Stabilization of the Trauma Patient: Going Beyond the Golden Hour

Cutting Edge
Surgical Medical Group

Disclosures

- I have no disclosures
- I wish I did …..!

Learning Objectives:

- Understanding the management and utilization of massive transfusion protocol and end points of transfusion
- Understanding which pelvic fractures need surgical management to control pelvic bleeding
- Understanding clinical decisions making on serve traumatic brain injury management and nonsurgical options for treatment
- Understanding and focusing on reducing end organ injury and damage after the initial stabilization

MTP

- How many Blood Products is enough?
- When do you stop or at least slow the rate of transfusion?
- End points of resuscitation?

Activating MTP

- The decision to activate a Massive Transfusion Protocol (MTP) is critical in managing trauma patients with significant hemorrhage. Several scoring systems are used to help guide this decision-making process, each with its own strengths and limitations. Here are some of the commonly used scoring systems:
- **Trauma-Associated Severe Hemorrhage (TASH) Score:**
- **Assessment of Blood Consumption (ABC) Score**:

Trauma-Associated Severe Hemorrhage (TASH) Score:

- The TASH (Trauma-Associated Severe Hemorrhage) scoring system is a tool used to predict the need for massive transfusion in trauma patients. It combines several physiological and anatomical parameters to assess the severity of hemorrhage and guide the initiation of massive transfusion protocols.

Trauma-Associated Severe Hemorrhage (TASH) Score:

Components of the TASH Score:

Age (A):

- Age ≤ 39 years: 0 points
- Age 40-59 years: 1 point
- Age ≥ 60 years: 2 points

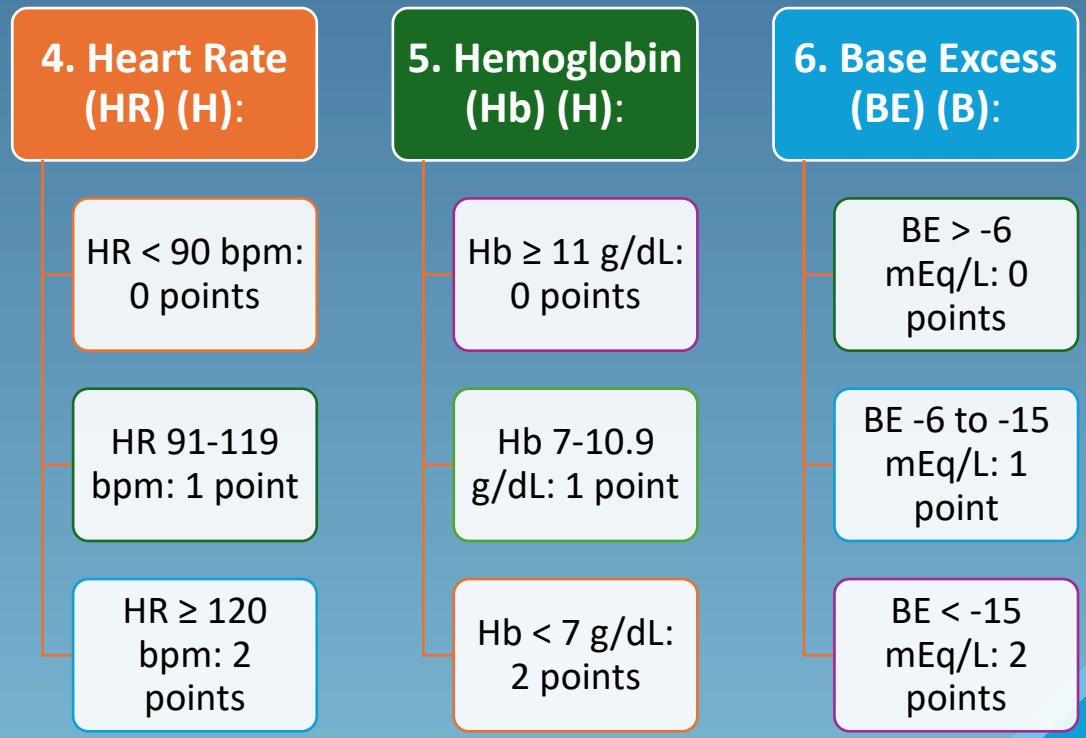
Injury Severity Score (ISS) (I):

- ISS ≤ 15: 0 points
- ISS 16-24: 1 point
- ISS ≥ 25: 2 points

Systolic Blood Pressure (SBP) (S):

- SBP ≥ 90 mmHg: 0 points
- SBP 76-89 mmHg: 1 point
- SBP ≤ 75 mmHg: 2 points

Trauma-Associated Severe Hemorrhage (TASH) Score:



Trauma-Associated Severe Hemorrhage (TASH) Score:

TASH Score < 3: Low likelihood of requiring massive transfusion.

TASH Score 3-6: Moderate likelihood of requiring massive transfusion.

TASH Score > 6: High likelihood of requiring massive transfusion.

Assessment of Blood Consumption (ABC) Score

- The Assessment of Blood Consumption (ABC) score correlates with the probability of requiring massive transfusion in trauma patients. While specific probabilities may vary slightly depending on the study or population, here's a general estimation of the probability associated with each ABC score:

Assessment of Blood Consumption (ABC) Score

The ABC score assigns points based on specific criteria related to the patient's injury and clinical presentation. Here's the scoring system typically used for the Assessment of Blood Consumption (ABC) score:

Penetrating Mechanism of Injury:	• Blunt trauma: 0 points • Penetrating trauma: 1 point
Systolic Blood Pressure (SBP) on Admission:	• SBP ≥ 90 mmHg: 0 points • SBP < 90 mmHg: 1 point
Heart Rate on Admission:	• Heart rate < 120 beats per minute (bpm): 0 points • Heart rate ≥ 120 bpm: 1 point
FAST Examination Results:	• Negative FAST exam (no intra-abdominal or pericardial fluid detected): 0 points • Positive FAST exam (intra-abdominal or pericardial fluid detected): 1 point

The total ABC score is calculated by summing the points assigned for each criterion. The score ranges from 0 to 4, with a higher score indicating a greater likelihood of requiring massive transfusion.

Assessment of Blood Consumption (ABC) Score

ABC score:

ABC Score of 0: The probability of requiring massive transfusion is typically low, ranging from less than 5% to around 10%.

ABC Score of 1: With an ABC score of 1, the probability of needing massive transfusion increases slightly compared to a score of 0, ranging from around 10% to 20%.

ABC Score of 2: Patients with an ABC score of 2 have a moderate probability of requiring massive transfusion, often ranging from approximately 20% to 40%.

ABC Score of 3: An ABC score of 3 indicates a high likelihood of needing massive transfusion, with probabilities typically ranging from 40% to 60% or higher.

ABC Score of 4: The probability of requiring massive transfusion is highest for patients with an ABC score of 4, often exceeding 60% and potentially approaching 80% or more in some cases.

Assessment of Blood Consumption (ABC) Score

- It's important to note that these probabilities are general estimates based on clinical studies and may vary based on factors such as patient demographics, trauma severity, and institutional protocols. Additionally, the ABC score serves as a tool to guide clinical decision-making and does not definitively predict the need for massive transfusion in every case. Clinical judgment and ongoing assessment of the patient's condition are crucial in determining the appropriate course of action.

End Points of Resuscitation

- In the context of medicine, MTP (Massive Transfusion Protocol) resuscitation involves the rapid administration of blood products to patients who have sustained significant blood loss, typically due to trauma or major surgical procedures. The endpoint of MTP resuscitation and when to stop it depends on various factors, including patient physiology, laboratory parameters, and clinical judgment. Here's a detailed description of the endpoint to be used for MTP resuscitation and when to consider stopping it based on patient physiology:

Endpoint of MTP Resuscitation: Points of Resuscitation

Hemodynamic Stability: The primary endpoint of MTP resuscitation is achieving and maintaining hemodynamic stability. This involves restoring and maintaining adequate perfusion to vital organs, evidenced by stable blood pressure, heart rate, and urine output.

Normalization of Lactate Levels: Lactate is a byproduct of anaerobic metabolism and is often elevated in patients with inadequate tissue perfusion. Normalization of lactate levels (usually defined as <2 mmol/L) indicates improved tissue perfusion and resolution of hypoperfusion.

Correction of Coagulopathy: MTP resuscitation aims to correct coagulopathy induced by massive bleeding. Monitoring parameters such as prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen levels can guide the administration of blood products (e.g., fresh frozen plasma, platelets, cryoprecipitate) to restore coagulation function.

Normalization of Base Excess: Base excess reflects the degree of metabolic acidosis or alkalosis. Resuscitation efforts aim to correct metabolic acidosis, often indicated by normalization of base excess or improvement in pH.

Clinical Assessment: Continuous clinical assessment is crucial in determining the effectiveness of MTP resuscitation. Parameters such as mental status, peripheral perfusion, skin color, and capillary refill time provide valuable insights into tissue oxygenation and overall clinical status.

End Points of Resuscitation

- **Endpoint of MTP Resuscitation:**

Points of Resuscitation When to Stop MTP Resuscitation Based on Patient Physiology:

1. **Achievement of Hemostasis**: Once surgical or interventional measures have achieved hemostasis, and ongoing bleeding is controlled, the need for ongoing massive transfusion may diminish.

2. **Hemodynamic Stability**: If the patient has achieved and maintained hemodynamic stability for a significant period, with stable vital signs and adequate tissue perfusion, the need for further blood product administration may decrease.

3. **Normalization of Laboratory Parameters**: When laboratory parameters such as lactate levels, coagulation studies, and base excess have normalized or significantly improved, this may indicate that the patient's physiological derangements have been corrected.

4. **Clinical Improvement**: Observing clinical improvement in the patient's overall condition, including mental status, peripheral perfusion, and urine output, may suggest that the patient's resuscitative needs are diminishing.

5. **Assessment of Bleeding Control**: Continuous assessment of bleeding control through surgical exploration, imaging studies, or clinical observation can guide decisions regarding the need for ongoing MTP resuscitation.

6. **Multidisciplinary Team Consultation:** In complex cases, involving a multidisciplinary team comprising surgeons, intensivists, hematologists, and transfusion medicine specialists can help guide decisions regarding the continuation or cessation of MTP resuscitation.

End Points of Resuscitation

- It's essential to recognize that the decision to stop MTP resuscitation is not solely based on one parameter but rather on a comprehensive assessment of the patient's overall clinical status, laboratory parameters, and ongoing bleeding risk. Close monitoring and frequent reassessment are crucial in optimizing patient outcomes.

End Points of Resuscitation

1. **In the management of massive transfusion protocol (MTP) in trauma care, which of the following is a key endpoint to monitor during transfusion therapy?**

   - A) Blood pressure
   - B) Heart rate
   - C) Tissue perfusion
   - D) Respiratory rate

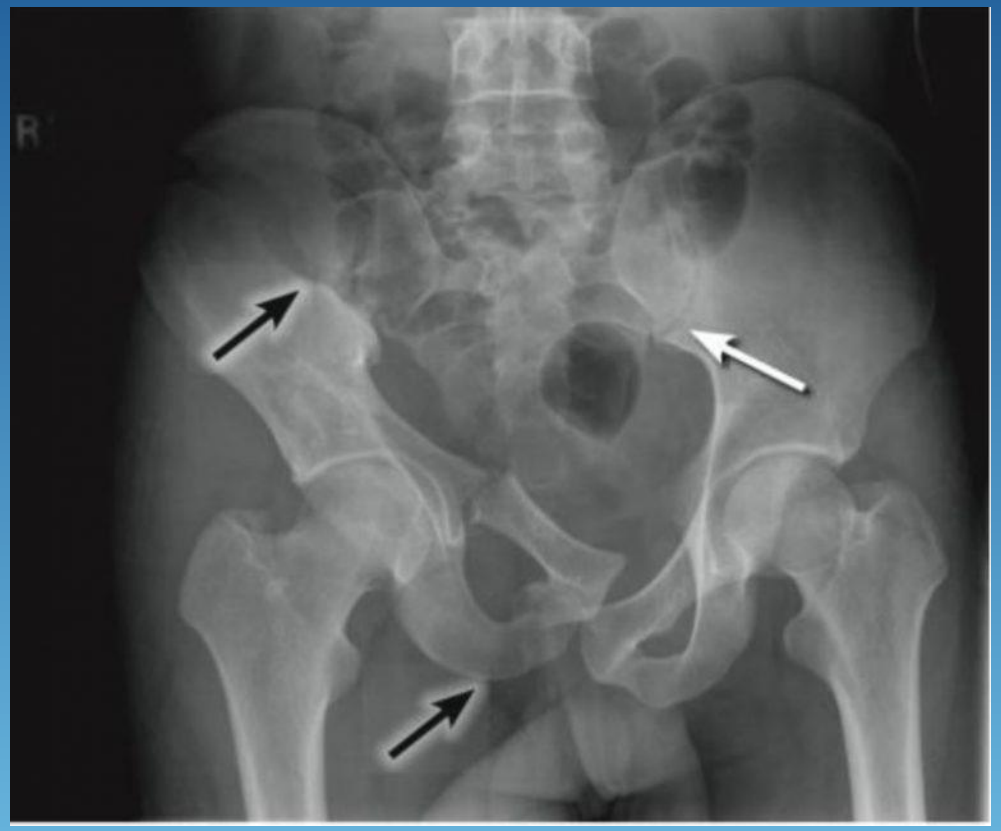
   - **Answer: C) Tissue perfusion**

Pelvic Fractures

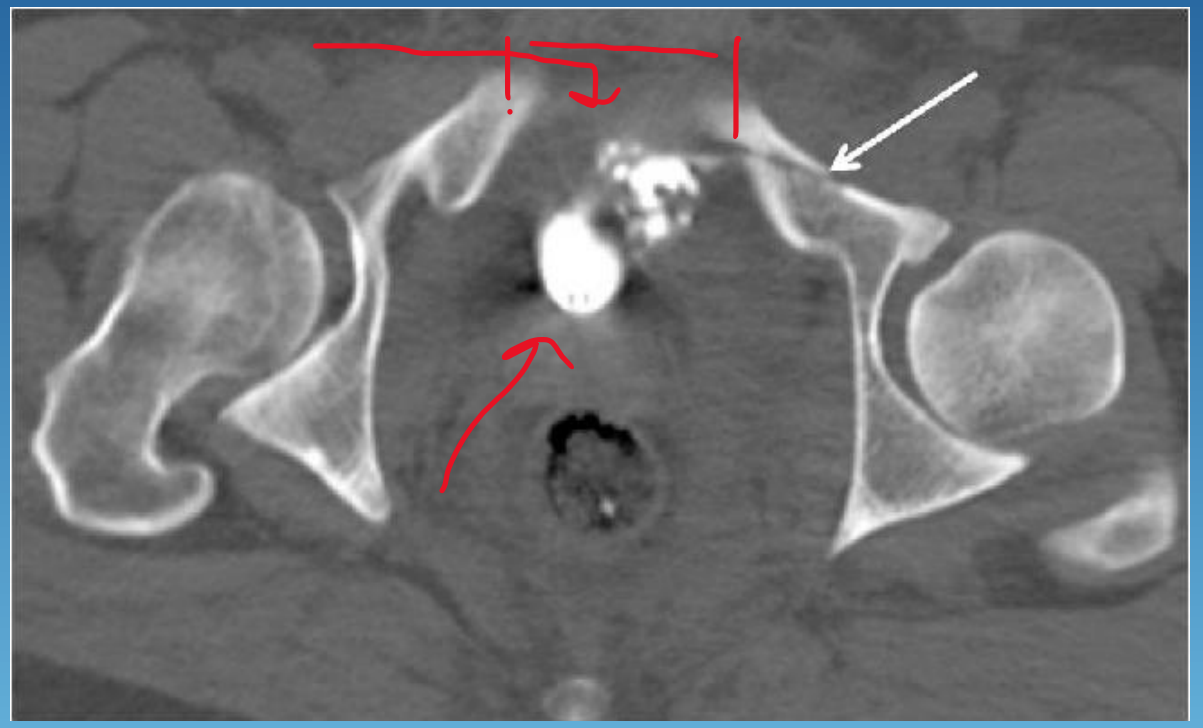
These Kill patients if not taken seriously…….point blank

What are the Wisniewski Rules of Pelvic Fracture management?

1. Close down the pelvic ring if open book pelvis	2. Transfuse blood products	3. Surgical Control of ongoing Bleeding (source control)



Which needs a pelvic Binder?



Active Pelvic Arterial Bleeding

Stopping Arterial Bleeding

Is the patient stable with/without transfusion?

If stable consider:

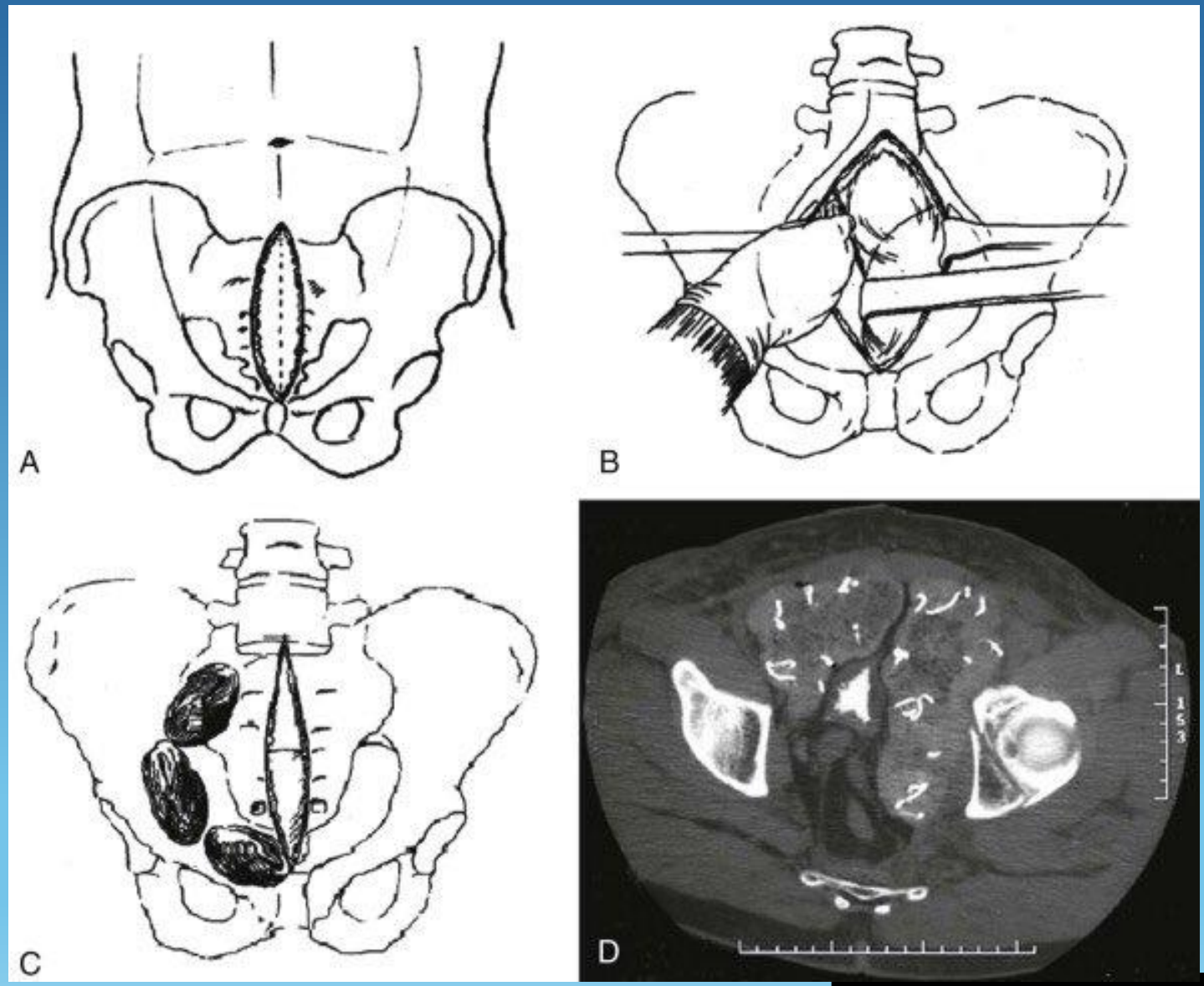
Interventional Radiology to embolize selectively or take out entire interal iliac system.

- Risk of gluteal necrosis with embolizing bilateral Internal iliac vessels
- Risk of impudence in men

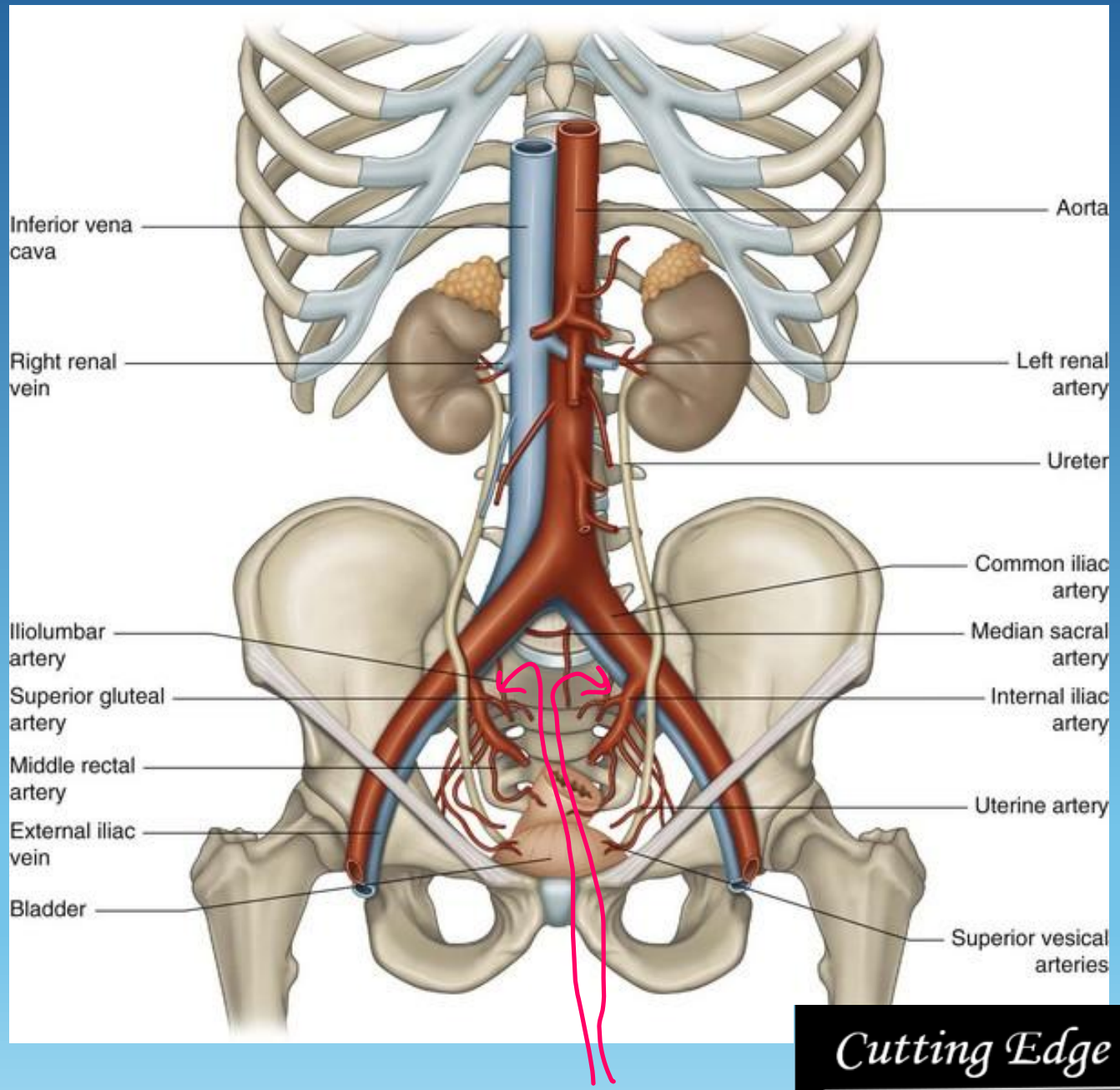
Surgical Options

- If Unstable need to consider surgical options
  - 1. Exploratory laparotomy with internal iliac artery ligation
  - 2. pre- peritoneal packing
  - 3. Exploratory laparotomy with either number 1 or number 2 or just pelvic packing.

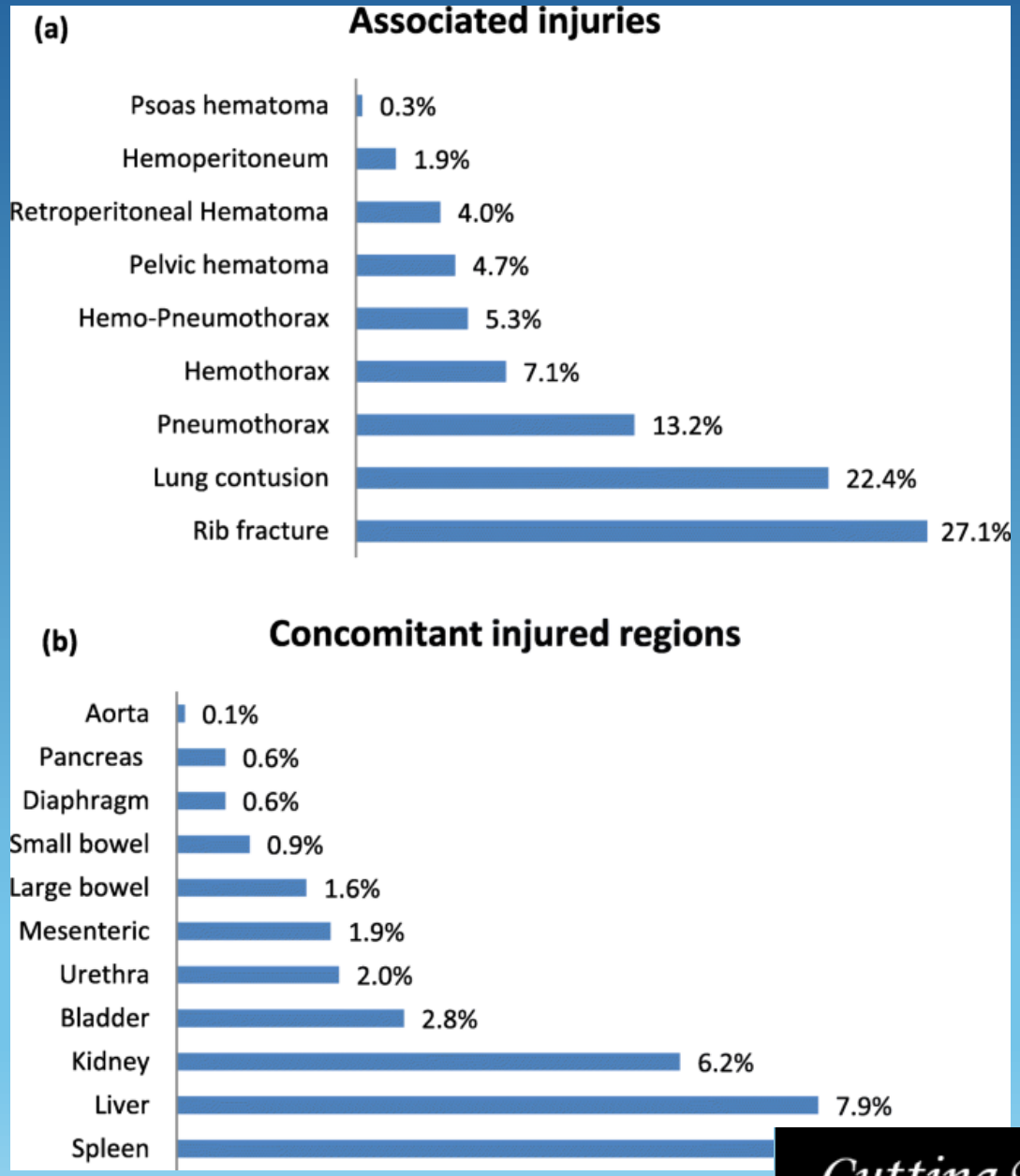
Preperitoneal packing



Internal Iliac Artery Ligation



What else to think about with Pelvic Fractures?



Pelvic Bleeding

It is estimated that 85% of pelvic fracture–related bleeding is due to venous and soft tissue bleeding. It is a low-pressure bleeding and will fill the space it is given. Thus, stabilization of the bony pelvis will help limit the space and facilitate early tamponade of the bleeding

In unstable pelvic ring fractures, a blood loss of approximately 9 to 15 units of blood must be expected

Question 2

2. **In trauma patients with pelvic fractures, which criteria are typically used to determine the need for surgical intervention to control pelvic bleeding?**

   - A) Presence of hemoptysis
   - B) Associated rib fractures
   - C) Hemodynamic instability and active arterial bleeding
   - D) Elevated creatinine levels

   - **Answer: C) Hemodynamic instability and active arterial bleeding**

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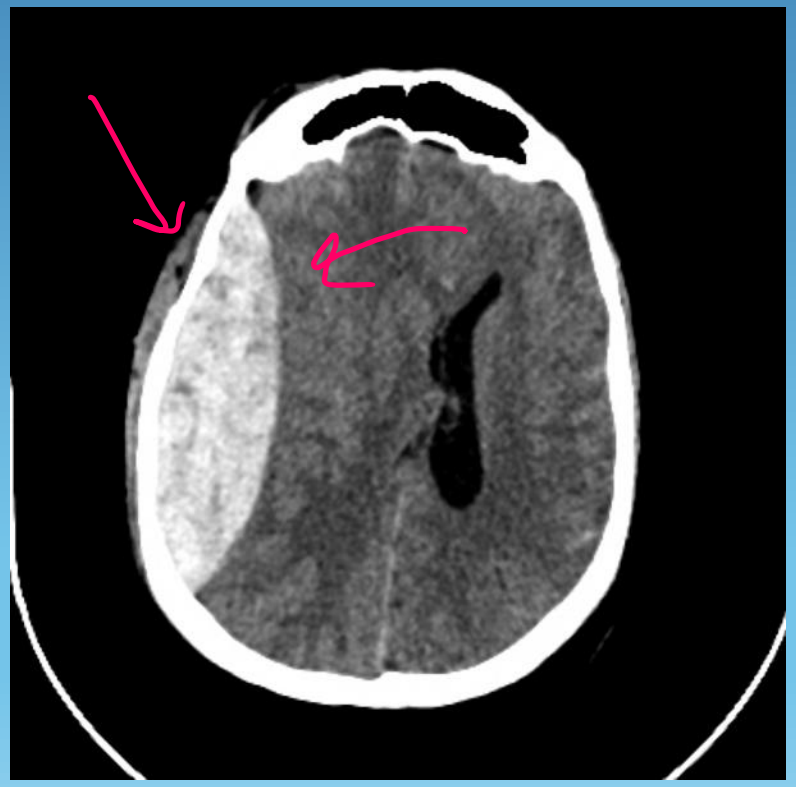
Traumatic brain injury management and nonsurgical options for treatment

- Which one will benefit from surgical decompression?



Intracranial Hypertension

Some of the key principles related to intracranial hypertension management that may be covered in the Brain Trauma Foundation guidelines include:

Monitoring and Measurement: Recommendations for monitoring intracranial pressure (ICP) and cerebral perfusion pressure (CPP) to guide treatment decisions. This may involve the use of invasive monitoring techniques such as intraventricular catheters or intraparenchymal monitors.

Treatment Thresholds: Guidelines for when to initiate treatment for intracranial hypertension based on ICP thresholds and other clinical indicators. This may include recommendations for using medical therapies such as osmotic agents, hyperventilation, or surgical interventions if conservative measures fail to control ICP.

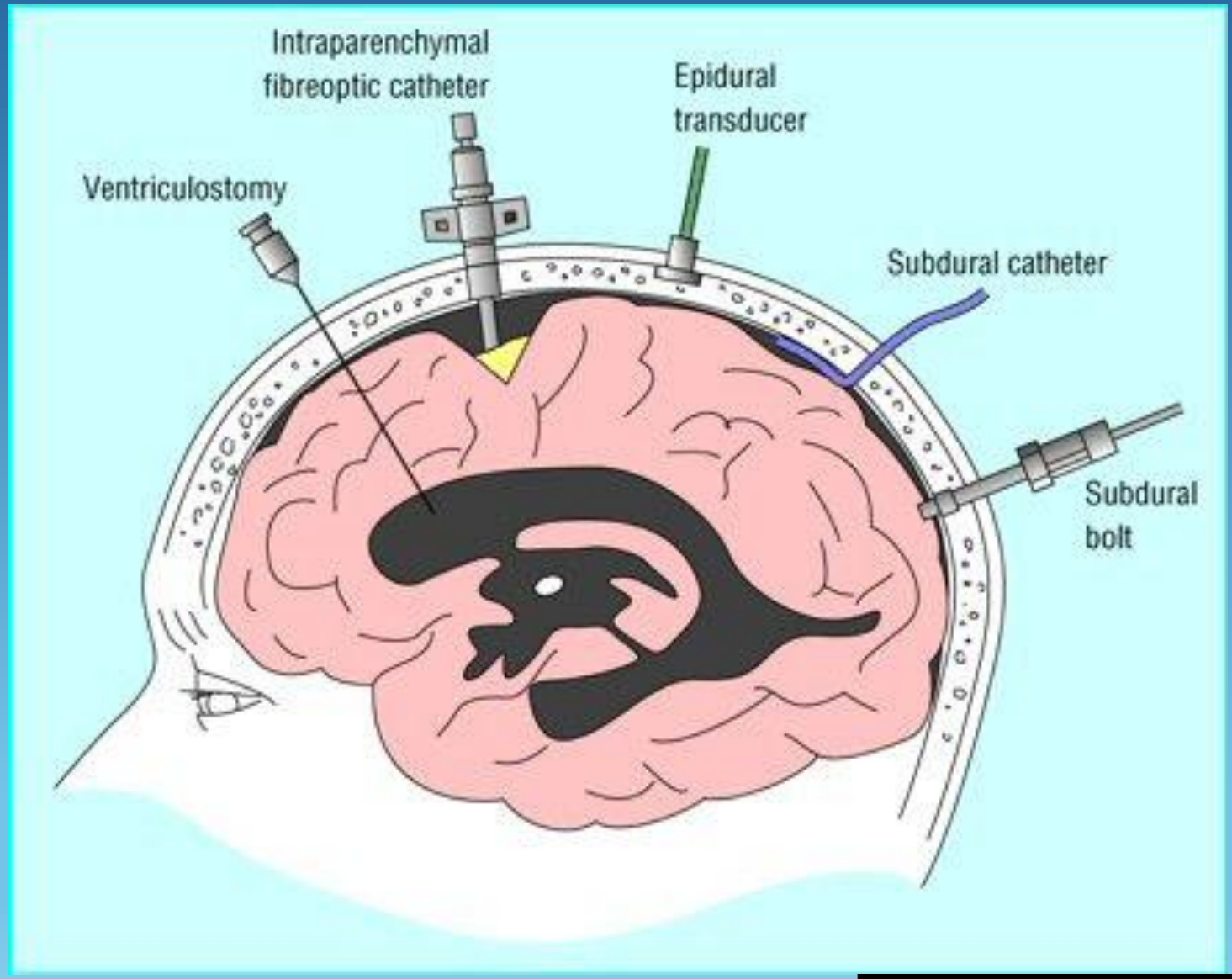
Cerebral Perfusion Optimization: Strategies to optimize cerebral perfusion and maintain adequate oxygenation and blood flow to the brain while managing intracranial hypertension. This may involve measures such as maintaining adequate blood pressure, avoiding hypoxia and hypercapnia, and using vasopressors if needed.

Management of Complications: Recommendations for managing complications associated with intracranial hypertension, such as cerebral edema, herniation syndromes, and secondary brain insults.

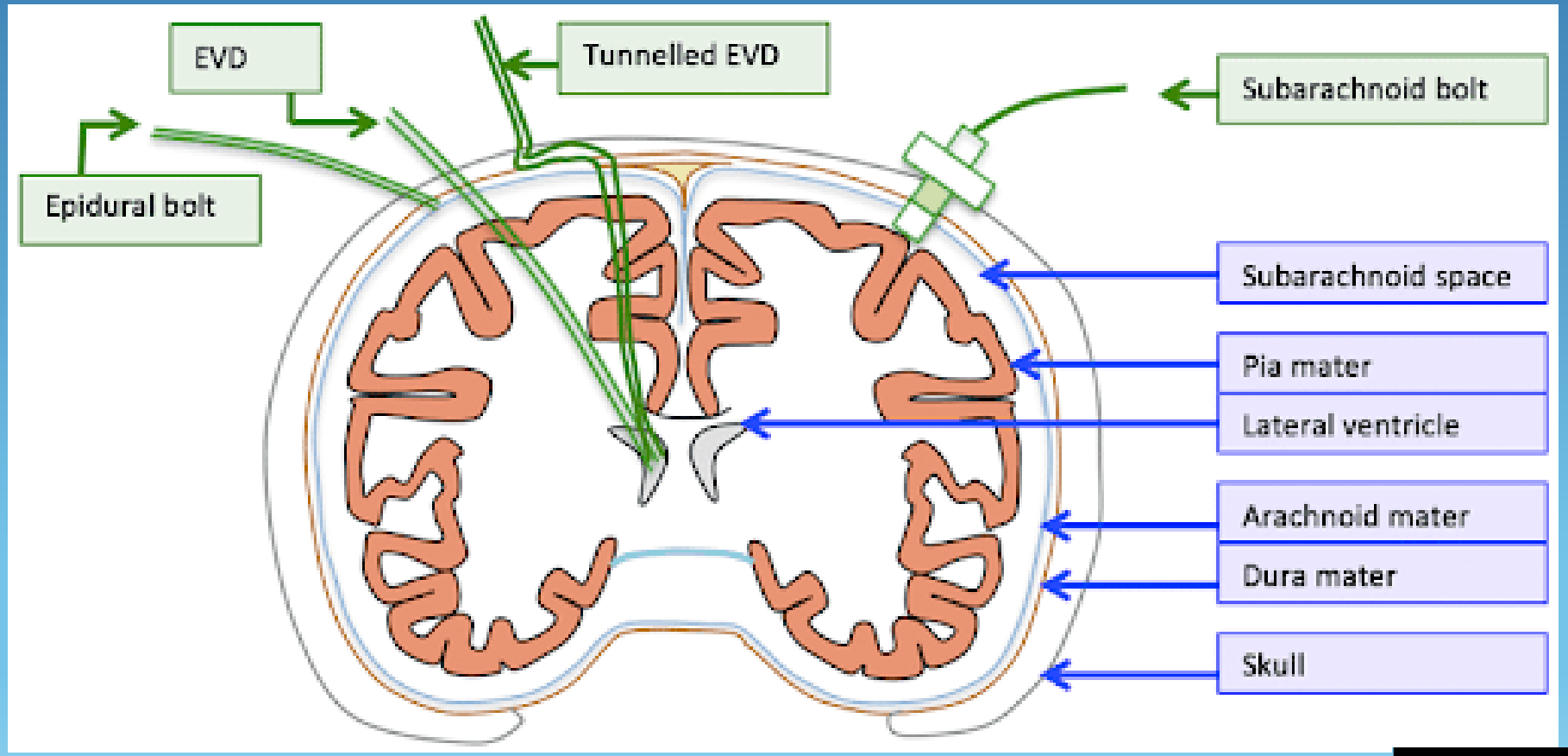
Multimodal Approach: Recognition that managing intracranial hypertension often requires a multimodal approach, involving a combination of medical therapies, surgical interventions, and supportive care tailored to the individual patient's needs.

Pressure monitoring

- CPP = cerebral perfusion pressure
- ICP = Intracranial pressure
- MAP = Mean arterial pressure
- CPP = MAP –ICP (goal 60-80 mmHg)
- Want ICP less than 20 mmHg (Ideal)



Pressure monitoring



Hyperosmolar therapy

- Hyperosmolar therapy involves the administration of agents that increase the osmolarity of the blood and extracellular fluid, drawing water out of brain tissue and reducing intracranial pressure (ICP). This therapy is commonly used in the management of intracranial hypertension, particularly in the setting of traumatic brain injury, stroke, or other conditions where cerebral edema contributes to elevated ICP.

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Hyperosmolar therapy

Two of the main agents used in hyperosmolar therapy are mannitol and hypertonic saline:

Mannitol:

- Mannitol is a sugar alcohol that is not metabolized by the body and acts as an osmotic agent.
- When administered intravenously, mannitol increases the osmolarity of the blood, drawing water out of brain cells and reducing cerebral edema.
- Mannitol also causes vasodilation in the renal arteries, increasing urine output and promoting diuresis, which can help reduce intracranial pressure indirectly.
- The typical dose of mannitol for treating intracranial hypertension is 0.25 to 1 gram per kilogram of body weight, administered as an intravenous bolus over 15 to 30 minutes.

Hyperosmolar therapy

2. **Hypertonic Saline**:

a. Hypertonic saline solutions have a higher concentration of sodium chloride compared to normal saline (0.9% NaCl).

b. When administered intravenously, hypertonic saline draws water out of brain cells through osmosis, reducing cerebral edema and intracranial pressure.

c. Hypertonic saline may also improve cerebral perfusion by increasing blood pressure and promoting vasodilation.

d. The concentration of hypertonic saline used in clinical practice varies, but common concentrations include 3%, 5%, or even higher.

e. The administration rate and volume of hypertonic saline depend on the patient's clinical condition and the severity of intracranial hypertension.

Intracranial Hypertension

By following the Brain Trauma Foundation guidelines, healthcare professionals can provide more standardized and evidence-based care to patients with traumatic brain injuries, including those with intracranial hypertension, leading to improved outcomes and quality of life.

It's important to monitor patients closely during hyperosmolar therapy for potential complications such as electrolyte imbalances, volume overload, and renal dysfunction. Additionally, these therapies are often used as temporary measures to stabilize intracranial pressure while the underlying cause of intracranial hypertension is addressed.

Question 3

3. Which of the following is a preferred treatment option for severe traumatic brain injury (TBI) when surgical intervention is necessary?

- A) Pharmacologic interventions to reduce intracranial pressure
- B) Hypothermia therapy
- C) Craniotomy for hematoma evacuation
- D) Steroid administration

- **Answer: C) Craniotomy for hematoma evacuation**

Minimizing End Organ Damage After Initial Resuscitation

- The areas that are of concern:
  - Kidneys
  - Liver
  - Brain
  - Lungs

Minimizing End Organ Damage After Initial Resuscitation

- Kidneys
  - Very sensitive to hypotension
  - Will notice the effects in 24-48 hours
  - Limit nephrotoxic drugs

Trend:

BUN/Create/UO

Recovery:

Days to weeks

If goes onto dialysis, then it is 1/3 :1/3 :1/3

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Minimizing End Organ Damage After Initial Resuscitation

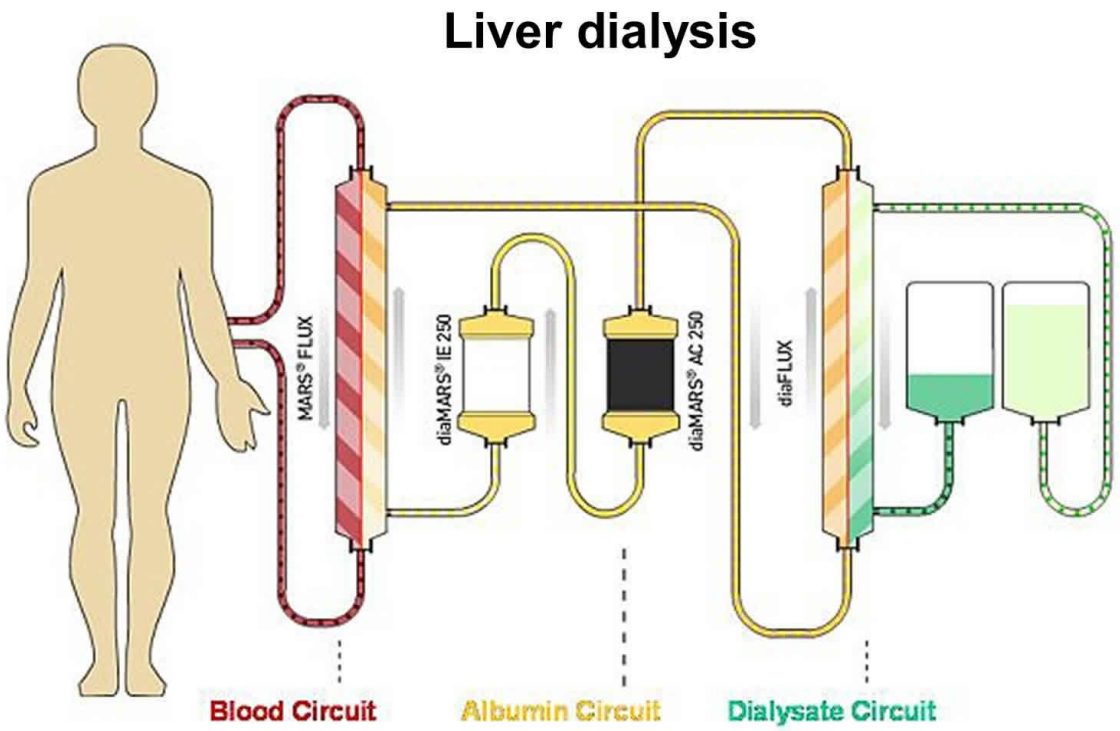
- If goes onto dialysis, then it is 1/3 :1/3 :1/3
  - 1/3 come off dialysis within 3 weeks
  - 1/3 come of dialysis within 3 month
  - 1/3 move on to permanent dialysis

- Best treatment early and aggressive resuscitation. This includes hemorrhage control.

Minimizing End Organ Damage After Initial Resuscitation

- Liver
  - Damage is seen at 3-5 days
  - Peaking in 7 days
  - Resolving in 10 -14 days

  - Mitigation
    - Limit hypotension
    - Limit Hepatotoxic drugs
    - No good liver dialysis exists at this time
  - Trend
    - AST/ALT/Bilirubin/Alk Phos/INR



Liver Dialysis

- Limited Data on efficacy and usage
- It is an area of further study

Minimizing End Organ Damage After Initial Resuscitation

- Brain
  - No way to fix primary injury
  - All efforts directed at secondary injury
    - Limit
      - Hypotension less than 80 mmHg
      - Hypoglycemia less than 70 mg/dl
      - Hypoxia PaO2 less than 60 mmHg
    - Any one of these will increase mortality 50 %

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Minimizing End Organ Damage After Initial Resuscitation

- Lungs
  - Do not flood the lungs
  - Fluid overload leads to ARDS
  - Mitigate crystalloids as much as possible
    - If bleeding blood products
  - Wet lungs become stiff and noncompliant
    - Will require lower tidal volume 6ml/kg ideal body wt
    - Higher peep up to 20 cm H2O
    - Inversion of I:E ratio
    - Tolerance by the provider for higher PCO2 and lower PaO2 numbers

Things that You should Ask Yourself Every Trauma Case

How is the management of massive transfusion protocol (MTP) crucial in trauma care?

What are the key endpoints to monitor during transfusion therapy?

Things that You should Ask Yourself Every Trauma Case

What criteria are used to determine which pelvic fractures necessitate surgical intervention for controlling pelvic bleeding in trauma patients?

How can healthcare providers effectively reduce end-organ injury and damage following initial stabilization in trauma patients?

Question 4

4. Which of the following complications can result from delayed or inadequate utilization of massive transfusion protocol (MTP) in trauma situations?

- A) Hypertension
- B) Hypoglycemia
- C) Coagulopathy
- D) Hyperkalemia

- **Answer: C) Coagulopathy**

Question 5

5. **Which proactive management strategy is essential to mitigate complications associated with delayed or inadequate utilization of massive transfusion protocol (MTP)?**

   - A) Early recognition of hypotension
   - B) Delayed initiation of blood product transfusion
   - C) Prompt initiation of interventions to prevent secondary insults
   - D) Delayed monitoring of coagulation parameters

- **Answer: C) Prompt initiation of interventions to prevent secondary insults**

References

- Biffl, W. L., Fox, C. J., Moore, E. E., & Bainbridge, J. (2018). Advanced Trauma Life Support, 10th Edition, Update 2018: Management and Applications of Trauma Protocols. The Journal of Trauma and Acute Care Surgery, 85(4), 805–807.
- Cannon, J. W., Khan, M. A., Raja, A. S., Cohen, M. J., Como, J. J., Cotton, B. A., Dubose, J. J., Fox, E. E., Inaba, K., Rodriguez, C. J., Holcomb, J. B., & Duchesne, J. C. (2018). Damage Control Resuscitation in Patients with Severe Traumatic Hemorrhage: A Practice Management Guideline from the Eastern Association for the Surgery of Trauma. The Journal of Trauma and Acute Care Surgery, 84(6), 915–925.
- Carney, N., Totten, A. M., O'Reilly, C., Ullman, J. S., Hawryluk, G. W. J., Bell, M. J., Bratton, S. L., Chesnut, R., Harris, O. A., Kissoon, N., Rubiano, A. M., Shutter, L., Tasker, R. C., Vavilala, M. S., Wilberger, J., Wright, D. W., & Ghajar, J. (2017). Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. Neurosurgery, 80(1), 6–15.
- Cotton, B. A., Reddy, N., Hatch, Q. M., LeFebvre, E., Wade, C. E., Kozar, R. A., Gill, B. S., Albarado, R., McNutt, M. K., Holcomb, J. B., & Brasel, K. J. (2013). Damage Control Resuscitation Is Associated with a Reduction in Resuscitation Volumes and Improvement in Survival in 390 Damage Control Laparotomy Patients. Annals of Surgery, 258(4), 591–597.
- Holcomb, J. B., Tilley, B. C., Baraniuk, S., Fox, E. E., Wade, C. E., Podbielski, J. M., del Junco, D. J., Brasel, K. J., Bulger, E. M., Callcut, R. A., Cohen, M. J., Cotton, B. A., Fabian, T. C., Inaba, K., Kerby, J. D., Muskat, P., O'Keeffe, T., Rizoli, S., Robinson, B. R. H., Scalea, T. M., Schreiber, M. A., Stein, D. M., Weinberg, J. A., Callum, J. L., Hess, J. R., Matijevic, N., Miller, C. N., Pittet, J.-F., Hoyt, D. B., Pearson, G. D., Leroux, B., van Belle, G., & GROUP, for the P. S. (2015). Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma: The PROPPR Randomized Clinical Trial. JAMA, 313(5), 471–482.
- Holcomb, J. B. (2019). Ten Clinical Trials That Have Shaped the Standard of Care in Trauma Surgery. The Journal of Trauma and Acute Care Surgery, 87(6), 1412–1423.

References

- Holcomb, J. B. (2019). Ten Clinical Trials That Have Shaped the Standard of Care in Trauma Surgery. The Journal of Trauma and Acute Care Surgery, 87(6), 1412–1423.
- Osborn, P. M., Smith, W. R., Moore, E. E., Cothren, C. C., Morgan, S. J., & Williams, A. E. (2019). Direct Retroperitoneal Pelvic Packing Versus Pelvic Angiography: A Comparison of Two Management Protocols for Hemodynamically Unstable Pelvic Fractures. Trauma Surgery & Acute Care Open, 4(1), e000291.
- Carney, N., Totten, A. M., O'Reilly, C., Ullman, J. S., Hawryluk, G. W. J., Bell, M. J., Bratton, S. L., Chesnut, R., Harris, O. A., Kissoon, N., Rubiano, A. M., Shutter, L., Tasker, R. C., Vavilala, M. S., Wilberger, J., Wright, D. W., & Ghajar, J. (2017). Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. Neurosurgery, 80(1), 6–15.
- Sperry, J. L., Guyette, F. X., Brown, J. B., Yazer, M. H., Triulzi, D. J., Early-Young, B. J., Adams, P. W., Daley, B. J., Miller, R. S., Harbrecht, B. G., Claridge, J. A., Phelan, H. A., Witham, W. R., Putnam, A. T., Duane, T. M., Alarcon, L. H., Callaway, C. W., Zuckerbraun, B. S., Neal, M. D., Rosengart, M. R., Forsythe, R. M., & Group, the P. R. O. P. P. R. (2012). Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock. The New England Journal of Medicine, 372(3), 315–324.
- Cannon, J. W., Khan, M. A., Raja, A. S., Cohen, M. J., Como, J. J., Cotton, B. A., Dubose, J. J., Fox, E. E., Inaba, K., Rodriguez, C. J., Holcomb, J. B., & Duchesne, J. C. (2018). Damage Control Resuscitation in Patients with Severe Traumatic Hemorrhage: A Practice Management Guideline from the Eastern Association for the Surgery of Trauma. The Journal of Trauma and Acute Care Surgery, 84(6), 915–925.
- Hutchinson, P. J., Kolias, A. G., Timofeev, I. S., Corteen, E. A., Czosnyka, M., Timothy, J., Anderson, I., Bulters, D. O., Belli, A., Eynon, C. A., Wadley, J., Mendelow, A. D., Mitchell, P. M., Wilson, M. H., Critchley, G., Sahuquillo, J., Unterberg, A., Servadei, F., Teasdale, G. M., Pickard, J. D., & Menon, D. K. (2016). Trial of Decompressive Craniectomy for Traumatic Intracranial Hypertension. The New England Journal of Medicine, 375(12), 1119–1130.
- Osborn, P. M., Smith, W. R., Moore, E. E., Cothren, C. C., Morgan, S. J., & Williams, A. E. (2019). Direct Retroperitoneal Pelvic Packing Versus Pelvic Angiography: A Comparison of Two Management Protocols for Hemodynamically Unstable Pelvic Fractures. Trauma Surgery & Acute Care Open, 4(1), e000291.
- Sperry, J. L., Guyette, F. X., Brown, J. B., Yazer, M. H., Triulzi, D. J., Early-Young, B. J., Adams, P. W., Daley, B. J., Miller, R. S., Harbrecht, B. G., Claridge, J. A., Phelan, H. A., Witham, W. R., Putnam, A. T., Duane, T. M., Alarcon, L. H., Callaway, C. W., Zuckerbraun, B. S., Neal, M. D., Rosengart, M. R., Forsythe, R. M., & Group, the P. R. O. P. P. R. (2012). Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock. The New England Journal of Medicine, 372(3), 315–324.
- Tai, D. K. C., Li, W. H. T., Lee, K. Y., Cheng, M., Lee, K. B. L., & Tang, L. F. Y. (2017). Clinical Predictors of Massive Transfusion and In-hospital Mortality in Trauma Patients Admitted to Intensive Care Unit from Emergency Department: A Retrospective Cohort Study. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 25(1), 40.

References

- https://www.bing.com/images/search?view=detailV2&ccid=VtcDdywP&id=2D3961D84156761770E0D442FD28CF25BD1EA6DE&thid=OIP.VtcDdywPxOeU1fvlOpeViwHaFj&mediaurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.56d703772c0fc4e794d5fbe53a97958b%3frik%3d3qYevSXPKP1C1A%26riu%3dhttp%253a%252f%252fimages.radiopaedia.org%252fimages%252f1506527%252f684c131c4663f81ac5f732067ad737.JPG%26ehk%3drNIy3STlUkZXUL%252fjIFlAOqhfYYYlLaMcyIpFEPk51TU%253d%26risl%3d%26pid%3dImgRaw%26r%3d0&exph=600&expw=800&q=open+book+pelvic+fracture&simid=607995485255893380&FORM=IRPRST&ck=C28A60D431903526C80D70B5E9CD9D59&selectedIndex=2&itb=0

- https://www.bing.com/images/search?view=detailV2&ccid=e%2bQbpGT5&id=F9DDD86305FE8D102F78E54B3159CA9B3965046D&thid=OIP.e-QbpGT5RrsogzqO3ONBDAHaGL&mediaurl=https%3a%2f%2fwww.rcemlearning.co.uk%2fwp-content%2fuploads%2fPelvis6-768x641.jpg&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.7be41ba464f946bb28833a8edce3410c%3frik%3dbQRlOZvKWTFL5Q%26pid%3dImgRaw%26r%3d0&exph=641&expw=768&q=pelvic+fracture&simid=608032709757783154&FORM=IRPRST&ck=7BA87A7FEC0BC743EDD355237516F0AC&selectedIndex=8&itb=0

- https://www.bing.com/images/search?view=detailV2&ccid=IBhKoKF8&id=E0DFF6DF44FBBAAB64516D284FB118BDB6B726D2&thid=OIP.IBhKoKF8EZxK9lv6fDl0BAHaEf&mediaurl=https%3a%2f%2fwww.researchgate.net%2fprofile%2fAzian-Aziz%2fpublication%2f51847798%2ffigure%2ffig15%2fAS%3a668481502580759%401536389818979%2fb-CT-scan-showing-fracture-of-the-pelvic-bone-A-lower-scan-of-the-same-patient-in-a.png&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.20184aa0a17c119c4af65bfa7c397404%3frik%3d0ia3tr0YsU8obQ%26pid%3dImgRaw%26r%3d0&exph=397&expw=655&q=Active+bleeing+pelvic+fracture+on+CT+scan&simid=607995562589100061&FORM=IRPRST&ck=EF8BF4AA8AF6D89BDBF9AEE867B852A9&selectedIndex=34&itb=0

- https://www.google.com/url?sa=i&url=https%3A%2F%2Ftwitter.com%2FCirbosque%2Fstatus%2F1295068021032202244&psig=AOvVaw2aRN23Ad01qS0E8Y_GGXHR&ust=1714428923708000&source=images&cd=vfe&opi=89978449&ved=0CBIQjhxqFwoTCLivrtj35YUDFQAAAAAdAAAAABAE

- https://www.google.com/url?sa=i&url=https%3A%2F%2Fmusculoskeletalkey.com%2Filiac-vessels%2F&psig=AOvVaw1G6eJYYnezkZ4eM63dYVLd&ust=1714429281250000&source=images&cd=vfe&opi=89978449&ved=0CBIQjhxqFwoTCNjPm_f45YUDFQAAAAAdAAAAABAE

Patterns, management, and outcomes of traumatic pelvic fracture: insights from a multicenter study

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References

- https://www.google.com/url?sa=i&url=https%3A%2F%2Fradiopaedia.org%2Fcases%2Fepidural-haematoma-11&psig=AOvVaw3ZhP0WrpdmlEd-JOY6Ab3o&ust=1714430675781000&source=images&cd=vfe&opi=89978449&ved=0CBIQjhxqFwoTCODa05D-5YUDFQAAAAAdAAAAABAE

Bratton SL, Chestnut RM, Ghajar J, et al. Guidelines for the management of severe traumatic brain injury. IX. Cerebral perfusion thresholds. J Neurotrauma. 2007;24 Suppl 1(Suppl 1):S59-S64. doi:10.1089/neu.2007.9989

Maas AI, Menon DK, Adelson PD, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. Lancet Neurol. 2017;16(12):987-1048. doi:10.1016/S1474-4422(17)30371-X

Carney N, Totten AM, O'Reilly C, et al. Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. Neurosurgery. 2017;80(1):6-15. doi:10.1227/NEU.0000000000001432

Bullock MR, Chesnut R, Ghajar J, et al. Surgical management of traumatic brain injury. Neurosurgery. 2006;58(3 Suppl):S2-62. doi:10.1227/01.NEU.0000210369.32223.0F

BTF Guidelines for the Management of Severe Traumatic Brain Injury 4th Edition, Chapter 3: Intracranial Pressure Monitoring Technology. Brain Trauma Foundation, 2016.

Tisdall MM, Smith M. Cerebral microdialysis: research technique or clinical tool. Br J Anaesth. 2006;97(1):18-25. doi:10.1093/bja/ael116

Chesnut RM, Bleck TP, Citerio G, et al. A Consensus-Based Interpretation of the Benchmark Evidence from South American Trials: Treatment of Intracranial Pressure Trial. J Neurotrauma. 2015;32(22):1722-1724. doi:10.1089/neu.2015.4203

Chaiwat O, Sharma D, Udomphorn Y, Armstead WM, Vavilala MS. Cerebral hemodynamic predictors of poor 6-month Glasgow Outcome Score in severe pediatric traumatic brain injury. J Neurotrauma. 2009;26(5):657-663. doi:10.1089/neu.2008.0674

https://www.google.com/url?sa=i&url=http%3A%2F%2Fsyllabus.cwru.edu%2FYearThree%2Fneuroscience%2FNeurLrngObjectives%2FICP%2520monitoring.htm&psig=AOvVaw3YpNsSzdIEU9OpJDai2EJ9&ust=1714457852281000&source=images&cd=vfe&opi=89978449&ved=0CBIQjhxqFwoTCNCM163j5oUDFQAAAAAdAAAAABAE