Trauma in Pediatric Patients

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Introductions

• Trauma is the leading cause of death in patients younger than 35 years.
• Number 1 Causes (1–16 years): unintentional injury in USA.
Case

- 2005. 4. 6. 17:10, ER of Young Dong Severance Hospital
- 5 years old male,
- Body Wt: 23Kg
- 2005년 4월 6일 17:00 경 상가 건물 지하 주차장 내려가는 길에 New Beetle 이 내려 간 후 아이가 깔려 쓰러져 있는 것을 발견하고 부근에 있던 사람이 택시에 태우고 응급실로 내원함.
Case

- PHx: No medicosurgical illness.
- FHx: N-S
- Initial V/S
  - BP: 80/40 mmHg
  - PR: 150/min
  - RR: 18/min
  - BT: 36 °C

How do you think about these vital signs?
What should we consider from these numerals?
Case

- BP: 80/40 mmHg
Cardiovascular Function

Is determined by

• The Preload
• The Cardiac Contractility
• The Heart Rate
• The Afterload
Shock

- A state in which the cardiac output is insufficient to deliver adequate oxygen to meet metabolic demands of the tissue.
  - Hypovolemic
  - Cardiogenic
  - Septic
  - Neurogenic
Summary of Cardiovascular Functions

Preload

Cardiac output and Heart rates

Cell Metabolism

Afterload

Cell Metabolism
Summary of Shock

- Hypovolemic Shock
- Cardiogenic Shock
- Septic Shock
- Neurogenic Shock
Hypovolemic Shock

- Preload represent the volume of blood presented to the ventricles.
- Due to the impracticality of measuring preload volume, preload is commonly monitored by atrial pressure measurement.
- In most clinical situations, right atrial pressure or CVP is the index of cardiac preload.
- Most shock situations in pediatric trauma are the result of bleeding or shift of fluid.
Definition of the Clinical Hypotension in Children

• A systolic blood pressure < 70 mmHg + 2 x Age (yrs)

• Frank Hypotension: late sign of shock developed at 30-35% of lost circulating volume

• Initial Management: 40 – 60 mL/Kg of warm Ringers’s Lactate solution (Hartman-S solution)

• 10-20 mL/Kg of packed RBC
Case

• Initial V/S
  – BP: 80/40 mmHg
  – PR: 150/min
  – RR: 18/min
  – BT: 36 °C
Case

– PR: 150/min
Tachycardia

• Due to the compensation of heart to increase the cardiac output, the heart rate is increased as the response to the catecholamine.

• We should remember that tachycardia is the early change of vital signs in hypovolemic shock before drop of blood pressure.

• However, the pain and stress by trauma also can increase the serum catecholamine level.
Catecholamine

- Serum catecholamine are increased by the trauma for the escape and survival of mammalian.
- Inotropic action$\rightarrow$ increased myocardiac contraction
- Chronotropic action$\rightarrow$ increased heart rate
- Appropriate catecholamine response in human body
  - Blood pressure $\uparrow$
  - Heart rate $\uparrow$
  - Cardiac output $\uparrow$
  - Vasoconstriction
Case

- BP: 80/40 mmHg
Case

- PR: 150/min
Case

• Inappropriate Response to the increased serum catecholamine levels in this case

• Why?
Bleeding (Hypovolemic Shock)

Large Three Body Cavities in Human?
Large Three Body Cavities in Human

1. Chest
2. Abdomen
3. Cranium
   - Major Potential Space for the bleeding from trauma except external bleeding is
   - CHEST and ABDOMEN
   - However, the HEAD INJURY is also very important in children’s trauma for the survival.
Head Injury is the Most Common Major Injury in Children

- Who has the larger head size between the mother and baby?
The Answer

- Almost same!
Kinetic Energy

\[ E_k = \frac{1}{2} mv^2 \]
## Incidences and Mortality of Pediatric Trauma

<table>
<thead>
<tr>
<th>By Anatomic Diagnosis</th>
<th>Incidence (%)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Injury</td>
<td>25.8</td>
<td>10</td>
</tr>
<tr>
<td>Fracture</td>
<td>25.9</td>
<td>4</td>
</tr>
<tr>
<td>Abrasion/contusion</td>
<td>19.6</td>
<td>3</td>
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<tr>
<td>Open wound</td>
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<td>Thoracic/abdominal injury</td>
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<td>14</td>
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</tr>
<tr>
<td>Other</td>
<td>3.6</td>
<td>9</td>
</tr>
</tbody>
</table>
Major Trauma in Pediatric Patients

- Head Injury
- Chest Injury
- Abdomen Injury
Lance Amstrong

Case

Initial V/S

- BP: 80/40 mmHg
- PR: 150/min
- RR: 18/min
- BT: 36 °C

Mental status: Drowsy

• Why the patient’s breathing is so slow and the mental status was so drowsy?
• What should we do in this situation?
To prevent the Hypoxic Brain Damage

- Think later!
- We don’t have a time for the brain

20% of total body oxygen
15% of total cardiac output

ABC!
Case

Initial Survey and Management
1. Keep the airway with C-spine protection
   - endobronchial intubation
   - no blood or food material in mouth
   - c-spine immobilization with stiff neck collar
Case

- No definite palpable rib Fx. or subcutaneous emphysema
- Coarse breath sound on both lung
- Self respiration
- Palpable carotid/femoral pulses
- Pinkish skin color
- Active bleeding on scalp wound → compression dressing
Case

-M/S drowsy
-No weakness: pain 에 반응하여 움직임
-Pupil size (5mm/5mm) with PLR
-No visible wound except scalp
-palpable fracture on both lower legs
Case

- No evidence of bony destruction and erosion in the skull vault, sella turcica and mastoid air-bone is not remarkable
- No abnormal calcification in skull vault.
Case

- Interspinous distance of C1 and C2 level is increased.
Case

The result of aerophagia

- Total haziness is noted in Lt. lung field.
- R/O alveolar hemorrhage and hemothorax
Characteristics of Child Chest Trauma

- Intense energy applied to a body with less fat, less elastic connective tissue, and close proximity of vital organs
- Remarkable compliant thorax
- High incidence of significant intrathoracic injury without any injury to bony structure
- Rare preexisting disease involving other organ systems
- High potential tremendous recovery
Case

- Stomach Decompression
- Central Line Insertion
- Reposition of intubation tube
Case

- Bilateral distal tibia shaft fractures are seen. Minimal bowing deformity of Lt. fibula is seen which can not be excluded bowing fracture.
Case

- Depressed fracture of left parietal bone.
- No evidence of abnormal intracranial hemorrhage.
- Ventricular systems are grossly preserved.
Abnormal scalp injury is seen at left parietal area.
Case

- Extensive lung parenchymal increased attenuation densities are noted at both lung especially in Lt. lung field area.
- Some overinflation and emphysematous change of Rt. lung field
Case

Abnormal liver lacerations are noted at Rt. lobe of liver with multiple splenic lacerations.
Case

- Abnormal periportal lower attenuation densities are also noted.
- Peripancreatic lower attenuation densities are noted probable from peripancreatic fluid collection. GB is not remarkable.
- However, abnormal pancreatic contour is suggested in this study with lower attenuation density of pancreatic head and body junction area which is highly suggestive of pancreatic injury.
Characteristics of Child Abdominal Trauma

- Nonoperative management of solid organs
• Abnormal bony fracture is seen at Rt. iliac bone just iliac side of Rt. sacroiliac joint area.
C2 fracture, left side is seen.
• IMPRESSIONS
  – lung contusion and hemorrhage, both
  – Hemothorax, both
  – hemoperitonium
  – liver and spleen laceration
  – pancreatic injury
  – depressed skull fracture with open wound and pneumocephalus
  – C1, C2 body fracture
  – right iliac fracture
  – both tibia fracture
  – r/o left fibula fracture
• Initial lab at ER

CBC      13330/13.1/40/191000  
electro   136/3.8/104/14  
amylase/lipase 179/38  
OT/PT     991/558  
BUN/Cr.   20.3/0.8  
ABG: PaO2 97.6/ PaCO2 44.2/ HCO3 17.3/O2 Sat. 95  
PT/PTT    53%/64sec  
U/A: protein(+), blood(+++)
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무차야!
그러 엉덩이에 압박이 싶하느냐?
05.4.7

- 9AM 100/51-180-16-36.8
- Ventilator mode: SIMV RR16 VT250 Fio2 0.6 O2 Sat.85%
- CBC 12580/15.8/48.6/88k
- OT/PT 806/286
- PT/PTT 27.2/57.3
- PaO2 52.6 PaCO2 50.0 HCO3 16.8
- Glucose 154
2005-04-07

Fluid resustation (NS, SD, transamin, HD)
Broad spectrum antibiotics
FFP, Albumin 투여
Endobronchial suction
Midazolam
Lasix
Levo
Dopa
2005-04-07

2:30 AM

V/S 68/52-189-20-38

O2 Sat. 41% -ambu bagging-O2 Sat 91%

Ventilator mode change:

(Bilevel PSV  PEEP30/10 FiO2 1.0 RR 30)
Aggravation of both lung haziness since previous study which seems to be development of ARDS.
Cardiac shadow obliteration is also seen.
Abdominal distention is noted in this study
• Chest tube insertion both
• Paracentesis d/t Hemoperitonium
• Endo tube change (8Fr/balloned)
FIGURE 15-4. Complex injury to the trachea and main-stem bronchi secondary to blunt trauma. Of note is that most such injuries are located within 2.5 cm of the carina. (From Millham FH, Rajii-Khorasani A, Birkett DF, et al: Carinal injury: Diagnosis and treatment-case report. J Trauma 31:1420, 1991.)
ABGA: PaO2 75.5/PaCO2 37.6/ HCO3 20.9/ O2 Sat.94%
Amylase/lipase: 3280/80
OT/PT: 504/212
Na/K/Cl: 156/3.4/106
T.Pro/Alb: 2.5/2.0
WBC: 20500 Hb.9.5 Plt 36k
PT/PTT: 38/65
- KCl
- Packed RBC
- Albumin
- Plt. Conc.
- FFP
- CVP 측정(7이상)-Lasix 투여 I/O negative
- Chest tube, Abd drain tube drainage
- Gomco suction(L-tube)
• 05.4.8
• V/S 111/76-150-44-37.8
• Sedative M/S
• Ventilator mode change
• (Bilevel peep 40/20 Fio2 1.0 RR 40 PSV 15)
• (Bilevel peep 40/18 Fio2 0.9 RR 25 PSV 15)
• (Bilevel peep 30/15 Fio2 0.8 RR 22 PSV 15)
• (Bilevel peep 30/15 Fio2 0.7 RR 22 PSV 15)
• (Bilevel peep 30/15 Fio2 0.6 RR 22 PSV 15)
• Ventilator mode change
• O2 Sat 100% 유지
• PaO2 313→459→218로 change함

• Position change
• Wound dressing
• BT elevation 시–ice bag apply/Diclon IV
• Lasix 4mg Q4hr (total I/O 2522/3020)
05.4.9
V/S 128/73-130-25-37
Sedative M/S
Ventilator mode change
(Bilevel peep 25/10 Fio2 0.5 RR 20 PSV 15)
O2 Sat.100% 유지됨
- WBC 17200 Hb 10.4 Plt 108k
- Na/k/Cl 147/3.4/112
- T.P/Alb 4.8/3.3
- PT/PTT 17/49
- Amy/lip 367/10

Lasix 4mg Q4hr or Q2Hr(CVP 9-14)로 유지됨
Total I/O 2106/2435

Generalized edema 감소됨
Levo, Dopa tapering
Foy+5%DW500cc Mix
SD1:2 1500CC
I/O Negative 심해 lasix D/C함
(Total I/O 1542/2040)
CVP 7-8까지 떨어짐
Neck collar주변의 compression area에 sore생김
-bid dressing, neck collar modification
• 05.4.11
• V/S 100/70-98-22-37
• Sedative MS
• Ventilator mode
• (Bilevel peep 18/8 Fio2 0.4 RR 22 PSV 15)
• O2 Sat. 100% 유지됨
• Levo, Lasix stop
• TPN 시행함
05.4.12.

- Coma without light reflex and fixed pupils
- High out-put urine with hyponatremia
- Follow-up Brain CT
Follow-up Brain CT

• IMP.
  - 1. Most likely extensive global brain edema including cerebrum and cerebellum and brain stem.
  - 2. The possibility of ischemic insult is highly suggested.
  - 3. The possibility of brain herniation or impending herniation is highly suggested.
• Hyponatremia (Na121)
• -q 4Hr electrolyte F/U 시행함.
• R/O Central DI로 소아내분비 consultation 시행함
• 3% NaCl, Na-40 side injection
• -Na 133까지 교정됨
• -Vasopressin 사용고려함.
• EEG 시행함
  – flat EEG, brain death
  – Brain death
• 05.4.15
• F/U EEG 시행함
  – flat EEG, brain death 소견
  – Brain death 로 확진됨.
• Central DI 로 진단
  – minirin nasal spray (Vasopressin) 사용
  – U/O 300cc/Hr -> 50cc/Hr 로 감소
  – Hyponatremia 교정되는 양상보임.
Initial management of severe head injury, GCS 8 or less

Endotracheal intubation
Fluid resuscitation
Ventilation (PaCO₂ 30–35 mm Hg)
Oxygenation
± Pharmacologic paralysis (short acting)

Deterioration
CT Scan
Surgical lesion?

YES
Mannitol 1 gm/kg

NO
Intensive care unit
Monitor ICP
CSF drainage
Optimize perfusion to brain

Operating theater

FIGURE 17-2. This algorithm describes a reasonable approach for treatment of patients with severe head trauma.
Too Late!

- 05.4.16
- Chest tube removal and chest PA F/U
- Haziness of Lt. retrocardiac area is seen with air bronchogram suggesting collapse consolidation.
- Intubation
- Percussion & Vibration, Endo-suction
Too Late!

- 05.4.17
- F/U Chest PA 시행
- Haziness of Lt. lower lung field is seen from parenchymal infiltrations
- 영양지원팀에 consultation
Too Late!

- 05.4.19
- 의찰서 제출용 진단서 발급
- Hb, plt 교정 (Pack RBC, Plt.conc.)
- Chest F/U
- parenchymal haziness of Lt. lower lobe area is persistently noted without significant interval change.
- Ventilator mode change 없이 O2 Sat. 100% 유지 됨.
Too Late!

- 05.4.21
- L-tube feeding 시도함.(물10cc/3hr)
- Scalp wound dressing-Pus culture시행
- NS,OS F/U consultation-Observation
- Cervical Spine AP/Lat
- -Mild kyphotic curvature of C-spine
Too Late!

- Both tibia AP/Lat
- Cast application state due to bony fractures at both distal tibia shaft area
Too Late!

- 05.4.23
소아경관 유동식 시행함.(500CC)
Chest PA F/U
- Comparing to the previous study, decreased aeration of both lungs.
- Both pleural effusion
Thoracentesis 고려함.
• BP, HR unstable함.(130/80->70/30)
• -dopa조정, Pentaspan(plasma expander) 사용 후 Normalization되는 양상을 보임.
• No CPR 보호자에게 설명함
• -denial하는 양상보이며 끝까지 치료하고자 함.
Too Late!

- 05.4.25
- 1주일간 Defecation 안함
- -Glycerin enema 1회/2일 시행하기로 함.

BP, HR unstable 한 양상보임.
Central DI 로 vasopressin 으로 I/O 유지함.
Too Late!

• 05.4.27
Chest PA/Lab F/U하면서 봄.
DIC lab시행함.
Scalp swelling, Face edema 심해짐.
Too Late!

- 05.5.2

Septic condition으로 R/O Brain abcess로 Brain CT F/U함.

- Severe brain edema with brain herniation and diffuse brain insult
- Marked and diffuse scalp swelling

BP 낮아지는 현상이 하루에 2-3회 관찰됨.(dopa, pentaspan, levo로 Mx.함)

Vancomycin 추가함.
Too Late!

- 05.5.3
- Scalp wound, Brain edema management 위해 NS로 transfer함.
Too Late!

- 05.5.10
- 00:15분 사망함.
Lance Amstrong