

ALGORITHM 1 (Basic ambulance or basic emergency transport - BET)

- a. Control external sources of bleeding by direct pressure, firm bandage or tourniquet.
- b. AVPU evaluation (consciousness level) or Glasgow Coma Scale (GCS) evaluation.
 - i. Alert
 - ii. Response to Verbal stimulus
 - iii. Response to Pain stimulus
 - iv. Unresponsiveness
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure (if available).
 - i. Administer supplementary oxygen (if available) Threshold: SpO₂ >94%.
 - ii. If SpO₂ is not available and RR <10 or >30BPM perform Bag Valve Mask (BVM) with RR between 10-20 BPM.
 - iii. If BVM is not available, perform a basic chin lift to maintain an open airway with spontaneous breathing.
 - iv. If unresponsiveness, and RR <10 or >30 or SpO₂ <90%, consider oral pharyngeal or nasal pharyngeal airway (NPA/OPA) or supra-glottic device (if available). If not available, maintain a chin lift manually.
- d. Confirm radial pulse presence or perform non-invasive systolic blood pressure (SBP) measurement (if available).
 - i. If the radial pulse is present, re-check every 5 minutes.
 - ii. If it is not present, and IV fluids are available, start IV at 20mL/Kg of Normal Saline (NS) or Ringer's Lactate (RL), check for radial pulse improvement. Repeat intravenous (IV) bolus if not an improvement of radial pulse.

- iii. It is not present, and IV fluids are not available, do not perform any other intervention.
- e. Perform glucose measurement (if available).
 - i. Administer 15-20 g of glucose if glucose level <110mg/dL.
 - ii. If glucose measurement is not available, do not perform any other intervention.
- f. Evaluate for seizures clinically.
 - i. If any seizure and medication available, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If any seizure and no medication available, evaluate airway patency and maintain a basic chin lift. Re-evaluate for steps **c**, **d**, and **e**.
- g. Re-evaluate **a**, **b**, **c**, **d**, every 5 minutes.
- h. Fill the medical record for data collection (if available).
- i. Transport to the nearest facility with CT, ICU, NSG, capacity (if available).
 - i. If not available, transfer to the nearest facility with the emergency room available.

ALGORITHM 2 (Advanced ambulance or advanced emergency transport – with medical capabilities - AET)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
 - i. If active bleeding or polytrauma starts tranexamic acid 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%.
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for endotracheal intubation (ETI).
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
- d. Confirm radial pulse presence and perform non-invasive SBP measurement.
 - i. If present, re-check every 5 minutes.
 - ii. If not present or SBP <90mmHg start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg.
 - iii. If not an improvement in SBP start Hypertonic Saline (HTS) 1-4cc/Kg of HTS 3% or 7.5%. See HTS preparation in **Table 3**.

- e. Perform glucose measurement.
 - i. Administer 15-20g of glucose if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- f. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil (s) to light, abnormal motor response with motor GCS 2-3) start HTS 7.5% as prepared in **Table 3**.
- g. Evaluate for seizures clinically
 - i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. Re-evaluate for steps **c, d, e and f**.
- h. Re-evaluate **a, b, c, d, e, f** every 5 minutes.
- i. Consider analgesia management with Dipyrone 1-2 g.
- j. Avoid hypothermia with blankets.
- k. Fill the medical record for data collection.
- l. Transport to nearest facility with CT, ICU, NSG, capabilities.

ALGORITHM 3 (Management algorithm of the patient with mild TBI in a low complexity ED - without CT)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15)
 - ii. Moderate (GCS 9-12)
 - iii. Severe (GCS 3-8)
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%.
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI. If BVM is not available, maintain patency of the airway by chin lift or jaw traction.
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request Arterial Blood Gases (ABG) (if available) to define variations in Fraction of Inspired Oxygen (FiO₂). Threshold PaO₂ >50mmHg/pCO₂ 30-35mmHg.

- vi. Start mechanical ventilation (if available) with an RR between 10-20 BPM with low tidal volumes (5-7mL/Kg) and physiologic Positive End-Expiratory Pressure (PEEP) of 5.
 - vii. If pCO₂ measurement available maintain a range between 30-35mmHg.
 - viii. If no possibilities of mechanical ventilation or pCO₂ measurements, maintain BVM ventilation trough endotracheal tube with RR between 10-20 BPM and SpO₂>94%.
- d. Confirm radial pulse presence and non-invasive SBP measurement.
- i. If present or SBP >100mmHg, re-check every 5 minutes.
 - ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg
 - iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.
 - iv. If active bleeding or polytrauma starts tranexamic acid 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.
 - v. If not an improvement in SBP after previous steps, start vasopressors (if available) with Noradrenaline or Adrenaline at doses presented in **Table 5**.
 - vi. Maintain urinary output greater than 50cc/h.
 - vii. Identify clinically other sources of shock (tension pneumothorax, cardiac tamponade, abdominal bleeding, pelvic bleeding).
 - viii. If tension pneumothorax (TN) is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle).

- e. Confirm suspected injuries with a chest X-ray (if available) or trauma ultrasound (if available).
 - i. If the cervical x-ray is available discard cervical fractures.
 - ii. If not X-ray available maintains C-Collar in position.
 - iii. Prepare for transfer the patient if there are other sources of shock and require General Surgery or Orthopedics and they are not available.
 - iv. If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.
- f. Measure glucose levels.
 - i. Administrate 15-20g of glucose, if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- g. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
 - iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
- h. Evaluate for seizures clinically
 - i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.

- ii. If seizures, after the use of Benzodiazepines (BZD), start phenytoin 15–20mg/Kg diluted in NS or 5% Dextrose.
 - iii. Re-evaluate for steps **c, d, e and f**.
- i. Define criteria for transfer to a higher-level facility with CT, ICU and NSG capabilities (**Table 4**).
 - j. Consider analgesia management with Dipyrone 1-2 g.
 - k. Start sedation with Midazolam and Fentanyl (if available) at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
 - l. Re-evaluate **a, b, c, d, e, f** every 5 minutes.
 - m. Avoid hypothermia with blankets.
 - n. Fill the medical record for data collection.
 - o. Transport the patient to nearest facility with CT, ICU, NSG, capabilities.

ALGORITHM 4 (Management algorithm of the patient with mild TBI in a medium-high complexity ED - with CT)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%.
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI.
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/pCO₂ 30-35mmHg.
 - vi. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP 5.
 - vii. If pCO₂ measurement available maintain a range between 30-35mmHg.

d. Confirm radial pulse presence and non-invasive systolic blood pressure measurement.

i. If present, re-check every 5 minutes.

ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg.

iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.

iv. If active bleeding or polytrauma starts tranexamic acid 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.

v. Identify clinically other sources of shock (tension pneumothorax, cardiac tamponade, abdominal bleeding, pelvic bleeding).

vi. If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.

vii. If TN is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle).

viii. If not an improvement in SBP after previous steps start vasopressors with Noradrenaline or Adrenaline at doses presented in **Table 5**.

ix. Maintain urinary output greater than 50cc/h.

e. Confirm suspected injuries with a chest X-ray.

i. Perform cranial CT.

ii. Evaluate the cervical x-ray or cervical CT for discard cervical fractures.

iii. If not injuries present, retire C-Collar.

iv. Require consultation by general surgery, orthopedics and/or neurosurgery.

- v. Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets. Suggested exams for decisions include: Lactate >2.5mg/dL and EB > - 6. Use TASH or ABC scores for transfusion indications (see Appendix B in supplementary material).
- f. Request hemoglobin levels. Threshold >9 g/dL.
- g. Measure glucose levels.
 - i. Administrate 15-20g of glucose, if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- h. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
 - iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
 - iv. Measure serum sodium. Threshold 135-145mEq/L.
- i. Evaluate for seizures clinically.
 - i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
 - iii. Re-evaluate for steps **c, d, e and f**.

- j. Re-evaluate **a, b, c, d, e, f** every 15 minutes.
- k. Consider analgesia management with Dipyrone 1-2 g.
- l. Start sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- m. Avoid hypothermia with blankets.
- n. Fill the medical record for data collection.
- o. Perform the WHO trauma care checklist (Table 6).
- p. Transport to the emergency room as soon as possible.

ALGORITHM 5 (Management algorithm of the patient with Moderate to severe TBI in a low complexity ED - without CT)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and Perform SpO₂ measure
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%.
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI.
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/PCO₂ 30-35mmHg.
 - vi. Start mechanical ventilation (if available) with an RR between 10-20 BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP of 5.
 - vii. If pCO₂ measurement available maintain a range between 30-35mmHg.

- viii. If no possibilities of mechanical ventilation or pCO₂ measurements, maintain BVM ventilation trough endotracheal tube with RR between 10-20 BPM and SpO₂>94%.
- d. Confirm radial pulse presence and non-invasive systolic blood pressure measurement.
- i. If present, re-check every 5 minutes.
 - ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg.
 - iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.
 - iv. If active bleeding or polytrauma starts tranexamic acid 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.
 - v. Identify clinically other sources of shock (TN, cardiac tamponade, abdominal bleeding, pelvic bleeding).
 - vi. If TN is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle).
 - vii. If not an improvement in SBP after previous steps, start vasopressors (if available) with Noradrenaline or Adrenaline at doses presented in **Table 5**.
 - viii. Maintain urinary output greater than 50cc/h.
- e. Confirm suspected injuries with a chest X-ray (if available) or trauma ultrasound (if available).
- i. If the cervical X-ray is available discard cervical fractures.
 - ii. If not X-ray available maintains C-Collar in position.

- iii. Prepare for transfer the patient if there are other sources of shock and you require General Surgery or Orthopedics and they are not available.
- iv. If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.

f. Measure glucose levels.

- i. Administrate 15-20g of glucose if glucose level <110mg/dl, re – check values to maintain a threshold of 110-170mg/dL.

g. Re-Evaluate GCS.

- i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in

Table 3.

- ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
- iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.

h. Evaluate for seizures clinically.

- i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
- ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
- iii. Re-evaluate for steps **c, d, e and f**.

i. Define criteria for transfer to a higher-level facility with CT, ICU and neurosurgical capabilities (**Table 4**).

- j. Re-evaluate **a, b, c, d, e, f** every 15 minutes.
- k. Consider analgesia management with Dipyrone 1-2 g.
- l. Start sedation with Midazolam and Fentanyl (if available) at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- m. Avoid hypothermia using blankets.
- n. Fill the medical record for data collection.
- o. Transport to nearest facility with CT, ICU, NSG, capabilities.

Algorithm 6 (Management algorithm of the patient with Moderate to severe TBI in a medium-high complexity ED - with CT)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and Perform SpO₂ measure
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/pCO₂ 30-35mmHg.
 - vi. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP 5.
 - vii. If pCO₂ measurement available maintain a range between 30-35mmHg.

d. Confirm radial pulse presence and non-invasive systolic blood pressure measurement.

i. If present, re-check every 5 minutes

ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg

iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.

iv. If active bleeding or polytrauma starts tranexamic acid 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.

v. Identify clinically other sources of shock (TN, cardiac tamponade, abdominal bleeding, pelvic bleeding)

vi. If TN is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle)

vii. If not an improvement in SBP after previous steps start vasopressors with Noradrenaline or Adrenaline at doses presented in **Table 5**.

viii. Maintain urinary output greater than 50cc/h.

e. Confirm suspected injuries with a chest X-ray, trauma ultrasound or CT.

i. Perform cranial CT

f. Evaluate the cervical X-ray or cervical CT for discard cervical fractures.

i. If not injuries present, retire C-Collar.

g. Require consultation by general surgery, orthopedics and/or neurosurgery.

h. If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.

- i. Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets. Suggested exams for decisions include Lactate >2.5mg/dL and EB > -6. Use TASH or ABC scores for transfusion indications (see appendix B).
- ii. Request hemoglobin levels. Threshold >9 g/dL.
- j. Measure glucose levels. Administrate 15-20g of glucose if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- k. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
 - iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
 - iv. Measure serum sodium. Threshold 135-145mEq/L.
- l. Evaluate for seizures clinically
 - i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If seizures, after the use of BZD, start Phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
 - iii. Re-evaluate for steps **c, d, e and f**.
- m. Re-evaluate **a, b, c, d, e, f** every 15 minutes.

- n. Consider analgesia management with Dipyrone 1-2 g.
- o. Start sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- p. Avoid hypothermia with blankets.
- q. Fill the medical record for data collection.
- r. Perform the WHO trauma care checklist (**Table 6**).

Algorithm 7 (Management algorithm of a patient who requires immediate surgery in a medical center that does it not have neurosurgery)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and perform SPO₂ measure
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI.
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/PCo₂ 30-35mmHg.
 - vi. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP 5.

vii. If PCO₂ measurement available maintain a range between 30-35mmHg. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg).

d. Confirm radial pulse presence and non-invasive systolic blood pressure measurement.

i. If present, re-check every 5 minutes

ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg

iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.

iv. If active bleeding or polytrauma starts tranexamic acid 1g/Kg IV diluted in 50ml of NS. Bolus administration in 15 minutes.

v. Identify clinically other sources of shock (tension pneumothorax, cardiac tamponade, abdominal bleeding, pelvic bleeding)

vi. If TN is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle)

e. Confirm suspected injuries with a chest X-ray, trauma ultrasound or CT.

f. Perform cranial CT.

g. Evaluate the cervical X-ray or cervical CT for discard cervical fractures.

h. If not injuries present, retire C-Collar.

i. Require consultation by General Surgery, Orthopedics. (if available).

ii. If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.

- iii. If not an improvement in SBP after previous steps start vasopressors (If available) with Noradrenaline or Adrenaline at doses presented in **Table 5**.
 - iv. Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets (If available). Suggested exams for decisions include Lactate >2.5mg/dl and EB > -6 (If available). Use TASH or ABC scores for transfusion indications (see Appendix B).
 - v. Maintain urinary output greater than 50cc/h.
 - vi. Request hemoglobin levels. Threshold >9 g/dL.
- i. Measure glucose levels. Administrate 15-20g of glucose if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- j. Re-Evaluate GCS.
- i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
 - iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
 - iv. Measure serum sodium (if available). Threshold 135-145mEq/L.
- k. Evaluate for seizures clinically
- i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.

iii. Re-evaluate for steps **c, d, e and f**.

I. Re-evaluate **a, b, c, d, e, f** every 15 minutes.

m. Consider analgesia management with Dipyrone 1-2 g.

n. Start sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 micrograms/Kg/h.

o. Use blankets to avoid hypothermia.

p. Fill the medical record for data collection.

q. Perform the WHO trauma care checklist (**Table 6**)

r. Transport to higher level of care with neurosurgery according to CT and Clinical score as soon as possible (**Table 7**)

Algorithm 8 (Management algorithm of a patient who requires immediate surgery in a medical center that does it have neurosurgery but not ICU)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation
 - i. Mild (GCS 13-15)
 - ii. Moderate (GCS 9-12)
 - iii. Severe (GCS 3-8)
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI.
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform ETI. See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/PCo₂ 30-35mmHg.
 - vi. Start mechanical ventilation with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg).
- d. Confirm radial pulse presence and non-invasive SBP measurement.
 - i. If present, re-check every 5 minutes

- ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP >100-110mmHg.
- iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.
- iv. If active bleeding or polytrauma starts tranexamic acid 1g/Kg IV diluted in 50mL of NS. Bolus administration in 15 minutes.
- v. Identify clinically other sources of shock (TN, cardiac tamponade, abdominal bleeding, pelvic bleeding).
- vi. If TN is suspected (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle).

Confirm suspected injuries with a chest X-ray, trauma ultrasound or CT.

Perform cranial CT.

Evaluate the cervical X-ray or **cervical CT** for discard cervical fractures.

i. If not injuries present, retire C-Collar.

Require consultation by general surgery, orthopedics and/or neurosurgery.

If a pelvic fracture is identified (clinically or radiological) put a pelvic binder or a sheet binder.

If not an improvement in SBP after previous steps start vasopressors with noradrenaline or adrenaline at doses presented in **Table 5**.

Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets. Suggested exams for decisions include Lactate >2.5mg/dL and EB > -6. Use TASH or ABC scores for transfusion indications (see Appendix B).

Maintain urinary output greater than 50cc/h.

- i. Request hemoglobin levels. Threshold >9 g/dL.
- ii. Measure glucose levels. Administrate 15-20g of glucose if glucose level <110mg/dL, re – check values to maintain a threshold of 110-170mg/dL.
- iii. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
 - iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
 - iv. Measure serum sodium. Threshold 135-145mEq/L.
 - vii. Request ICP monitoring (Optional). Threshold 20-25mmHg or 28cm of H₂O. CSF drainage if ventriculostomy as therapeutic measure to maintain thresholds.
 - viii. Maintain a CPP between 60-70mmHg with variations according to metabolic requirements.
 - ix. Perform Optic Nerve US (ONUS) or Pupillometry (PPM) (if available) in order to see trends following patient under sedation. Thresholds: ONUS (<5.2mm) / PPM: NPi >3
 - x. Evaluate with neurosurgery primary cranial decompression as a damage control therapy if brain edema or midline shift in the first CT.

- xi. Perform hourly neurologic examination if the patient remains in the operating room (OR) waiting for transfer to an external ICU.
 - xii. Perform new CT if clinical signs of brain hernia after neurosurgery. Suggested times include 24h after surgery or early if patient deteriorates clinically.
- q. Evaluate for seizures clinically
- i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
 - iii. Re-evaluate for steps **c, d, e and f**.
- r. Re-evaluate **a, b, c, d, e, f** every 15 minutes.
- s. Consider analgesia management with Dipyrone 1-2 g.
- t. Start sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- u. Avoid hypothermia with blankets.
- v. Fill the medical record for data collection.
- w. Perform the WHO trauma care checklist (**Table 6**)
- x. Transport to higher level of care with ICU capabilities as soon as possible.

Algorithm 9 (Management algorithm of a patient with moderate-severe TBI in an intermediate care unit)

- a. Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.
- b. GCS evaluation.
 - i. Mild (GCS 13-15).
 - ii. Moderate (GCS 9-12).
 - iii. Severe (GCS 3-8).
- c. Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.
 - i. Administer supplementary oxygen. Threshold: SpO₂ >94%
 - ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI
 - iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform endotracheal intubation (ETI). See medications in **Table 2**.
 - iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
 - v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/pCO₂ 30-35mmHg.
 - vi. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP 5.
 - vii. If pCO₂ measurement available maintain a range between 30-35mmHg.
- d. Confirm radial pulse presence and non-invasive SBP measurement.

- i. If present, re-check every 5 minutes
 - ii. If not present start IV Fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg.
 - iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.
 - iv. If tranexamic acid was not started in ER and the patient has less than 8 hours of trauma, starts 1g/Kg IV diluted in 50ml of NS. Bolus administration in 15 minutes.
 - v. Re-evaluate other sources of shock (TN, cardiac tamponade, abdominal bleeding, pelvic bleeding).
 - vi. If there is suspect for TN (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle).
 - vii. Evaluate sources of internal bleeding if this was not discarding at ER.
- e. Evaluate with a chest X-ray, trauma ultrasound or CT.
- f. Evaluate the cervical X-ray or cervical CT for discard cervical fractures if was not evaluated in the ER.
- i. If not injuries present, retire C-Collar.
- g. Require consultation by general surgery, orthopedics if were not requested at ER.
- h. If a pelvic fracture is identified (clinically or radiological) and is untreated in ER, call for orthopedics consultation.
- i. If not an improvement in SBP after previous steps start vasopressors with noradrenaline or adrenaline at doses presented in **Table 5**.

- i. Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets. Suggested exams for decisions include Lactate >2.5mg/dL and EB > -6. Use TASH or ABC scores for transfusion indications (see Appendix B).
- ii. Maintain urinary output greater than 50cc/h.
- iii. Request hemoglobin levels. Threshold >9 g/dL.
- iv. Check lactate levels after transfusion. Threshold <2mmol/L.
- v. Perform evaluation of coagulation profile including PT, PTT, and INR. Threshold INR <1.5.
- vi. Check platelet level, threshold: >100.000 PLT
- vii. Measure fibrinogen (if available): threshold >150mg.
- j. Measure glucose levels. Administrate 15-20g of glucose if glucose level <110mg/dl, re – check values every 8 hours to maintain a threshold of 110-170mg/dL.
- k. Check levels of Potassium, threshold: 3,5-5mEq/L.
- l. Check levels of Chloride, threshold: 90-110mEq/L.
- m. Check levels of Magnesium, threshold: 1,5-2,5mEq/L.
- n. Check levels of Sodium, threshold: 135-155mEq/L.
- o. Re-Evaluate GCS.
 - i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in **Table 3**.
 - ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.

- iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
 - iv. If signs of brain hernia, perform a new CT Scan and define transfer if surgical indication (**Table 4**).
- p. Evaluate for seizures clinically
- i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.
 - ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
- q. Continuous monitoring of main parameters included in b, c, d.
- r. Consider analgesia management with Dipyrone 1-2 g or opioids.
- s. Continue sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- t. **Avoid hypothermia with blankets.**
- u. Fill the medical record for data collection and transfer the patient ASAP if surgical indication for Neurosurgery.

Algorithm 10 (Management algorithm of a patient with moderate-severe TBI in an ICU)

Control external sources of bleeding by direct pressure, firm bandage, hemostatic agent or tourniquet.

GCS evaluation

- i. Mild (GCS 13-15)
- ii. Moderate (GCS 9-12)
- iii. Severe (GCS 3-8)

Evaluate respiratory rate (RR) clinically and perform SpO₂ measure.

- i. Administer supplementary oxygen. Threshold: SpO₂ >94%
- ii. If RR <10 or >30BPM perform BVM with RR between 10-20 BPM and prepare for ETI.
- iii. If after BVM and RR between 10-20 BPM, the patient remains unresponsiveness, and SpO₂ <90%, perform endotracheal intubation (ETI).

See medications in **Table 2**.

- iv. If ETI fails, perform airway management with a supraglottic device. Start ventilation once in position.
- v. Request ABG to define variations in FiO₂. Threshold PaO₂ >50mmHg/PCo₂ 30-35mmHg.
- vi. Start mechanical ventilation (if available) with an RR between 10-20BPM with low tidal volumes (5-7mL/Kg) and physiologic PEEP 5.
- vii. If pCO₂ measurement available maintain a range between 30-35mmHg.
- d. Confirm radial pulse presence and non-invasive SBP measurement.

- i. If present, re-check every 5 minutes
 - ii. If not present start IV fluids at 20mL/Kg (NS or RL), check for radial pulse improvement and SBP > 100-110mmHg
 - iii. If not an improvement in SBP start HTS 1-4cc/Kg of HTS 7.5% or 3%. See HTS preparation in **Table 3**.
 - iv. If tranexamic acid was not started in ER and the patient has less than 8 hours of trauma, starts 1g IV diluted in 50mL of NS. Bolus administration in 15 minutes.
 - v. Re-evaluate other sources of shock (TN, cardiac tamponade, abdominal bleeding, pelvic bleeding)
 - vi. If there is suspect for TN (progressive dyspnea, absence of breath sounds and absence of radial pulse: decompress with a needle)
 - vii. Evaluate sources of internal bleeding if this was not discarded at ER. Evaluate with a chest X-ray, trauma ultrasound or CT.
- Evaluate the cervical x-ray or **cervical CT** for discard cervical fractures if was not evaluated in the ER.
- i. If not injuries present, retire C-Collar.
 - ii. Require consultation by general surgery, orthopedics if were not requested at ER.
 - iii. If a pelvic fracture is identified (clinically or radiological) and is untreated in ER, call for Orthopedics consultation.
 - iv. If not an improvement in SBP after previous steps start vasopressors with Noradrenaline or Adrenaline at doses presented in **Table 5**.

- v. Check requirements of early blood transfusion in a rate of 1:1:1 of RBC, Plasma and Platelets. Suggested exams for decisions include Lactate >2.5mg/dL and EB > -6. Use TASH or ABC scores for transfusion indications (see Appendix B).
 - vi. Perform a thromboelastography (TEG) or rotational thromboelastometry (ROTEM) test to guide transfusion therapy (if available)
 - vii. Maintain urinary output greater than 50cc/h.
 - viii. (0.5-3mL/Kg/h)
 - ix. Request hemoglobin levels. Threshold >9 g/dL.
 - x. Check lactate levels after transfusion. Threshold <2mmol/L.
 - xi. Perform evaluation of coagulation profile including PT, PTT, and INR Threshold INR <1.5.
 - xii. Check platelet level, threshold: >100.000 PLT
 - xiii. Measure fibrinogen (if available): threshold >150mg
 - xiv. Measure continuous cardiac output (if available) or perform cava venous US to monitoring fluid status.
- f. Measure glucose levels. Administrate 15-20g of glucose if glucose level <110mg/dL, re – check values every 8 hours to maintain a threshold of 110-170mg/dL.
- g. Check levels of Potassium, threshold: 3,5-5mEq/L.
- h. Check levels of Chloride, threshold: 90-110mEq/L.
- i. Check levels of Magnesium, threshold: 1,5-2,5mEq/L.
- j. Check levels of Sodium, threshold: 135-155mEq/L.
- k. Re-Evaluate GCS.

- i. If GCS 3-12 and clinical signs of brain hernia (GCS fall of 2 points, pupils response asymmetry >1cm or non-responsive pupil(s) to light, abnormal motor response with motor GCS 2-3) start HTS 3% or 7.5% as prepared in

Table 3.

- ii. In patients with SBP >110mmHg, a second option is Mannitol 1g/Kg in replacement of the HTS.
- iii. Hyperosmolar therapy with HTS or Mannitol can be repeated every 4 to 6 hours.
- iv. If signs of brain hernia, perform a new CT Scan and define neurosurgery consultation if possible surgical indication (**Table 4**).
- v. Request ICP monitoring. Threshold 20-25mmHg. CSF drainage if ventriculostomy as therapeutic measure to maintain thresholds.
- vi. Request PbtO₂ monitoring (if available). Threshold: 25-55mmHg
- vii. Perform jugular venous saturation measurement: Threshold: 55-70%.
- viii. Perform trans cranial doppler to monitoring brain auto-regulation (if available).
- ix. Maintain a CPP between 60-70mmHg with variations according to metabolic requirements.
- x. Perform ONUS or PPM (if available) in order to see trends in daily following of patients under sedation. Thresholds: ONUS (<5.2mm) / PPM: NPi >3.
- xi. Evaluate with neurosurgery cranial decompression as optional management for high ICPs resistant to medical therapies.

I. Evaluate for seizures clinically

- i. If any seizure, administer Diazepam 10mg IM or IV or Midazolam 10mg IM.

- ii. If seizures, after the use of BZD, start phenytoin 15-20mg/Kg diluted in NS or 5% Dextrose.
- iii. Perform continuous EEG evaluation if available.
- iv. If Not Continuous EEG available, perform EEG in patients that remain unconscious after sedation withdrawn without clear explanation for the type of injury. Also, in patients who develops status epilepticus.
- m. Maintain a sedation level measured by RASS scale between -4 and -5 (**Table 9**)
- n. Continuous monitoring of main parameters included in b, c, d.
- o. Consider analgesia management with Dipyrone 1-2 g or opioids.
- p. Continue sedation with Midazolam and Fentanyl at standard doses of 0,03 – 0,5 mg/Kg/h and 1-2 mcg/Kg/h.
- q. Avoid hypothermia with blankets. Maintain a temperature threshold between 36-37.5°C.
- r. Start mechanical or chemical anti thrombotic prophylaxis in the first 24 hours if there is not blood in the CT or after 72h if there is bleeding on the CT according to Berne-Norwood Criteria (**Table 13**).
- s. Start nutritional therapy in the first 24-48h if there are not contraindications for feeding.
- t. Start early rehabilitation (after 48 hours) if there is not contraindication.
- u. Consider tracheostomy after 7-10 days of mechanical ventilation without successful weaning.
- v. Fill the medical record for data collection.