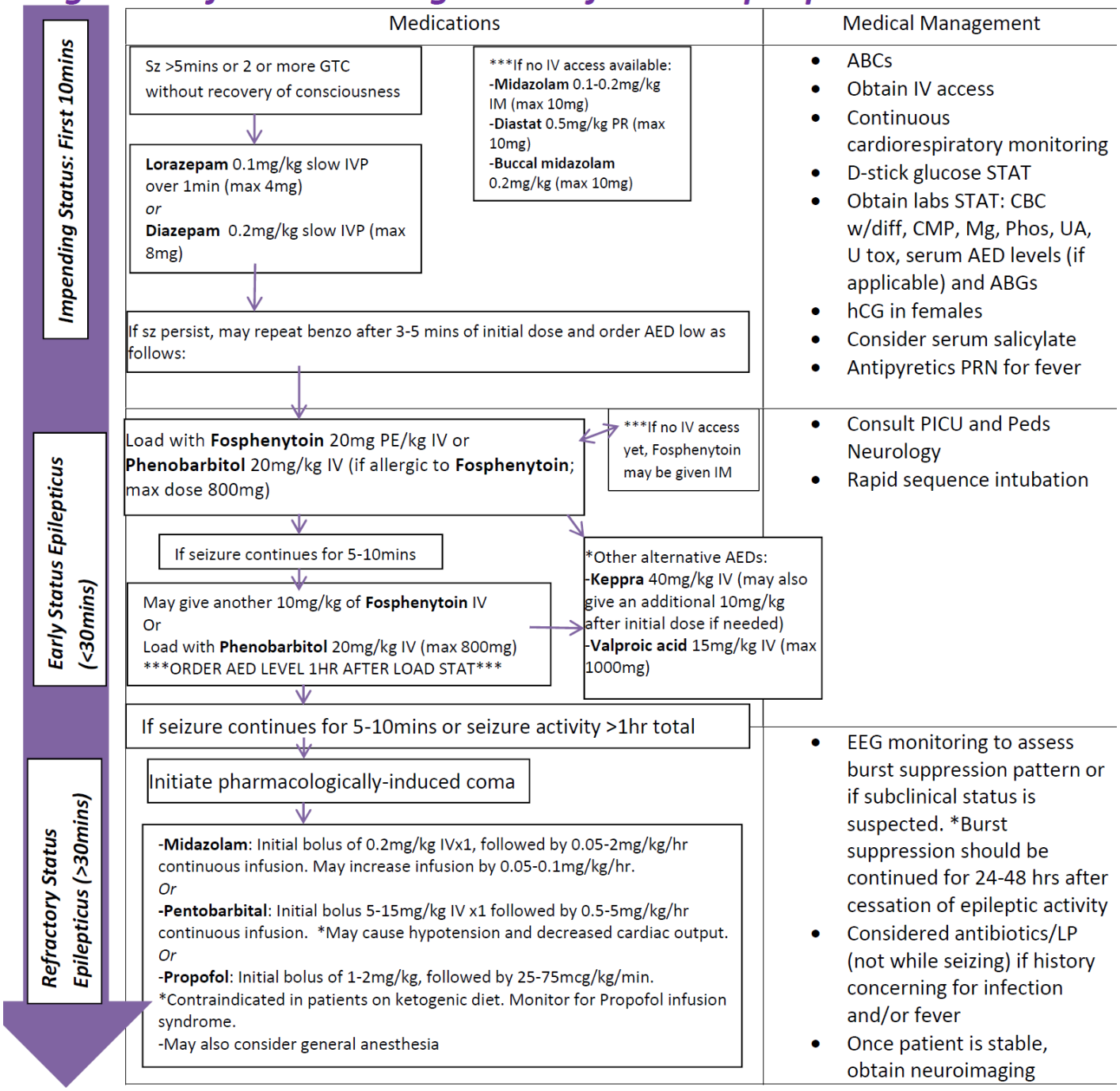
NEUROLOGY

Algorithm for the Management of Status Epilepticus in Children



*References:
Uptodate.com
AAN Continuum: Status Epilepticus
Neurology, Practice Parameter: Diagnostic assessment of the child with status epilepticus

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NEUROLOGY

ACUTE MANAGEMENT OF INCREASED INTRACRANIAL PRESSURE (ICP) ALGORITHM

GCS ≤ 8 in absence of: hypotension, hypoxemia, hypothermia

Remember: Cushing's Triad (HTN, bradycardia, abnormal respirations) is a late /preterminal event

↓

Airway - Breathing - Circulation
Continuously monitor vital signs and pulse oximetry
Administer oxygen and perform airway maneuvers
Assist ventilation if indicated
Establish IV/IO access and begin NS at maintenance
Use rapid sequence protocol for intubation
Obtain emergent head CT
Neurosurgery consult for EVD / ICP monitor placement

↓

PATIENT CARE GOALS:
SpO_2 100%; **Temperature** 35 - 37° C; **$PaCO_2$** 35 - 40 mmHg; **CVP**: 5 - 10 mmHg;
ICP: < 20 mmHg
CPP (MAP – ICP): 0 - 5 yo mmHg ≥ 40 mmHg; 6 - 17 yo ≥ 50 mmHg; adult ≥ 60 mmHg
Serum sodium > 140 < 155; **Serum osmolarity**: > 290 < 320; **Glucose** < 180

ICP > 20 mmHg? ↓ **Yes**

Tier 1 Therapies:
CSF diversion with EVD
HOB at 30 degrees
Maintain $PaCO_2$ 35 - 40 mmHg
Optimize sedation / paralysis
Consider thiopental for ICP spikes
Consider lidocaine IV prior to suctioning

ICP Remains > 20 mmHg? ↓ **Yes**

Tier 2 Therapies:
Repeat head CT
Fluids / Pressors to maintain CPP
Mannitol therapy (if serum Osm < 320)
Hypertonic saline therapy (if serum Osm < 370)
Mild hyperventilation ($PaCO_2$ 30 - 35 mmHg)
Consider barbiturate coma

Refractory ICP > 20 mmHg? ↓ **Yes**

Tier 3 Therapies:
Decompressive craniectomy
Moderate hypothermia (32 - 34° C)
Transient hyperventilation to $PaCO_2$ < 30 mmHg

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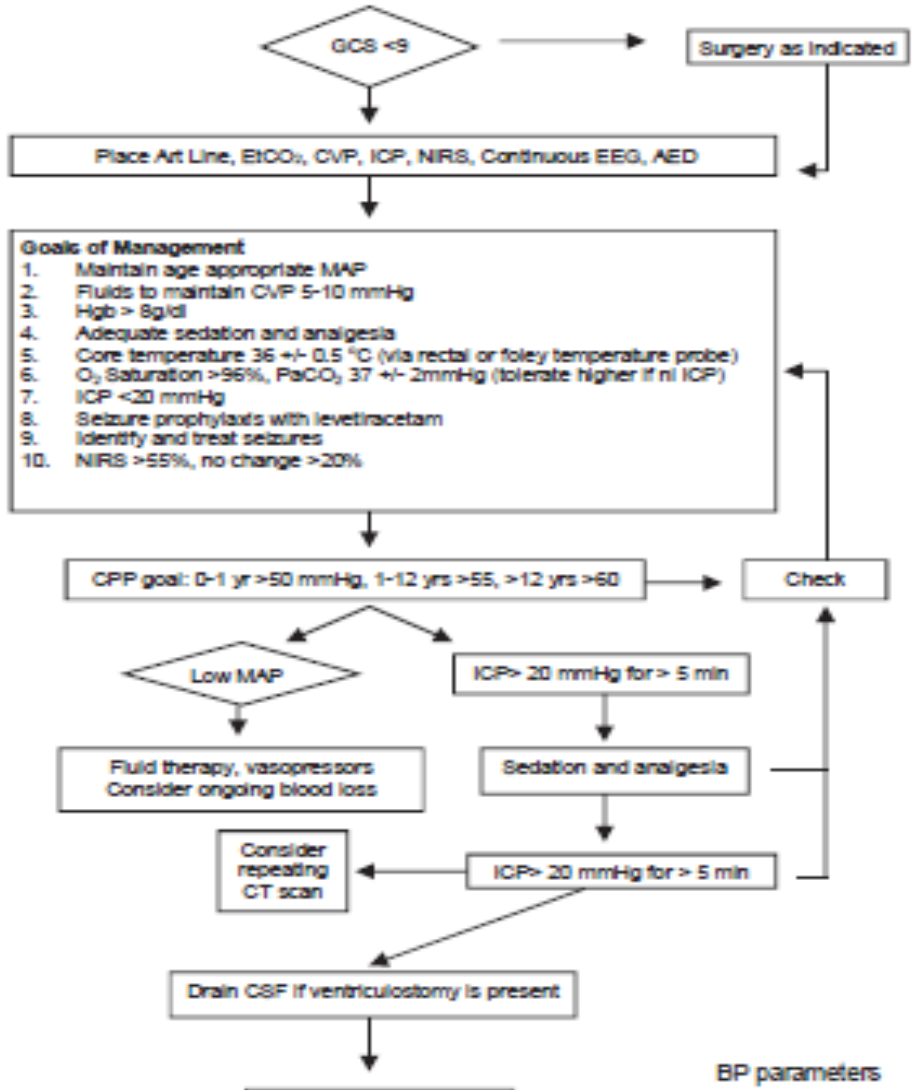
Pediatric Severe TBI Acute Phase Management Flowsheet

Sept 2011



Check

- Patient position (head neutral, HOB at 30°)
- Equipment functioning properly
- No recent interventions (respiratory, nursing)
- Exclude seizure activity

Seizures

- Prophylaxis:
  - Load– Levetiracetam (Keppra) 20 mg/kg IV
  - Maintenance– Levetiracetam 10 mg/kg/dose IV Q12 hrs
- Treatment
  - notify Neurology service immediately
  - Versed 0.1 mg/kg bolus for acute control
  - Load fosphenytoin 20 mg PE/kg

Fluid Therapy, Vasopressors

- Maintain CVP 5 to 10 mmHg (NS for fluid resuscitation)
- If <6 mos, use D5W/NS for maintenance
- If >6 mos use NS for maintenance
- Maintain serum glucose between 80-150
- Maintain Hgb >8 g/dl
- Once volume loaded, use inotropic/vasopressor
  - 1st line– Dopamine
  - Once Dopamine >10 mcg/kg/min, start Norepinephrine (warm ext) or Epinephrine (cool extremeties)

Sedation and Analgesia

- Versed
- Morphine or Fentanyl
- Avoid hypotension secondary to sedative/ analgesic agents
- Consider NMB agents for ICP control– see NMB algorithm

CSF Drainage Options

- Initial settings and changes to drainage level per Neurosurgical service
- Drain CSF for 15 minutes, then re-evaluate ICP. If persistent ICP >20, consider continuous CSF drainage with intermittent reading of ICP (close drain for 5 min to obtain reading)

Hyperosmolar Therapies

- Hypertonic Saline (3%) bolus 5 ml/kg (max 250 ml), and continuous infusion at 1 ml/kg/hr, titrate for serum Na 150-160 and/or serum osmolality <360
- Mannitol 1gm/kg
- See hyperosmolar algorithm for more details

Consider 2nd Tier Therapies

- Consider **transient** controlled hyperventilation ($PaCO_2$ 25-35 mmHg) and monitor effect on markers of cerebral blood flow (NIRS, Ilocx)
- Is the patient salvageable?
  - Assess: mech of injury, best GCS, age, pupil reactivity, CT scan
  - Frontal/ focal contusions with initial good GCS, consider decompressive craniotomy
  - Barbiturate therapy: bolus pentobarbital 5 mg/kg q30 minutes until 2-3 bursts per screen. Then start infusion of 1 mg/kg/hr. If # of bursts increase, repeat bolus until appropriate # of bursts are seen and then increase infusion
  - Stop infusion if brain death is suspected (do not wean)

NIRS

- If rSO2 <55% or, change > 20%, evaluate for changes in-
  - Ventilation (EtCO2 appropriate?)
  - Perfusion (MAP and CPP appropriate?)
  - Increased metabolic demand (fever, seizure, shivering?)
  - Consider transcranial doppler to evaluate for vasospasm

ICP monitoring

- Indications- GCS </= 8
- Contraindications-
  - Coagulopathy (consider Factor VII if >20 ml/kg of FFP is required to correct)
  - Keep INR <1.35, plts >100K
- Ventriculostomy if open ventricles

BP parameters

Age	MAP*
1-2 yrs	53-59
3-4 yrs	61-65
5-6 yrs	67-69
7-8 yrs	70-72
9-10 yrs	73-75
11-12 yrs	75-77
13-14 yrs	77-79
15-17 yrs	80-84

*MAP value is 50%ile for 50% of height

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Ventricular Shunt Malfunction Diagnostic Algorithm

June 2013

Acute Symptoms		
• Nausea	• Headache	• Irritability
• Vomiting	• Positional Headache	• Lethargy
• Hypertension	• Double Vision	• Stupor
• Bradycardia	• Sundown Sign	• Coma
• Seizures	• Transient visual obscurations (e.g. visual blackouts)	

Subacute/Chronic Symptoms	
• Change in behavior (e.g. agitation)	• Developmental regression
• Altered gate	• Change in cognitive function (e.g. attention span)
• Change in feeding patterns	• Daily headaches
• Change in school performance	• Increased head size

History to be Obtained Prior to Neurosurgical Consult

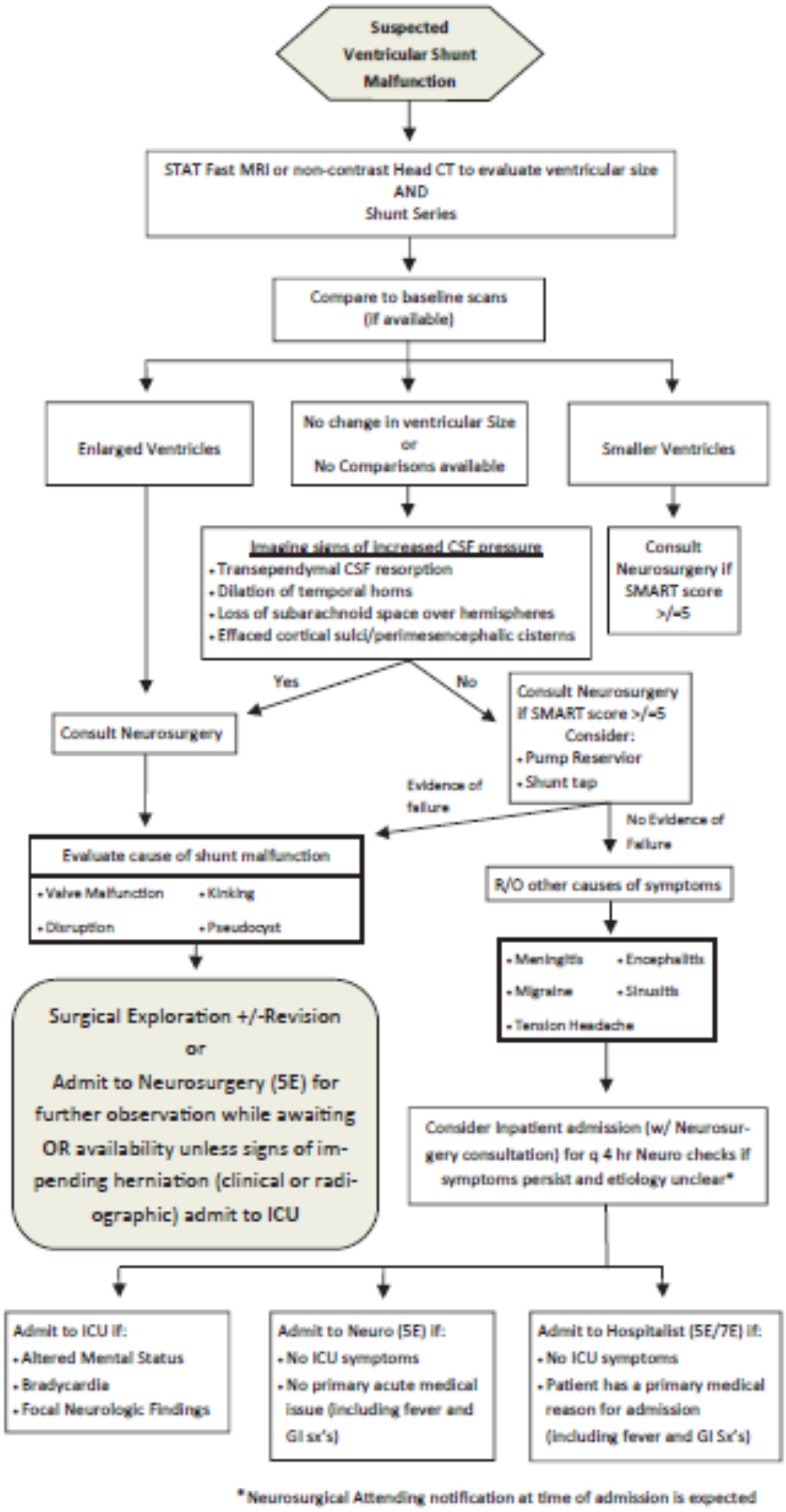
- Prior history of shunt failure
- Size of ventricles at last shunt failure
- Prior history of shunt failure without change in ventricular size
- Presence or absence of fevers
- Presence or absence of above acute and chronic symptoms

Fast MRI vs Head CT

- Available weekdays 8 am– 10 pm and weekends 8 am – 4 pm
- Patient must be able to lie still/cooperate for 10 minutes without sedation (roughly age >/~5 yrs)

Contraindications to Fast MRI

- History of trauma
- Altered mental status
- r/o hemorrhage or pneumocephalus
- If shunt catheter needs to be visualized
- Programmable VP shunts
- Patients with other MRI contraindication (ex– pacemaker)
- Unable to obtain within 1 hour of presentation



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SMART SCORE
(SHUNT MALFUNCTION ASSESSMENT AND REASSESSMENT TOOL)

Inclusion Criteria: Patient with VA or VP shunt and age > 1 month
Exclusion Criteria: Patients in the NICU

Major Criteria: (10 points each)

* Clinical signs of herniation (including Cushing's Triad)
* Imaging with signs of herniation/impending herniation
* Papilledema

Minor Criteria:

Tier 1 (5 points each)

* Positional headache (include awakening from sleep due to headache pain)
* New diplopia/CN VI palsy
* Altered MS (e.g. irritability, lethargy) in a patient w/ no (or mild) prior neurological deficit
* Neuroimaging with increased size of ventricles and/or decrease in sulci and/or cisterns (more sensitive if baseline large ventricles)
* History of VP shunt failure without prior change in ventricular size
* Head circumference increasing across percentiles (e.g. > 10%)

Tier 2 (2 points each)

* Nausea/vomiting
* Headache
* Bradycardia (not baseline)
* Increased seizure frequency from baseline
* Recent manipulation of VP shunt (e.g. change of setting of valve, revision in the last 30 days)
* Change in baseline in a patient with moderate to severe baseline deficits
* Neuroimaging with inc size of ventricles and no change in sulci and/or cisterns
* Radiographic evidence of shunt tubing disconnection

Recommended response based on assigned score

10 = immediate response from neurosurgery attending

5 -9 = high suspicion for shunt malfunction, neurosurgical consult. If no intervention prescribed, consider escalation to neurosurgical attending.

4 = moderate suspicion for shunt malfunction. Observation recommended. If symptoms not easily explained by other medical condition, consult neurosurgery.

** If score remains ≥ 4 consider repeat imaging Q2-3 days and/or ophthalmology evaluation for papilledema, even if other explanations plausible for observed symptoms.

NEUROLOGY

KETOGENIC DIET THERAPY: ADMISSION GUIDELINES

Criteria for Initiation of Ketogenic Diet

Patient has greater than or equal to two (2) seizures per week (Hopkins)
Patient has failed at least two (2) anti-convulsants (Hopkins). Some require failure of 3+.
Patient's whose seizure control is at the expense of med toxicity or side effects
Family is motivated and able to follow through with diet at home
Home environment conducive to managing diet
Patient has pre-admission evaluation by WRNMMC Ketogenic Diet Clinic
Confirm that Fatty Acid and Carnitine Defects have been tested and ruled out prior to starting Ketogenic Diet
Contraindications for Ketogenic Diet Therapy

Exclusion Criteria ***Epilepsia 2009; (50):10**
-Malnourished patient -Non-compliance with antiepileptic drug regimen -Carnitine deficiency (primary), --Carnitine palmitoyltransferase (CPT) I or II deficiency -Carnitine translocase deficiency, -Beta oxidation defects : *Medium- Chain acyl dehydrogenase deficiency (MCAD), Long- Chain acyl dehydrogenase deficiency (LCAD), Short-chain 3-hydroxyl-CoA deficiency (SCAD), Long-chain 3-hydroxyl-CoA deficiency,* *Medium-chain 3-hydroxyl-CoA deficiency* -Pyruvate Carboxylase deficiency -Porphyria

Admit to Pediatric Ward Team; Plan for 3-5 day admission

Consults on Admission:

Neurology Nutrition Pharmacy
Social work Discharge planner

Lab Orders:

Admission Labs:CBC, CMP, Mg, Phos, Lipid panel, Carnitine (total, free, acyl), AED levels
Daily Labs: BMP, Mg, Phos, UA

Crystalloid Orders: Daily maintenance IVF (NO DEXTROSE)

Medication Orders:

Limit carbohydrates for all medications; total daily carbs for meds usually <1 gm
Continue Antiepileptic drugs
No dextrose-containing carrier fluids (use NS)
Sodium Citrate/Citric Acid (Bicitra) 1mEq/kg/day PO/GT divided TID
Polyethylene glycol (Miralax) PRN
Diazepam (Diastat Acudial) RECTAL order to hold at bedside

Ketogenic Diet

Day 1 Order (see RD (registered dietician) consult for dosing)
Ketogenic Diet must be reordered DAILY by RD under NOTES in ESSENTRIS.
Ketogenic Diet Initiated as follows:

Day 1: Regular breakfast + keto beverage & 1 keto meal
Day 2: 1/3 kcals from ketogenic beverage + 2 keto meals
Day 3: Full strength diet (3 keto meals)
Child must eat and keep down 3 full-strength meals prior to discharge

SEE NEXT PAGE

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Recommended Dietary Supplements:

Multivitamins

Nano VM (multivitamin with adequate calcium & vitamin D supplementation);
www.solacenutrition.com/products/nanovm/nanovm; not available through DoD pharamacies

Calcium and Vitamin D Oral Citrates

Mirilax and GI medications including anti-reflux medications

Carnitine MCT oil Omega 3 Selenium

Nursing Orders:

Daily Training to parents per SOP Ketogenic Therapy Initiation; Nutritionist for bedside teaching

Seizure precautions

Daily AM weights

V/S q4hrs until patient tolerates diet, without any emesis or hypoglycemia, the V/S qshift

Blood glucose checks: GOAL = 50-80mg/dl

<1yr, q 2 hours x 24hrs; Then q 4 hrs if not hypoglycemic or asymptomatic

>1yr, q 4 hours x 24hrs; Then q 4 hrs if not hypoglycemic or asymptomatic

Notify HO for BG <40 mg/dl

PO: give 15 ml apple juice; recheck BG in 30 minutes

NPO: give 50ml D5W or 0.25g/kg of D10W; recheck BG in 30min

Recheck BG: q2 hours if <1 year, until >50 and stable

q4 hours if >1 year, until >50 and stable

For intractable hypoglycemia (3 episodes of BG <40mg/dl within 24hrs consider D5W continuous to maintain BG 50-80mg/dl)

Urinalysis qVOID

Ketones: GOAL=80-150mg/dl

Urine specific gravity: GOAL=1.010-1.025

SG >1.025 encourage fluids; >1.030 over 24hrs, give IVF bolus (no dextrose)

PH: GOAL= 6-8

Serum Bicarb: GOAL= 16-18mg/dL

CO2< 12mg/dL: consider starting IVF

Discharge Criteria:

Patient is ready for discharge after physician evaluation

Patient has consumed and tolerated full ketogenic diet for at least 24 hrs (3 full-strength keto meals or feedings)

Patient's lab values are within GOAL therapy (U. Ketones, U. SG, S. Bicarb, S. Glucose)

Normal glycemic (>50 mg%) for previous 12 hours

Ketones in urine are moderate to large. Absence of excessive ketosis

Carbon dioxide (CO2) level should be normal.

Family education completed by SOP KDT Protocol and caregivers are competent in managing ketogenic diet therapy.

Discharge Instructions:

Patient to be weighed on discharge

Follow up with Neurology and Outpatient Registered Dietician in one month

Standard Prescriptions needed:

Keto stix Disp.#50 (1bottle) Check ketones qam and pm

Multistix Disp. #100 (1bottle) Check urine for blood 1x per week

Blood glucose test strips (brand varies) Disp. #50 Test blood sugar prn w symptoms of low BG

Other Rx as needed