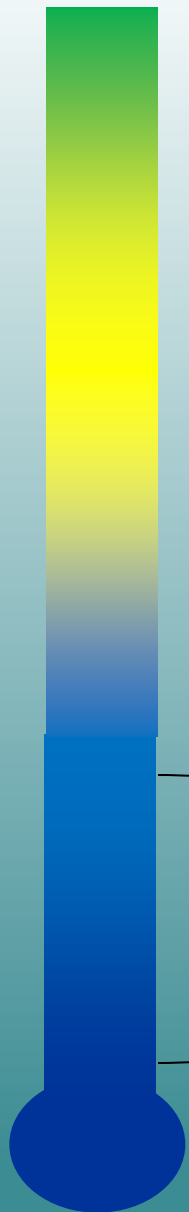


← 98.6°F

82-90°F

- Awake with profound mental status changes to V on AVPU
- Shivering ceases at 86°F or when sugar stores are depleted
- Vital signs depressed
- Skin very pale, cyanotic

Severe Hypothermia



← 98.6°F

Below 82°F

- P or U on AVPU
- No shivering
- Vital signs severely depressed and difficult to assess
- Cardiac dysrhythmias
- May appear dead
- **DIFFICULT TO ASSESS**

Take Away Points

- Its important to establish baseline vitals
- Essential everyone knows important facts
- Double check documentation for
 - Accuracy
 - Completeness
- Severe hypothermia
 - No shivering
 - Unresponsive

Summary

- Rural trauma is responsible for 60% of trauma deaths
- Many of these deaths are preventable
- We can decrease preventable deaths
 - Staying calm
 - Always providing the same thorough assessment
 - Monitoring for changes over time
 - Remembering our documentation does impact in-hospital care

What Questions Do You Have?

Kevin.collopy@nhrmc.org

www.linkedin.com/in/ktcollopy

www.facebook.com/ktcollopy

See you at EMS Expo 2014