EMERGENCY MEDICINE

TRAUMA

General aproach

EMERGENCY

Dr Alireza Ala

Professor of emergency medicine

TUMS

Trauma systems

- RTS, ISS, Outcome evaluation
- Triage decision scheme
- Trauma mechanism

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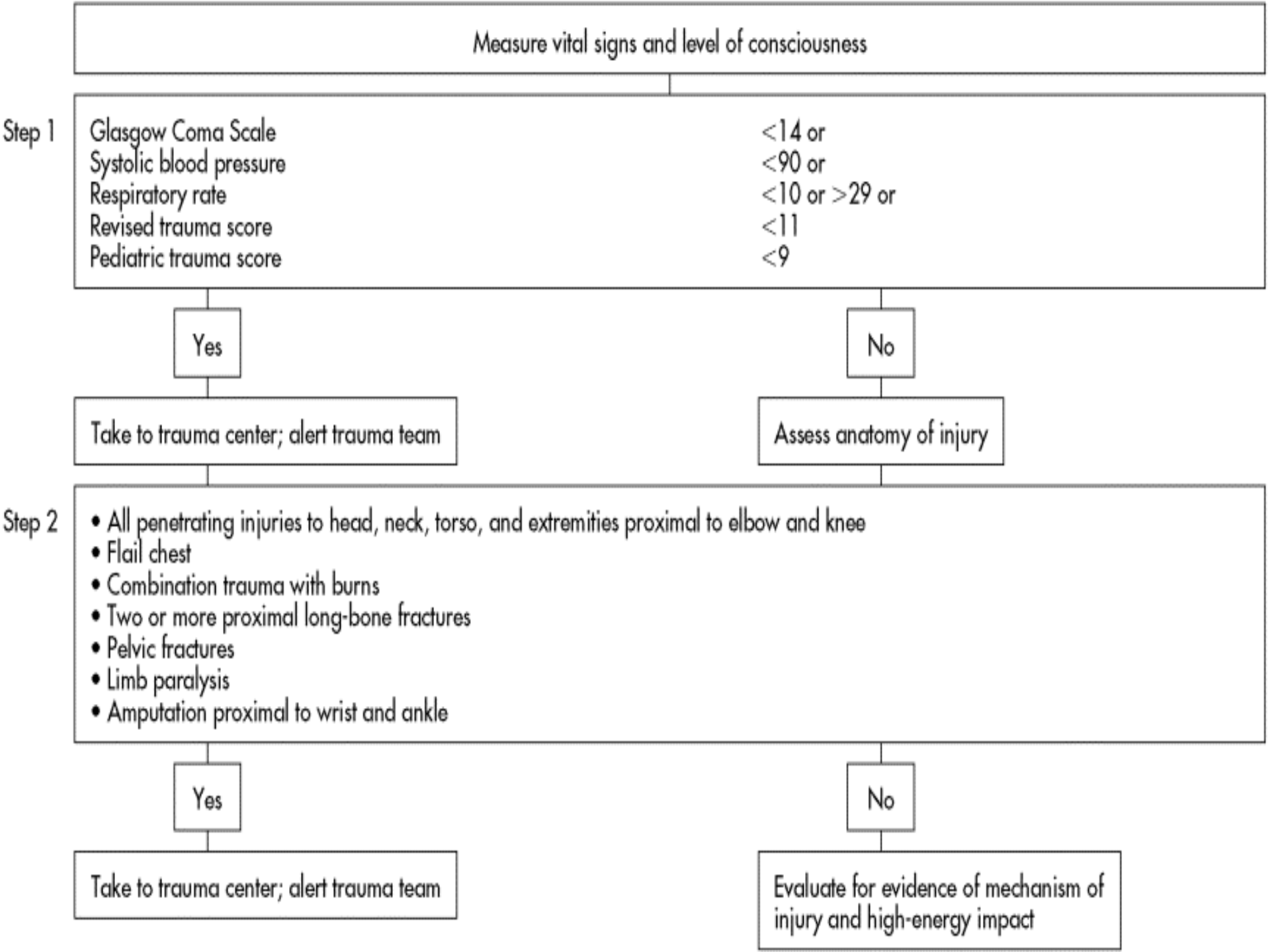
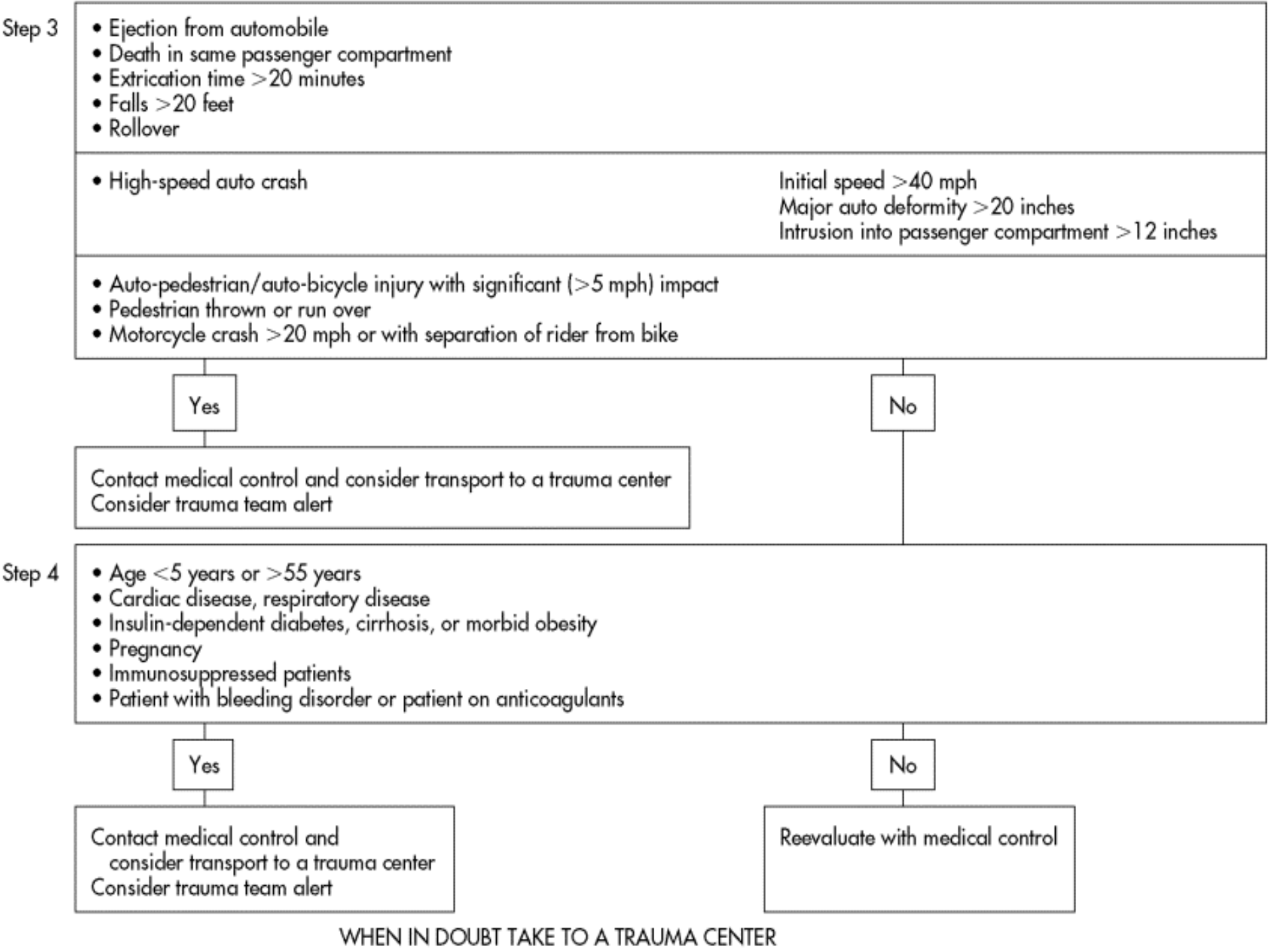

Measure vital signs and level of consciousness
Step 1
Glasgow Coma Scale <14 or
Systolic blood pressure <90 or
Respiratory rate <10 or >29 or
Revised trauma score <11
Pediatric trauma score <9
Yes
No
Take to trauma center; alert trauma team
Assess anatomy of injury
Step 2
• All penetrating injuries to head, neck, torso, and extremities proximal to elbow and knee
• Flail chest
• Combination trauma with burns
• Two or more proximal long-bone fractures
• Pelvic fractures
• Limb paralysis
• Amputation proximal to wrist and ankle
Yes
No
Take to trauma center; alert trauma team
Evaluate for evidence of mechanism of injury and high-energy impact


Step 3
• Ejection from automobile
• Death in same passenger compartment
• Extrication time >20 minutes
• Falls >20 feet
• Rollover
• High-speed auto crash
Initial speed >40 mph
Major auto deformity >20 inches
Intrusion into passenger compartment >12 inches
• Auto-pedestrian/auto-bicycle injury with significant (>5 mph) impact
• Pedestrian thrown or run over
• Motorcycle crash >20 mph or with separation of rider from bike
Yes
No
Contact medical control and consider transport to a trauma center
Consider trauma team alert
Step 4
• Age <5 years or >55 years
• Cardiac disease, respiratory disease
• Insulin-dependent diabetes, cirrhosis, or morbid obesity
• Pregnancy
• Immunosuppressed patients
• Patient with bleeding disorder or patient on anticoagulants
Yes
No
Contact medical control and
consider transport to a trauma center
Consider trauma team alert
Reevaluate with medical control
WHEN IN DOUBT TAKE TO A TRAUMA CENTER

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Principles of Trauma Management

- Organized team approach
- Priorities in management and resuscitation
- Assumption of the most serious injury
- Treatment before diagnosis
- Thorough examination
- Frequent reassessment
- Monitoring

1^0 – 2^0 Survey Approach

1^0	A B C D E	assess & manage ↓ basic interventions
2^0	A B C D	assess & manage ↓ advanced interventions adjuncts and tests

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1^0 – immediate life-threats

A	Airway open?	C-spine
B	Breathing?	Decompression
C	BP, pulse?	Control bleeding, fluids
D	Disability?	GCS, Pupils
E	Exposure	Keep warm

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Initial Assessment (Primary Survey)

Airway with C-Spine Control

Anticipate airway problems with

- Decreased level of consciousness
- Head trauma
- Facial trauma
- Neck trauma
- Upper thorax trauma
- Severe Burns to any of these areas

Open, Clear, Maintain

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Breathing

- Look
- Listen
- Feel

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Initial Assessment (Primary Survey)

- Breathing
  - Oxygenate immediately if:
    - Decreased level of consciousness
    - Shock
    - Severe hemorrhage
    - Chest pain
    - Chest trauma
    - Dyspnea
    - Respiratory distress
    - Multi-system trauma

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Initial Assessment (Primary Survey)

Circulation

- Is the heart beating?
- Is there serious external bleeding?
- Is the patient perfusing?
  - How do we know?

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Initial Assessment (Primary Survey)

- Disability (CNS Function)
  - Decreased LOC =
    - Brain injury
    - Hypoxia
    - Hypoglycemia
    - Shock
  - NEVER think drugs, alcohol, or personality first

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Initial Assessment (Primary Survey)

- Expose and Examine
  - You can't treat what you don't find!
  - If you don't look, you won't see!
  - Remove ALL clothing from critical patients ASAP
  - Avoid delaying resuscitation while disrobing patient
  - Cover patient with blanket when finished

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Initial Assessment (Primary Survey)

A blood pressure or an exact respiratory or pulse rate is NOT necessary to tell that your patient is critical !!!!!

Primary Resuscitation

Never delay transport of a critical patient to start an IV!!!

Secondary Survey(Detailed/Rapid Trauma)

- History and Physical Exam
- You WILL get here with MOST trauma patients
- Perform ONLY after primary survey is completed and life threats corrected
- Do NOT hold critical patients in field for secondary survey

Secondary Survey(Detailed/Rapid Trauma)

- Physical Exam
  - Stepwise, organized
  - Every patient, same way, every time
  - Superior to inferior; proximal to distal
  - Look--Listen--Feel

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Secondary Survey(Detailed/Rapid Trauma)

- Physical Exam
  - Use your stethoscope
  - Listen to patient's chest
  - Most frequently missed areas
    - Back
    - Mouth
    - Neuro exam

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Secondary Survey(Detailed/Rapid Trauma)

- Physical Exam
  - Assessment of extremities MUST include:
    - Pulses
    - Skin color
    - Skin temperature
    - Capillary refill
    - Motor function
    - Sensory function

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Secondary Survey(Detailed/Rapid Trauma)

- History
  - Ample history
    - A = Allergies
    - M = Medications
    - P = Past medical history
    - L = Last oral intake
    - E = Events leading up to incident

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Priorities

ABC

Airway – OK

Breathing ?

- Rate 32, sat 81%, ↓↓ AE Left
- Action?

Priorities in Trauma

- *High-Priority Areas*
  - Airway/breathing
  - Shock/external hemorrhage
  - Impending cerebral herniation
  - Cervical spine
- *Low-Priority Areas*
  - Neurologic
  - Abdominal
  - Cardiac
  - Musculoskeletal
  - Soft tissue injury

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Definitive Care

- Reevaluation en route
  - Ventilation and perfusion status
  - Vital signs every five minutes
  - Continued management of identified problems
  - Continued reassessment for unidentified problems

Adjuncts and tests

Adjuncts

- Pulse oximeter
- Cardiac monitor
- Foley catheter
- NG tube

Diagnostic tests

- CXR
- Pelvic x-ray
- C-spine x-ray
- EKG
- Pregnancy test
- Labs

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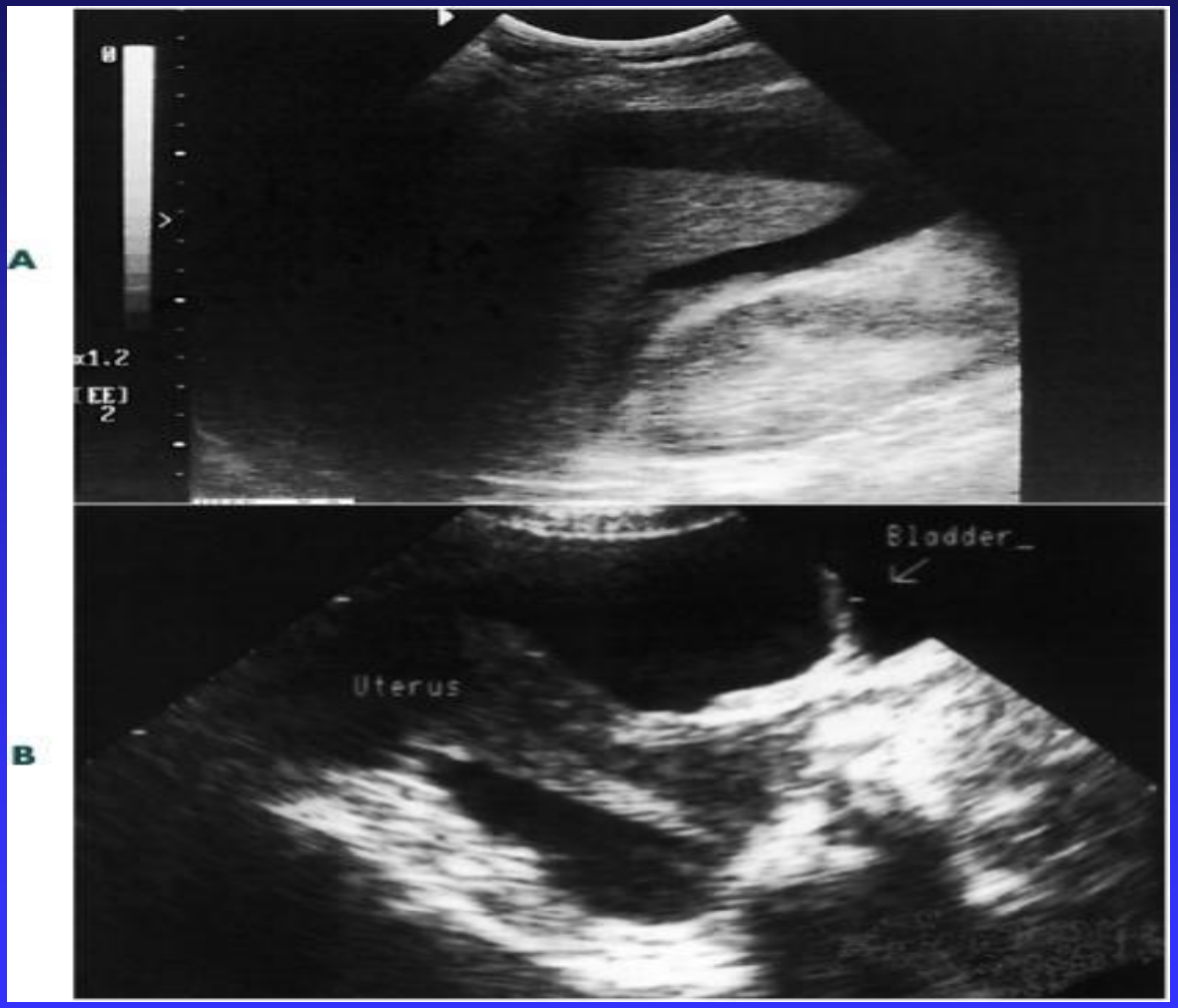

There are two ways to live your life.
One is as though nothing is a miracle.
The other is as though everything is a miracle.

Albert Einstein (1879–1955)

Case Presentation

- 30 yo helmeted motorcyclist presents to the ED fully immobilized with c-spine precautions following an accident. He states he was ejected approximately 25-30 feet from the vehicle. He recalls most of the accident but believes he may have lost consciousness briefly.
- Physical exam is normal with a non-tender c-spine. GSC 15

Case: Questions

- Does he need neuroimaging of the c-spine prior to “clearing the c-collar”?
- What if he were intoxicated or he had an altered mental status?
- What if he had a “distracting injury”?

Traumatic Brain Injury

- 2 mechanism of injury
  - Primary insult
    - Contusion, haemorrhage, DAI
  - Secondary insult
    - Hypoxic, hypotensive, cytoxic effects post injury
    - We can prevent further damage

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Secondary brain injury

- Things to do
  - Prevent hypoxia SpO_2 >90%
  - Keep systolic BP >90, MAP>90
  - Paralyze and sedate
  - Head of bed >30º
  - Avoid seizures
- Things NOT to do
  - Leave unsecure airway
  - Hyperventilation
  - Mannitol
  - Steroids
  - Delay transport to neurosurgical center

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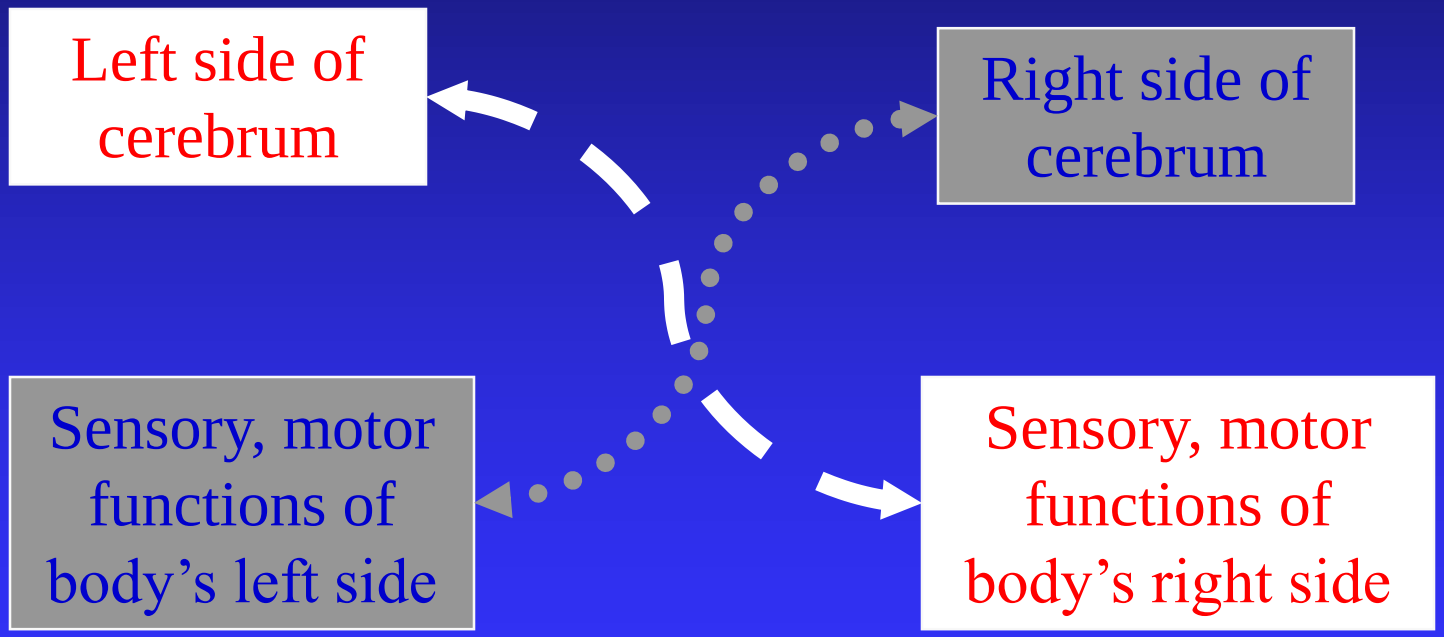
Cerebrum



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Scalp Lacerations

- VERY vascular area
- Can distract EMT from possible underlying injuries
- Care for laceration, but ask, "WHAT HAPPENED TO BRAIN AND NECK?"

Scalp Lacerations

- **Bleeding usually NOT severe enough to produce hypovolemic shock**
- **If shock present, think about other injuries**
- **Exceptions**
  - **Laceration that involves a large artery**
  - **Scalp injuries in children. Why?**

Skull Fractures

- **Injury to rigid box around brain**
- **Indicates significant force**
- **What happened to brain and neck?**

Types of Skull Fracture

- **Linear**
  - Most common
  - Crack in skull
  - Detected only on x-ray
- **Comminuted**
  - Multiple cracks radiate from impact point

Types of Skull Fracture

Depressed

- Bone fragments pressed inward
- Places pressure on brain
- Brain tissue may be exposed through injury

Basilar

- Fractures in floor of skull
- Diagnosis made clinically
- Signs and symptoms
  - Periorbial ecchymosis (Raccoon eyes)
  - Battle's sign
  - CSF drainage from nose, ears

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Skull Fractures

DO NOT TRY TO STOP FLOW OF BLOOD, FLUID FROM NOSE OR EARS

MAY CAUSE INCREASED INTRACRANIAL PRESSURE AND BRAIN INFECTION

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Concussion

- Temporary disturbance in brain function
- Probably due to brain being “rattled” inside the skull by a blow to the head
- Usually confused or unconscious
- Retrograde amnesia--“What happened?”
- Effects clear without residual effects

Cerebral Contusion

- Bruising, swelling
- Results from brain hitting skull's inside
- Coup-contracoup pattern
- Since brain is in closed box, pressure increases as brain swells, blood flow to brain decreases

Cerebral Contusion

- Signs and Symptoms
  - Personality changes
  - Loss of consciousness
  - Paralysis (one-sided or total)
  - Unequal pupils
  - Vomiting

Epidural Hematoma

- Usually associated with skull fracture in temporal area
- Fracture damages artery on skull's inside
- Blood collects in epidural space between skull and dura mater
- Since skull is closed box, intracranial pressure rises

Epidural Hematoma

- Signs and Symptoms
- Loss of consciousness followed by return of consciousness (lucid interval)
- Headache
- Deterioration of consciousness
- Dilated pupil on side of injury
- Weakness, paralysis on side of body opposite injury
- Seizures

Subdural Hematoma

- Usually results from tearing of large veins between dura mater and arachnoid
- Blood accumulates more slowly than in epidural hematoma
- Signs and symptoms may not develop for days to weeks

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Subdural Hematoma

Signs and Symptoms

- Deterioration of consciousness
- Dilated pupil on side of injury
- Weakness, paralysis on side of body opposite injury
- Seizures

Because of slow or delayed onset, may be mistaken for stroke

Cerebral Laceration

- Tearing of brain tissue
- Can result from penetrating or blunt injury
- Can cause:
  - Massive destruction of brain tissue
  - Bleeding into cranial cavity with increased intracranial pressure

Assessment of Head Injury

- Early detection of increased intracranial pressure is critical
- If pressure inside skull exceeds average blood pressure, blood flow to brain stops
- Increasing intracranial pressure can force brain downward into spinal canal, crushing it

Assessment of Head Injury

- Level of consciousness is BEST indicator of patient's condition
  - AVPU system
  - Glasgow scale

Glasgow Coma Scale

Eye opening	
Spontaneous	4
Response to speech	3
Response to pain	2
None	1

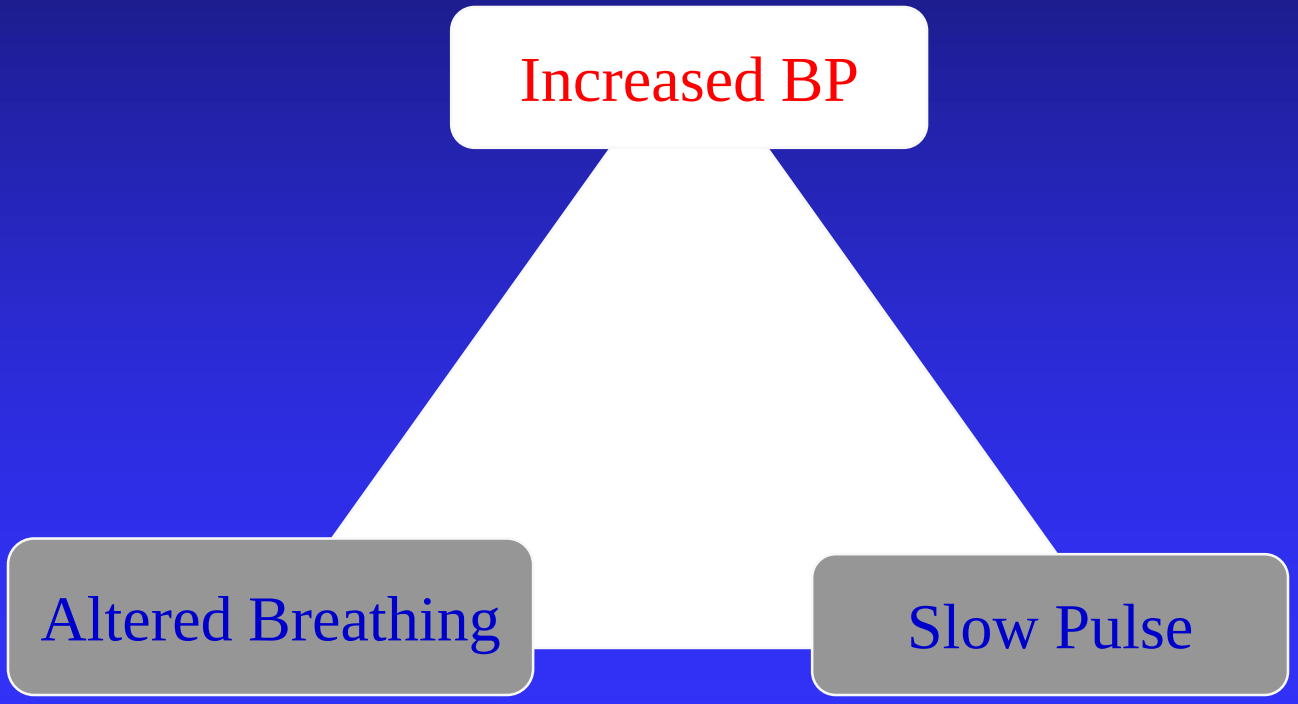
Best verbal response	
Oriented	5
Confused	4
Inappropriate	3
Incomprehensible	2
None	1

Best motor response	
Obeying	6
Localizing	5
Withdrawing	4
Flexing	3
Extending	2
None	1

Assessment of Head Injury

- Vital Signs
  - Body responds to increasing intracranial pressure by raising BP
  - Increased BP moves blood into brain against rising ICP
  - Heart rate falls in response to rising BP

Cushing's Triad



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Vital Signs

Isolated head injury does not cause hypotension or tachycardia!

Signs of shock in head injured patient indicate other injuries are present!

Management

- Need to secure airway early
  - Prevent hypoxia and aspiration
- Rapid sequence intubation
  - What are neuroprotection drugs?
  - Which induction agent to choose from?
  - Remember the airway sessions!!!

Management of Head Injury

ABCs with C-spine control

C-collar, long board, CID

Any patient with significant head injury has neck injury until proven otherwise

Ensure adequate oxygenation

If signs of increased ICP present, controlled hyperventilation with BVM at 20-24 breaths/minute

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Management of Head Injury

- Controlled hyperventilation
  - Lowers blood carbon dioxide levels
  - Causes constriction of blood vessels in brain
  - As vessels constrict brain shrinks
  - As brain shrinks intracranial pressure drops

Management of Head Injury

- Do NOT apply pressure to open or depressed skull fractures
- Do NOT attempt to stop flow of blood or CSF from nose, ears
- Do NOT remove penetrating objects

Spinal Injuries

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Significance

- Spinal injury can lead to spinal cord injury
- Spinal cord injury can lead to:
  - Paraplegia
  - Quadraplegia

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Most important spinal injury indicator…

MECHANISM

Common Mechanisms

- Compression
- Flexion
- Extension
- Rotation
- Lateral bending
- Distraction
- Penetration

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Significant Head Injury = Neck Injury Until Proven Otherwise

Other indications

Decreased LOC in trauma patient

Pain in spine or paraspinal area

Pain in back of head, shoulders, arms, legs

Absent, altered sensation (numbness, paresthesias, loss of temperature, position, touch sense)

Absent, altered motor function (weakness, paralysis)

Other indications

- Diaphragmatic breathing (paralysis of chest wall)
- Shock with slow heart rate and dry skin
- Incontinence
- Priapism

Or, there may be no signs at all. . .

- Neurologic deficits are a result of cord injury
- Spinal injury without cord involvement may produce no significant signs and symptoms

Management

- ABCs with C-spine control
- Ensure adequate oxygenation, ventilation
- Keep ENTIRE spine immobilized
- Repeatedly assess, document neurologic status:
  - Position sense
  - Pain
  - Motion
- Repeatedly monitor respirations, blood pressure

Suspect spinal injury with...

- Sudden decelerations (MVCs, falls)
- Compression injuries (diving, falls onto feet/buttocks)
- Significant blunt trauma above clavicles
- Very violent mechanisms (explosions, cave-ins, lightning strike)

Spinal Trauma Complications

Respiratory Failure

- Chest wall innervated from thoracic spine
- Diaphragm innervated from C3,4,5 via phrenic nerve
- Cord injury can produce paralysis of respiratory muscles, lead to ventilatory failure

Spinal Trauma Complications

- Neurogenic Shock
  - Damage to cord produces peripheral vasodilation
  - Peripheral resistance to blood flow decreases, BP falls
  - Heart rate remains normal or slows
  - Skin below level of injury is flushed, dry

Spinal Trauma Complications

- Hypothermia
  - Damage to cord produces peripheral vasodilation
  - Peripheral vasodilation causes increased heat loss through skin

Spinal Trauma Complications

- **How would you manage:**
  - Ventilatory failure caused by spinal injury?
  - Hypoperfusion caused by spinal injury?
  - Hypothermia caused by spinal injury?

Case A

28 male

Drinking at local bar

Found unconscious in parking lot,

(bloody baseball bat near by)

- reeks of alcohol
- GCS 8,
- PERL 3mm
- temporal hematoma,
- facial swelling

Rapid sequence intubation

- Neuroproctection drugs (Premedication)
  - Lidocaine
  - Opiate
  - Atropine
  - Defasiculating agent
  - Topical anesthetic to hypopharynx

Rapid sequence intubation

- Induction agent
  - Normotensive
    - Thiopental 3-5 mg/kg
  - Hypotensive
    - Etomidate .3 mg/kg
    - Midazolam
    - Minimal medications

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Management

- Why not hyperventilate?
  - Shown in studies that prophylactic hyperventilation $PaCO_2$ <35; has no benefit and may be harmful.
- What about Mannitol?
  - Again shown to be of no benefit prophylactically.
- Both should be used if patient is herniating

Our patient A

- Likely has an epidural hematoma
- Intubate early with RSI and neuroprotection
- Have Mannitol and hyperventilation as back up plan if patient has signs of herniation (blown unilateral pupil)
- Transfer to neurosurgeon ASAP

Case #2

50 year old male, MVA,
2 passengers dead at scene

- Alert, GCS 14, 81% on 3L O_2
- 91/52 HR138
- Decreased AE left chest
- HS not muffled
- Abdominal pain, tenderness, distension
- Left leg crooked

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Definitive Care

- Reevaluation en route
  - Ventilation and perfusion status
  - Vital signs every five minutes
  - Continued management of identified problems
  - Continued reassessment for unidentified problems

Intubation Issues in Trauma

- Head Injury:
  - Neuroprotective RSI
- C-Spine: protection, +/- bougie
- If time allows:
  - Quick gross neuro exam before paralysis

Intubation Issues in Trauma

- Hypotension:
  - Smaller doses of agents, consider ketamine for induction (not with head injury)
- Crush injury or burn:
  - Succinylcholine OK acutely

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Post Intubation

- Confirm tube placement
  - EasyCap CO_2 Detector
- Keep sedated / paralyzed
- Remember sedation often wears off before paralysis – watch vital signs
- Chest XRay

Back to the patient …

Sedated, paralyzed,intubated, 100% O_2

- 85/52, HR 130, Sat 93%

- Several large IV's - fluids
- Decreased AE left side, hypotension
  - Left chest tube
  - 300cc blood returns

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Fluid Resuscitation

- Consider colloid (packed cells) if >4 liters crystalloid
- If >2 liters and still unstable or bleeding, consider starting blood
- Monitor heart rate, blood pressure, urine output (foley post rectal exam)

Back to the Patient …

- ETT, Left Chest Tube, 2 large IV's and 3 L NS infused
  - HR 112, 98/68
  - Air entry equal, Sat 99%
- Chest seems better -
- What next?

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Persistent Hypotension

- Continue Crystalloid
- G&M blood or emergency blood (O+)
  - (If no blood, consider pentaspan)
- Reassess abdomen:
  - Distended, firm, unstable pelvis?
- Reassess extremities:
  - Left thigh crooked, firm, distended

Pelvic Fractures

- Potential for massive bleeding, transfuse early
- Examine once – don't keep rocking it
- If ‘open book’ – possibly some benefit from splinting (by binding pelvis with a sheet)
- High association with bladder and urethral injuries

Pelvic Fractures

- Posterior arch fracture plus hypotension is potentially lethal.
- Open-book fractures or displacement of more than 0.5 cm are predictors for major blood transfusion requirements.
- Assess closely and carefully for open fractures

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Femur Fractures

- Can lose 500 – 1000 cc blood per femur
- Splint pre-transport
- If open fractures
  - antibiotics,
  - don’t reduce bone under skin if exposed
  - Sterile dressing

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Plan?

- Transfer, bring blood
- What Xrays pre-transport?
  - Chest
  - Pelvis
  - Lateral CSpine

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Objectives

- Unique Aspects of Obstetrical Trauma
- Approach to Trauma in Pregnant Patient
- Cases in Obstetrical Trauma
- Safe radiation dose
- Emergency C-section

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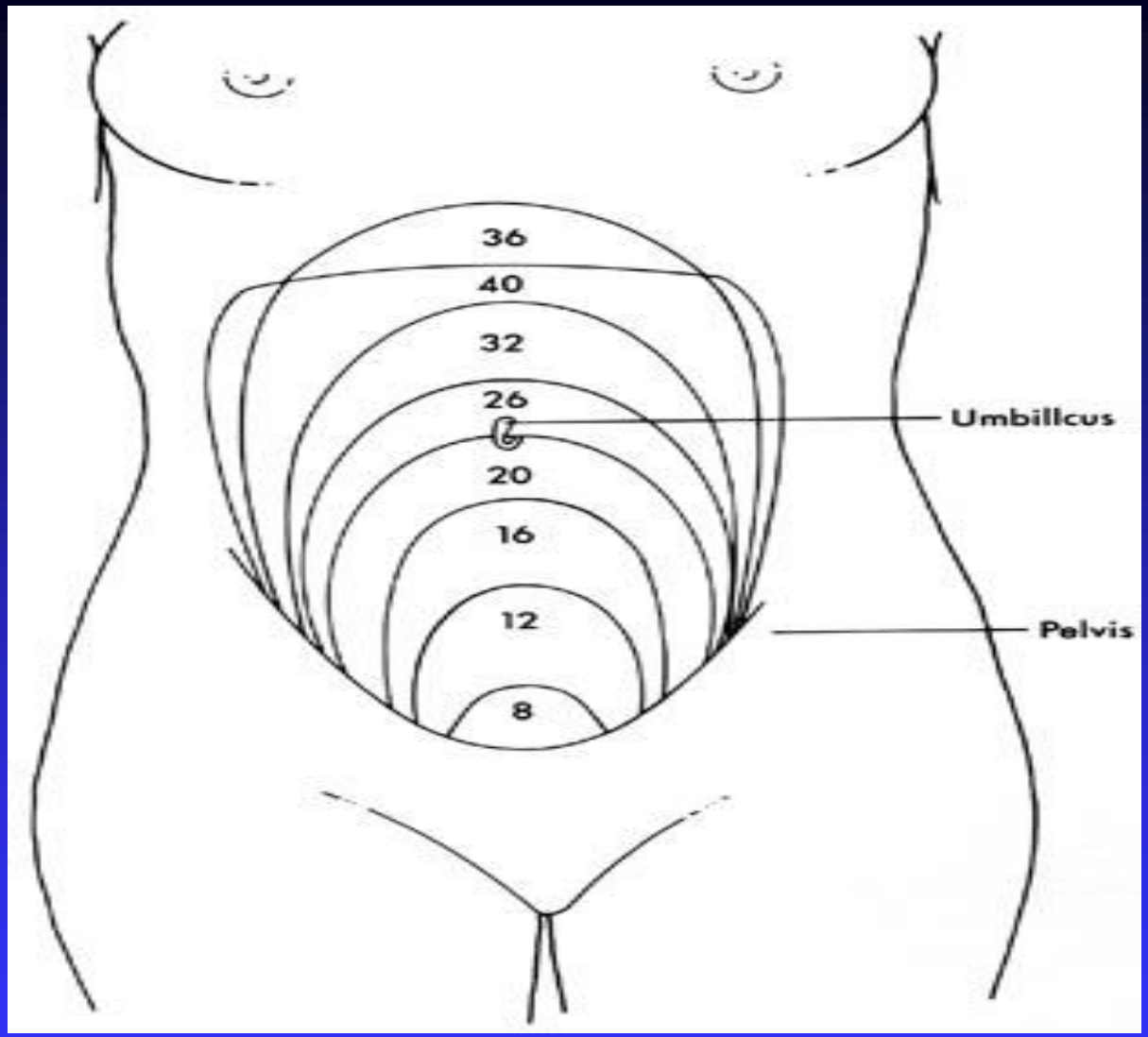

Figure 27-1. Uterine size at different weeks of gestation. (From Trauma in emergency medicine.
In Kravis TC, Warner CG (eds): Emergency medicine: a comprehensive review, Rockville, Md,1979,

Aspen Publishers.)

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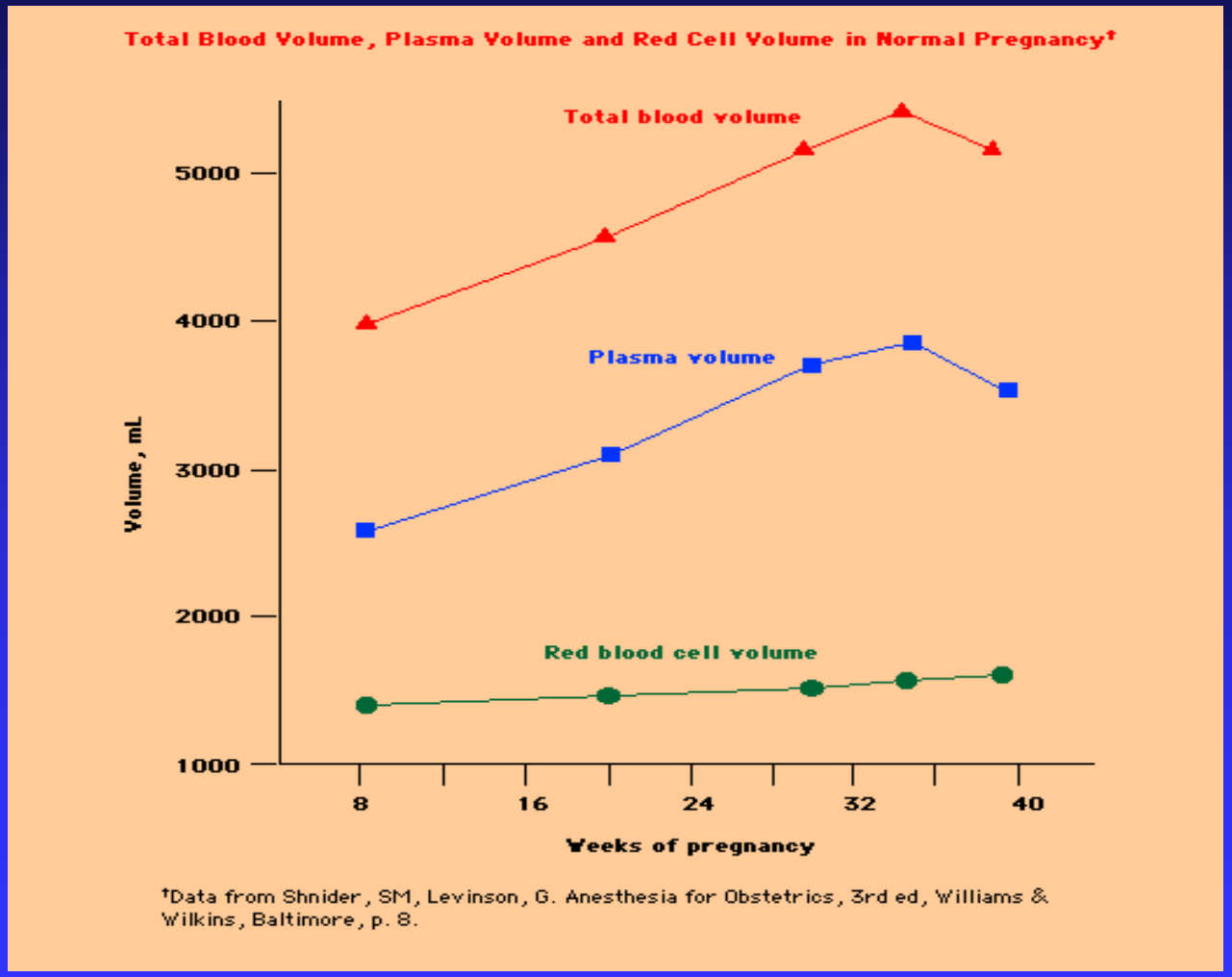
What to do with a pregnant women in ER sustaining abdominal trauma?

- ABCDE, C-spine, Primary survey, Secondary survey, Gestation Age of fetus, RH status
- Airway management critical
- Tilt pelvis towards left side to prevent IVC compression (20+ weeks gestation)
- Vital signs may not be indicative of state of shock



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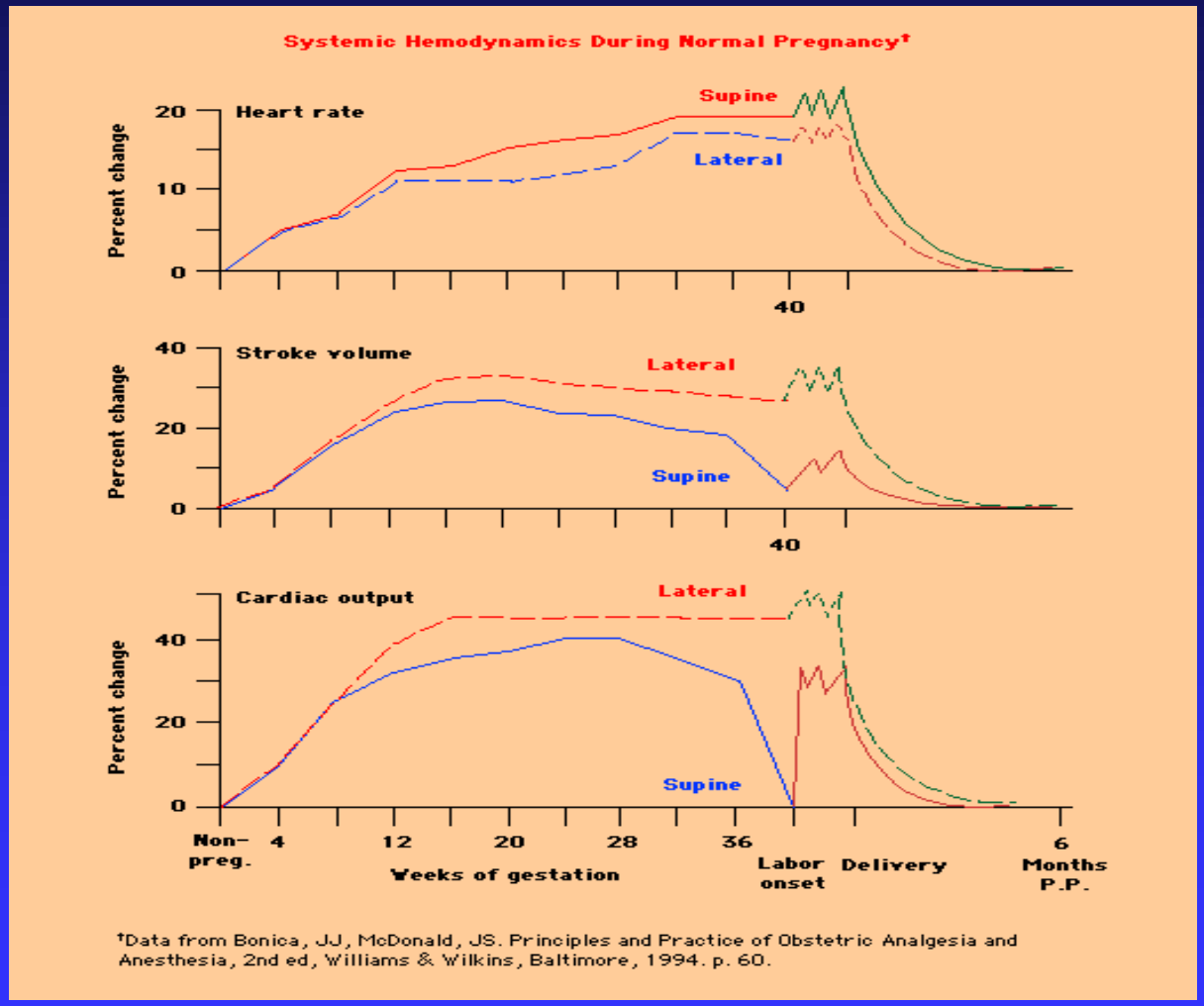
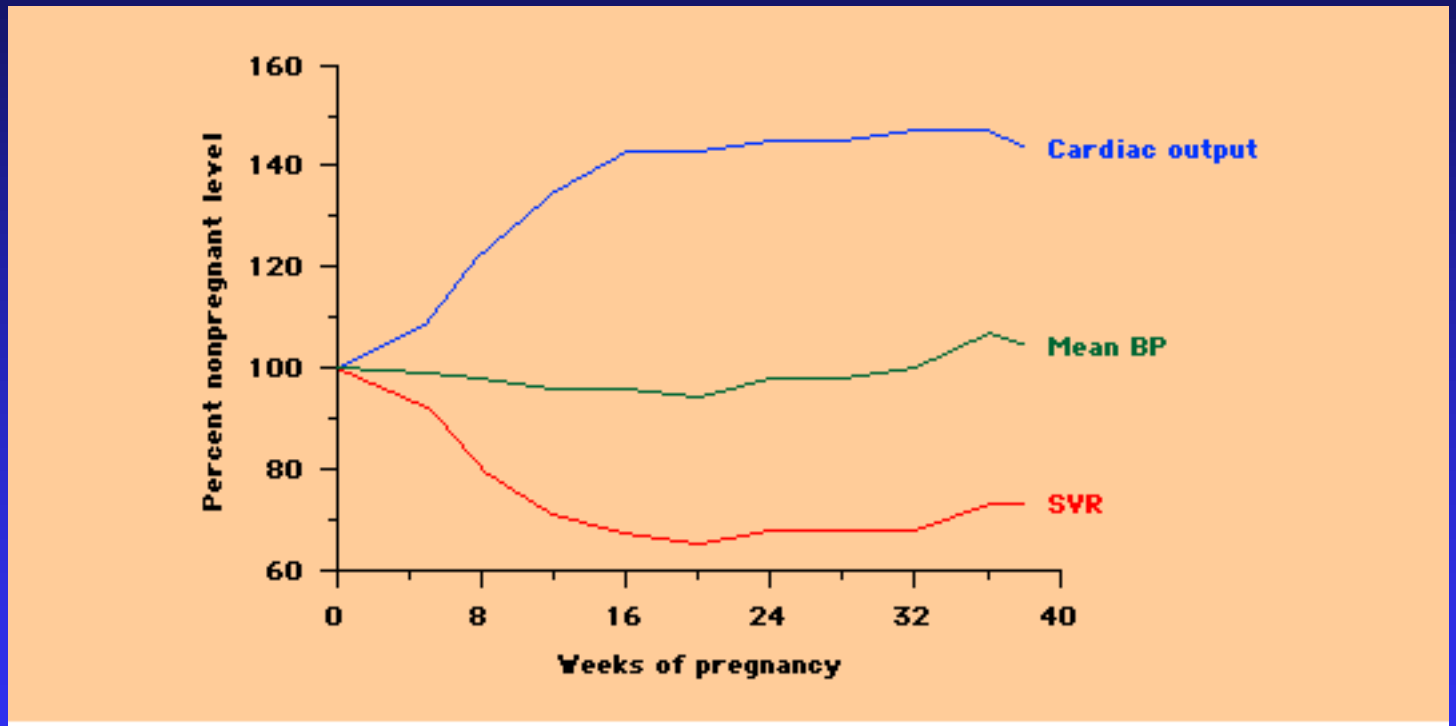


†Data from Bonica, JJ, McDonald, JS. Principles and Practice of Obstetric Analgesia and Anesthesia, 2nd ed, Williams & Wilkins, Baltimore, 1994. p. 60.



Hemodynamic changes in normal pregnancy Normal pregnancy is characterized by an increase in cardiac output, a reduction in systemic vascular resistance, and a modest decline in mean blood pressure. These changes are associated with a 10 to 15 beat/min increase in heart rate.

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Pregnancy Outcome in Trauma Patients†

Maternal outcome	Untraumatized controls, percent	Delivery during hospitalization for traumatic event, percent**	Delivery subsequent to hospitalization for traumatic event, percent
Preterm labor	7.1	14.4	18.4#
PROM	1.6	2.4	1.9
Abruption	0.9	8.0	1.5#
Death	0.01	0.9	0.06#
Uterine rupture*	0.01-0.06	0.3-0.6	0-0.04
Transfusion	0.3	4.2	0.6#
Infant outcome			
Preterm delivery	10.6	20.1	13.7#
Low birth weight	5.9	14.5	9.2#
Fetal distress	9.6	16.7	11.5#
Asphyxia	0.5	1.6	0.5
RDS	1.4	5.5	1.7
Fetal death	0.4	3.2	0.5
Neonatal death	0.3	1.5	0.4
Infant death	0.5	1.7	0.7

* range indicates before labor and during labor
** all values significantly different from controls
# values significantly different from controls

†Adapted from El Kady, D, Gilbert, WM, Anderson, J, et al. Am J Obstet Gynecol 2004; 190:1661.

SECONDARY SURVEY

- Determine uterine fundal height and Fetal Heart Tones
- Exam perineum for gross blood or amniotic fluid in vaginal vault
- 3rd trimester with vaginal bleeding avoid speculum exam (*Placenta previa)

Diagnostic Testing

- Radiographs and risks to fetus?
  - Fetus can safely receive under **5000 mrads** without ill effect
  - radiation most lethal during 0-1 week (implanting embryo)
  - teratogenic (2-7 weeks gestation) due to major organogenesis
  - beyond 8-40 weeks: ? Growth retardation, CNS dysfunction, neoplasia

Radiation Dosages

Ovarian Radiation Dose Due To Radiography

PROCEDURE	MRAD
Cervical spine	0.01-1.0
Extremities	.01
Chest	1-5
Pelvis	150-300
Lumbar spine	600-1300
CT head	<50
CT upper abdo	<3000
CT lower abdo	3000-9000

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CASE #3

MVA 25 female, 35 weeks GA, Rh +ve

abdominal pain, ?cramping.

? fetal movements.

Very concerned fetal well being.

- **ABC stable. BP 120/70 HR 88 RR 15**
- FHR 140
- No signs of injuries on exam.
- No contractions palpable. No guarding/rebound. No lap belt sign. No blood from vagina.Os closed

Fetal Assessment

When should cardiotocographic monitoring be used?

It is necessary to monitor patients who are >24 weeks gestation.
Primary reason is to determine if an emergency C-section is indicated.

How long should we monitor these patients?

4-6 hours for minor trauma; 24 hours in major trauma, **or** vaginal bleeding, frequent contractions (6-8/hr), abdominal pain

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Gestational Age Specific Survival Rates

Gestational Age (Weeks)	Survival Rates (%)
22	0.0
24	**9.9**
26	54.7
28	77.4
30	90.6
32	96.5
34	98.7
36	99.5

CASE #4

20 year old female, 30 weeks gestation

Struck by truck across the street from hospital.

Cardiac arrest at scene. Paramedics have intubated and started CPR.

Down time about 5 minutes. Arrival in ER, Pulseless Electrical Activity.

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Management

- Continue resuscitation, ABCDE, Rapid Primary and Secondary Survey
- Find reversible causes of PEA (tension pneumo, cardiac tamponade, hypovolemia)

When should we consider Emergency C-section? How much time do we have?

EMERGENCY MEDICINE

Perimortem C-section

When should we consider perimortem C-section?

In any Pregnant trauma patient we think is greater than 20 weeks gestation.
(Uterus is between the umbilicus and xiphoid.)

How much time do we have?

In a cardiac arrest situation, every attempt should be made to consider cesarean delivery within **4 minutes of arrest**.

EMERGENCY MEDICINE

Postmortem Cesarean Deliveries With Surviving Infants With Reports of Time From Death of the Mother Until Delivery (From 1900-1985)

Cases	No. Patients	Percent
0-5 min	42 (normal infants)	70
6-10 min	7 (normal infants) 1 (mild neurological sequelae)	13
Subtotal	8	
11-15 min	6 (normal) 1 (severe neurological sequelae)	12
Subtotal	7	
16-20 min	1 (severe neurological sequelae)	1.7
21+ min	2 (severe neurological sequelae) 1 (normal infant)	3.3
Subtotal	4	
Total	61	100

Conclusion

- All pregnant trauma patients greater than 20-24 weeks gestation should have cardiotographic monitoring for a minimum of 4 hours.
- Emergency C-section should be initiated within 4 minutes of cardiac arrest.
- Resuscitation involves a team approach

There are two ways to live your life.
One is as though nothing is a miracle.
The other is as though everything is a miracle.

Albert Einstein (1879–1955)