UNIVERSITY of CALIFORNIA, IRVINE
MEDICAL CENTER

AUTHORIZED FOR USE ONLY AT THE UNIVERSITY OF CALIFORNIA IRVINE MEDICAL CENTER

CLINICAL ALGORITHM – MANAGEMENT OF ADULT PATIENTS WITH DEVASTATING BRAIN INJURIES

GOAL
To maintain hemodynamic stability in patients with devastating brain injuries

Patient evaluated in ED or ICU with devastating brain injury

- Penetrating and/or blunt trauma to the brain or devastating stroke
- Evaluated by Neurosurgery and/or Neurology
- Deemed to be non-survivable with no benefits from neurosurgery intervention
- Still requires resuscitation by Trauma/Critical Care Services-consult to be obtained during course of treatment
- Patient should weigh greater than or equal to 100 lbs

Note: All patients with devastating brain injury have the potential to be organ donors. However, organ donation should not be discussed with the family unless directed by the attending M.D.

Consider Social Work and or Palliative Care team consultation

Call one Legacy to refer patient within one hour of being intubated and having a GCS≤5

Initial Steps of Management

- ABG/Serum lactate
- CBC wdiff, PT/PTT, Electrolytes, Hepatic Function Panel
- Type & Crossmatch 4 PRBC. Transfuse to maintain HCT>30, INR <1.4,Platelets >100, fibrinogen > 100
- Bolus 1 liter Normal saline
- Protect from hypothermia
- Central line (large lumen) & arterial line placement
- Control active bleeding*
- Maintain MAP >70 with fluid bolus
- If CVP >8 add Dopamine gtt(@ 5mcg/kg/min) or if tachyarrythmia develops switch to norepinephrine drip @ 5 mcg/min-titrate MAP>70
- Consider placement of PA catheter
- If UOP > 200ml/hr- order serum osmolality urine osmolality , and urine specific gravity

CAUTION:
Avoid hypotension and hypoxia in all head injury patients
Patient can go from hypertension to hypotension rapidly

All patient's require q 4 hour central or mixed venous blood gases, ABGs, CMP, CBC, DIC follow up, serum lactate, and cardiac output if available (even after declaration of brain death unless care is withdrawn)

Patient MAP >70

Yes

- Continue maintenance fluids and correct lab abnormalities
- End points of resuscitation should include normalization of base deficit, lactate, CVP 6-10 mmHg and/or PAOP 8-15 mmHg, and minimal use of pressors
- Rules of 100's: Goal - SBP> 100mmHg UOP >100 ml/hr, Pa02 >100 or FiO2 < 0.3
- Maintain fluids; either NS or LR, adjust as indicated

No

- Continue to fluid resuscitate with 5% Albumin (if serum albumin <2.0), Blood products (if indicated) and/or Normal saline until MAP >70
- Double dopamine to max 20 mcg/kg/min or norephinephrine to max of 20mcg/min q 5 minutes until MAP > 70
- If require 10 mcg/kg/min Dopamine or 10mcg/min norepinephrine, add vasopressin gtt at 2.4 units/ hour

CVP > 10 and/or PAOP (wedge) >17

Yes

- Cardiac index <2.5 add Dobutamine 2.5mcg/kg/min and titrate to an index of 2.5
- Cardiac index > 4 add phenylephrine (20 to 200 mcg/min) or norepinephrine (1 to 20 mcg/min) and titrate to a MAP > 70
- Cardiac index 2.5 – 4 add epinephrine (1 to 20 mcg/min) or norepinephrine titrate to MAP > 70

Refer to Hormone Replacement protocol
see next page

No

- Continue to bolus with crystalloid/ colloid/blood products if indicated
- Lab values and symptoms suggestive of Diabetes Insipidus:
  - UOP > 600ml/hr
  - serum sodium > 150 (units)
  - urine specific gravity, < 1.005
  - Urine osmolality < serum osmolality

Yes

Start vasopressin at 2.4 units/ hour, and replace UOP >200 ml with ½ NS ml for ml every hour

ABBREVIATIONS
ABG – arterial blood gases
CBC – complete blood count
CVP – central venous pressure
DI - diabetes insipidous
DIC – disseminated intravascular coagulation
FFP – fresh frozen plasma
gtt – drip
Hb - hemoglobin
HCT – hematocrit
H & H – hematocrit & hemoglobin
HFP- Hepatic function panel
LR- Lactated Ringers
LVH – left ventricle hypertrophy
LVEF – left ventricle ejection fraction
MAP – mean arterial pressure
NS – normal saline
PA – pulmonary artery
PAOP – pulmonary arterial occlusion pressure
PCWP – pulmonary capillary wedge pressure
SBP – systolic blood pressure
SVR – systemic vascular resistance
UOP – urine output

D. Malinoski, MD; J. Roum, MD; L. Vu, Pharm D.; T. Bridgeman RN; L. Willis, MHA

Hormone Replacement Protocol (to be initiated only after Primary Attending approval)
Goal: To maintain hemodynamic stability in patients with devastating brain injuries

Pretreatment:
1. Continue resuscitation to minimum CVP of 7 mmHg
2. Transfuse to achieve an Hct > 30
3. Maintain K+, CA ++, Mg ++
and Phosphorous within normal limits

Prerequisite:
Patient is requiring a combined vasopressor need greater that 15 mcg (all VP added as mcg/kg/min or mcg/min) to maintain a systolic pressure of 100 after pre-treatment is completed.

Hormone Replacement Protocol
1. Administer IV boluses of the following in rapid succession:
 1 amp of 50% Dextrose
 2 gms of Methlyprednisolone
 20 units Regular Insulin
 Insulin drip to maintain glucose between 80 – 150 mg/dl, minimum rate 1 unit/hr
 20 mcg Levothyroxine (Thyroid Hormone)
 (do not give unless serum K+ >3.5)

2. Start a drip of 200 mcg thyroxine in 500 ml NS (0.4 mcg/ml). Administer at 25 ml (10 mcg) per hour initially. Reduce levels of other pressors as much as possible and then adjust thyroxine as necessary to maintain desired pressure per M.D. order

3. Monitor K+ levels carefully. The only perceived complication of the Hormone replacement protocol identified to this point is an unusually high K+ requirement (hypokalemia) in some cases.

4. Maintain CVP at desired level by replacing urine output if over 200ml/hour
** Note: thyroxine may lead to tachycardia and hyperthermia within 30 min of initiation

Authorized for use only at the University of California Irvine Medical Center

Common Problems and Special Considerations

- **DIC**: If a patient has clinical signs of DIC, transfuse immediately with 4-6 units of FFP. Delaying transfusion while waiting for lab results with uncontrolled hemorrhage is not indicated. Maintain Hct >30 with pRBC.
- **DI**: If patient is normotensive, serum sodium >150 and UOP >600 ml/hr, give 1-2 micrograms of DDAVP IVP (q 6 hours as needed) and replace UOP ml for ml with ½ NS q hour for UOP >200 (example: for UOP of 1000 ml replace with 800 ml of ½ NS). If patient is hypotensive, then use vasopressin gtt as described in above protocol. **Common error**: Assuming high UOP is from DI, but is really from ED lasix and/or mannitol. Replace diuretic fluid loss with NS or LR. (Another marker of DI: urine specific gravity <1.005).
- **Tachycardia and hypertension**: This commonly occurs prior to complete herniation and should only be treated with short acting medication (esmolol) as patients can quickly change to a hypotensive state
- **Neurogenic pulmonary edema**: This may occur and decreases the PO2; increase ventilator support as needed. With severe problems of oxygenation, use the oscillating ventilator.
- **Hyperglycemia or hypokalemia**: Use insulin gtt and replace as needed.
- **Cardiac arrest**: Follow ACLS code guidelines. Epinephrine boluses and gtts are often needed

If a patient's neurologic exam has deteriorated and brain death is suspected based on the loss of brainstem reflexes, please refer to the Declaration of Brain Death Guidelines and Form and contact the attending physician immediately.

D. Malinoski, MD; J. Roum, MD; L. Vu, Pharm D.; T. Bridgeman RN; L. Willis, MHA