VANDERBILT UNIVERSITY MEDICAL CENTER

Protocol: Burn Critical Care Electrolyte Replacement	Category	Clinical Practice
	Approval Date:	12/17/2019 (CMT)
	Review Date:	1/2022

Applicable to
☒ VUH ☐ Children's ☐ DOT ☐ VMG Off-site locations ☐ VMG ☐ VPH ☐ Other
Team Members Performing
☐ All faculty & staff ☒ Faculty & staff providing direct patient care or contact ☒ MD ☒ House Staff ☒ APRN/PA ☒ RN ☐ LPN ☐ Other:
Content Experts
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I. Purpose:

Provide standardization in the electrolyte replacement of patients admitted to the Vanderbilt Burn Center.

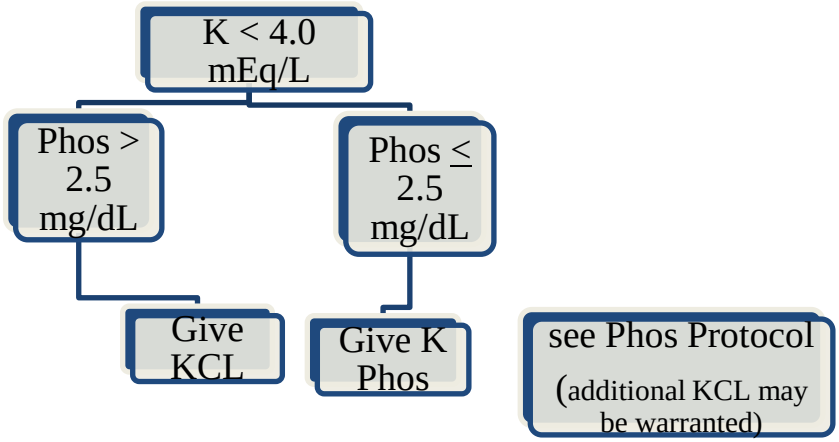
II. Population:

Adult patients admitted to Vanderbilt Regional Burn Center

III. Potassium Replacement (Provider Driven Only)

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, electrical burns where rhabdomyolysis is present, rhabdomyolysis, DKA, crush injury, hypothermic patients or those with active transfer orders out of the ICU.

Always review or draw a phosphorus level to determine the appropriate potassium repletion product.



Serum K+	Replace with	Recheck level
3.3-3.9 mEq/L	40 meq KCL **PO/PT**/IV **(enteral route preferred if available)**	With next set of AM labs
3.0-3.2 mEq/L	60 meq KCL PO/PT/IV **(IV route preferred)**	Immediately and with next AM labs
2.6-2.9 mEq/L	80 meq KCL **IV** and NHO	Immediately and with next AM labs
< 2.6 mEq/L	100 meq KCL **IV** and NHO	Immediately and with next AM labs

Consider PO/PT replacement if GI tract is available

- If central line present and continuous cardiac monitoring, infuse at 20mEq/hr (max=20mEq/hr).
- If peripheral access only, infuse slowly at 10mEq/hr and have nursing monitor for extravasation.
- Serum K+ level may be expected to increase by ~0.25mEq/L for each 20mEq IV KCL infused
- All burn patients (apart from the exemptions aforementioned) that are undergoing excision and grafting should have potassium levels replaced prior to the OR.
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IV. Magnesium Replacement (Provider Driven Only)

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, electrical burns where rhabdomyolysis is present, rhabdomyolysis, DKA, crush injury, hypothermic patients or those with active transfer orders out of the ICU.

Special considerations: If there are concerns for re-feeding syndrome, labs may need to be re-checked/replaced numerous times within a 24-hour period.

Serum Magnesium	Replace with	Recheck level
1.3-1.9 mg/dL	4 grams IV over 4 hours	No indication to re check unless persistent diarrhea/vomiting
≤ 1.2 mg/dL	8 grams IV over 8 hours	Re-check level 6 hours after replacement

IV administration:

- Magnesium replacement will be one-time doses
- Infuse at rate of 1gram/hr

Provider considerations for initiating oral administration:

- It should be considered in burn patients that have persistently low mag levels despite adequate repletion via the IV route. This will be guided by the ICU intensivist
- If elemental magnesium (supplied as magnesium oxide) or milk of magnesia is initiated, diarrhea may be a limiting factor. Separate orders must be entered into Epic for oral replacement at discretion of the ICU intensivist.

V. Phosphorus Replacement (Provider Driven Only)
only for phos level of 2.5mg/dL or lower

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, electrical burns where rhabdomyolysis is present, rhabdomyolysis, DKA, crush injury, hypothermic patients or those with active transfer orders out of the ICU.

Always review or draw a phosphorus level to determine the appropriate phosphorus repletion product
Special considerations: If there are concerns for re-feeding syndrome, labs may need to be re-checked/replaced numerous times within 24 hours period

Product	Phosphate	Potassium	Sodium
K- Phos Neutral Tablet	250mg (8mmol)	1.1 mEq	13 mEq
K-Phos Injection (per mL)	3 mmol/mL	4.4 mEq	
Na Phos Injection (per mL)	3 mmol/mL		4 mEq

Serum Phos	Replace With	Repeat Level	mEq K if K Phos
2.0-2.5mg/dL	**15 mmol** KPhos or NaPhos IV -or- K-Phos Neutral 2 tabs PO/PT q4hrs x3 doses (enteral route preferred)	With next AM labs	~ 22 mEq (~ 5.5 mEq/hr based on 4-hour infusion)
1.6-1.9 mg/dL	**30 mmol** Kphos or NaPhos IV -or- K-Phos Neutral 2 tabs PO/PT q4hrs x4 doses (IV route preferred)	With next AM labs	~ 44 mEq (~ 11 mEq/hr based on 4-hour infusion)
< 1.6 mg/dL	**45 mmol** Kphos or NaPhos IV	6 hours after replacement	~ 66 mEq (~ 16.5 meq/hr based on 4-hour infusion)

- Always look at the potassium level to determine appropriate IV phosphorus product for use: **use KPhos if K <4.0mEq/L and Na Phos if K ≥ 4.0 mEq/L**
- For IV replacement: pharmacy will dilute in 250mL NS or D5W. Infuse over 4-6 hours
- For PO/PT replacement: K-Phos neutral tablet (current agent or formulary at VUMC)
- Those who are intubated/trach on vent should have a minimum of phos level checked bi-weekly until phos no longer requires frequent repletion

VI. Calcium Replacement (Provider Driven Only)

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, electrical burns where rhabdomyolysis is present, rhabdomyolysis, DKA, crush injury, hypothermic patients or those with active transfer orders out of the ICU.

Special considerations: if there are concerns for re-feeding syndrome, labs may need to be re-checked/replaced numerous times within a 24hour period. Burn patients that are greater than 20% may require preop repletion or postop repletion.

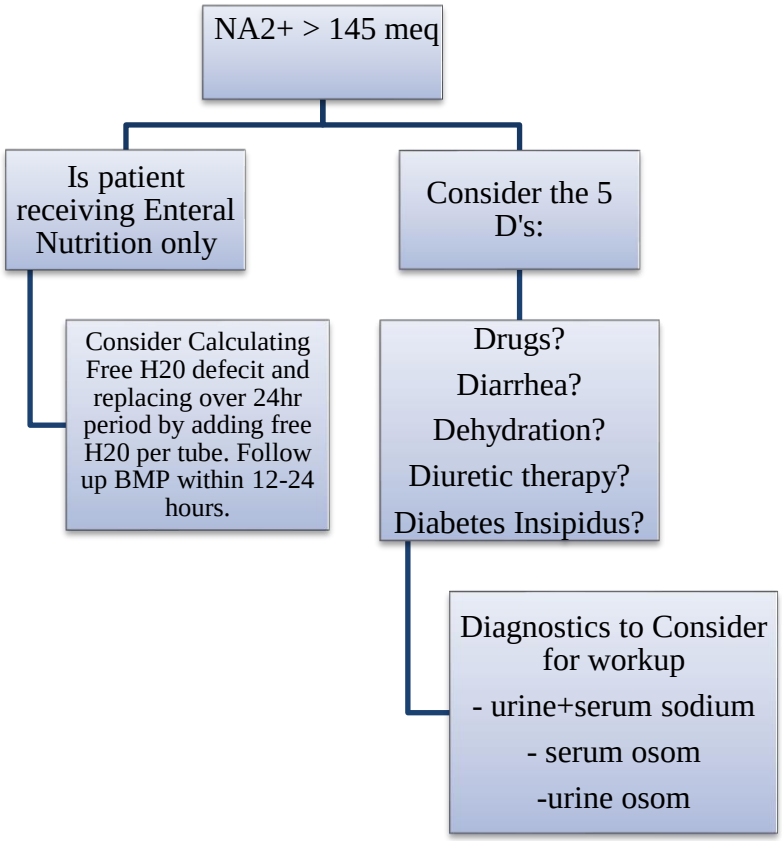
Calcium replacement based upon Ionized Calcium Levels		
Ionized Calcium	Replace with	Recheck Level
3.5-3.9	4 grams Ca Gluconate	With next AM labs
3.0-3.4 mg/dL	6 grams of Ca Gluconate	4 hours after replacement
2.5-2.9 mg/dL	8 grams Ca Gluconate	4 hours after replacement
< 2.5 mg/dL	10 grams Ca Gluconate +NHO	4 hours after replacement

- Infuse Calcium gluconate at a rate of 2 grams per hour.

VII. Hypernatremia Management/Considerations

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, or worsening acute renal failure. These patients should have other ancillary teams or be in collaboration with their cardiologist or nephrologist for guidance. >20% TBSA in ongoing fluid resuscitation within the first 24-72 hours and those in the initial phases of excision/debridement.

Step 1: Determine if acute vs chronic. Acute is defined as <48-hour period, chronic is >48 hours
Step 2 (Caution): Never correct sodium levels more than 12mmol in a 24-hour period for acute hypernatremia. Never correct sodium levels >8mmol/24 hours for chronic hypernatremia. It can be fatal.
Step 3: Assess current fluid volume status and proceed to simple algorithm below:



Drugs- some common drugs that cause hypernatremia: 0.9% NaCl infusions, Lactated Ringers, IV antibiotics such as ciprofloxacin, voriconazole, ceftriaxone, cefazolin

Dehydration/Diarrhea- Burn patients >20% suffer from catabolism, this can lead to renal losses. Excessive diarrhea also can contribute to extrarenal water losses.

Diabetes Insipidus (central or nephrogenic)- consider this in patients who suffer from trauma or head injuries. Nephrogenic causes include drugs like lithium, amphotericin B, or antiviral drugs

DI diagnosis- polyuria defined as 24 hours of UOP equivalent to 2.5L/24 hours or 40ml/kg/day in the setting of a high sodium level and a serum osom higher than urine osom. Consult endocrine for further eval including potential use of desmopressin testing.

Diuretic therapy-loop diuretics

Step 4 (Diagnostics): Interpret diagnostic data to determine type of hypernatremia (hypovolemic, euvolemic, or hypervolemia). See table referenced immediately below. * **Of note, diagnostic testing is not indicated if the cause can be determined off history/PE findings.**

Labs	Hypovolemic Hypernatremia	Euvolemic Hypernatremia	Hypervolemic Hypernatremia
Urine Osom level	> 600 mOsm/kg	< 300 mOsm/Kg	
Serum Sodium level	> 145meq/L	> 145meq/L	> 145meq/L
Urine Sodium level	< 20 meq/L	variable	>20 meq/L
Clinical considerations for differentiating between each Hypernatremia	Recent diuretic use, Recent mannitol use, lack of enteral free H20 replacement, diarrhea, dehydration, Correct glucose levels in those w/ DKA	Central/nephrogenic DI? Antibiotics?	Recent sodium Bicarb administration, Hypertonic saline admin

Step 5 Treatment Considerations: Always treat the underlying cause. The intensivist should guide the treatment portion/management section. Labs should be drawn at minimum every 6-12 hours toe valuate changes in serum sodium levels when implementing changes that can affect Na2+ levels.

Hypovolemic Hypernatremia	Euvolemic Hypernatremia	Hypervolemic Hypernatremia
*Initial fluid resuscitation with crystalloid - Consider free H20 replacement per tube if route available - If PO route not available consider 5% dextrose/half isotonic saline - if diuresis consider stopping the diuretic	- consider 5% dextrose ± loop diuretics - Considering removing medications such as lithium/Dilantin - if central DI suspected then place endocrine consult after ordering diagnostics for desmopressin use	- Consider 5% dextrose + loop diuretic - Consider discontinuing the offending agents such as bicarb drip or hypertonic saline if

VIII. Hyponatremia Management/Considerations

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, or worsening acute renal failure. >20% TBSA in ongoing fluid resuscitation within the first 24—72hours and those in the initial phases of excision/debridement.

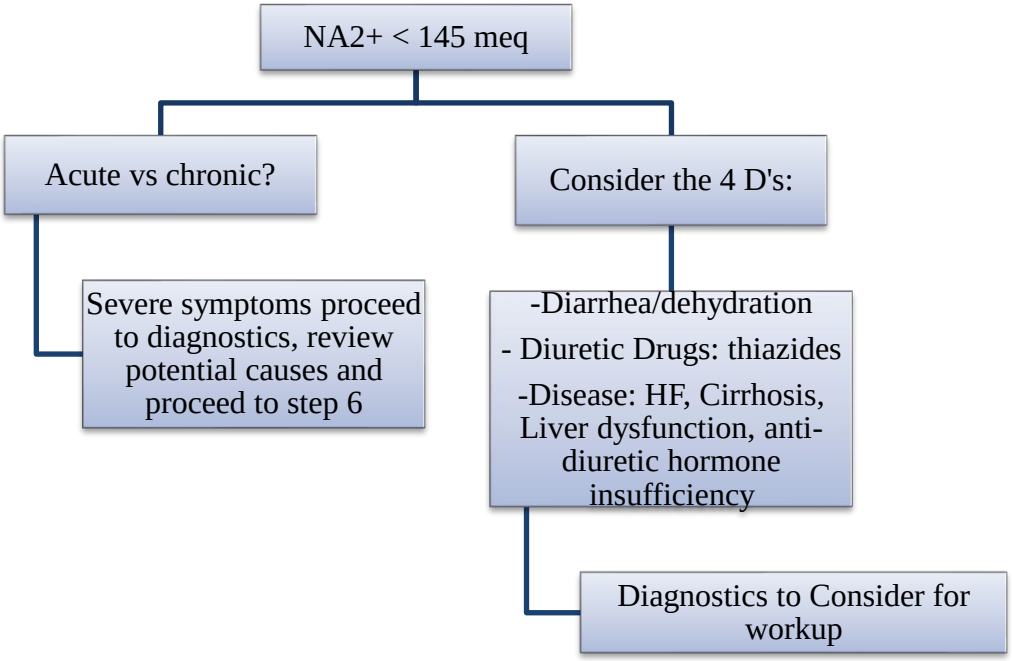
Considerations: Those with HF and chronic renal insufficiency should resume their diuretics if stable and in the perioperative period.

Definitions:

- Acute hyponatremia-developed within a 24-48-hour time frame

- Chronic hyponatremia-a chronic issue occurring pre hospital or for 72 hours or more during hospital stay. Typically prevalent in HF, renal failure, liver cirrhosis, patients with ascites.
- High risk Osmotic Demyelination Syndrome (ODS)-Alcoholism, hypokalemia, cirrhosis, malnutrition or liver disease
- Severe symptomatic hyponatremia-sodium levels decrease within <24 hours and typically occur when sodium level is <120meq/l (can occur at 125meq/l). Symptoms include seizures, coma, and neurological disturbances like AMS.

Algorithm
Step 1: Determine if acute vs chronic. Acute is defined as <48-hour period, chronic is > 48 hours
Step 2 (Caution): Never correct sodium levels more than 10mmol in a 24-hour period for acute hyponatremia. Never correct sodium levels > 10mmol/24 hours for chronic hyponatremia or >6mmol/24 with high risk ODS. Risks can be debilitating.
Step 3: Assess current fluid volume status & proceed to simple algorithm below



Step 4 (Diagnostics): Interpret diagnostic data to determine type of hyponatremia (hypovolemic, euvolemic, or hypervolemia). See table referenced immediately below.

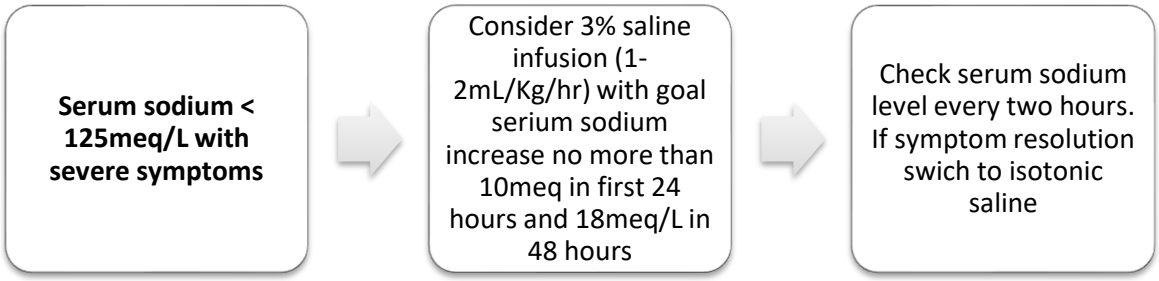
Labs	Hypovolemic Hyponatremia	Euvolemic Hyponatremia	Hypervolemic Hyponatremia
Serum Osom	< 280 mOsm/kg	< 280-295 mOsm/Kg	>295mOsm/kg
ECF volume	Decreased	Normal	Elevated
Serum Sodium	< 135meq/L	< 135meq/L	< 135meq/L
Urine sodium (may be occur elevated in cases of diuretic therapy)	< 20 to 30 mmol/L	≥ 20-30mmol/L	< 20-30meq/L
Other labs to consider for each type:	If uric acid level known, it will be elevated	If SIADH suspected Urine osom >100 mosm/kg	Elevation of BNP support volume overload
Clinical considerations for differentiating the type:	Vomiting, Diarrhea, orthostatic vitals +, mucous membranes dry. BUN/Cr+ may be elevated. Recent thiazide use or those with high urinary output and underlying brain pathology	Lack signs of volume depletion or volume expansion (edema or ascites). Consider SIADH. BUN/Cr+ may be normal to low	Presence of excess intravascular volume utilizing history, PE, signs of volume overload (edema, ascites, pulmonary edema.

Step 5 Treatment Considerations: Always treat the underlying cause. The intensivist should guide the treatment portion/management section. See general causes/treatment considerations in the table below.

Hypovolemic Hyponatremia Due to:	Euvolemic Hyponatremia Due to:	Hypervolemic Hyponatremia Due to:
- Diuretics: withhold diuretics & replete patient w/ isotonic fluid - Hypokalemia: correct hypokalemia - Cerebral Salt wasting: NaCl tablets or Hypertonic saline if Sodium < 131. Neurology should be consulted for underlying pathology and use of steroids - GI losses: IV fluids	- Drug induced SIADH: eliminate the offending med - SIADH: consider vaptans and endocrinology - Due to ETOH intoxication: nutrition consultation for increasing protein and possible ETOH consultation.	- HF: Consider dietary sodium restriction and diuretic therapy w/ loop diuretics. If pt has stable home regimen with diuretics and they have been held in the perioperative/operative period resume. Fluid restriction may also be implemented - Renal Failure: Fluid restriction may be implemented, if dialysis patient continue with regimen per nephrology team -Hepatic failure/cirrhosis: may benefit from sodium restriction, diuretic therapy

- Mineralocorticoid deficiency: identify cause with cortisol testing and proceed to the proper steroid replacement. Consider endocrinology consultation - Osmotic diuresis secondary to DM or profound glucose elevations: correct glucose level		and large volume paracentesis. Spironolactone along w/ a loop diuretic is recommended. Consider hepatology involvement

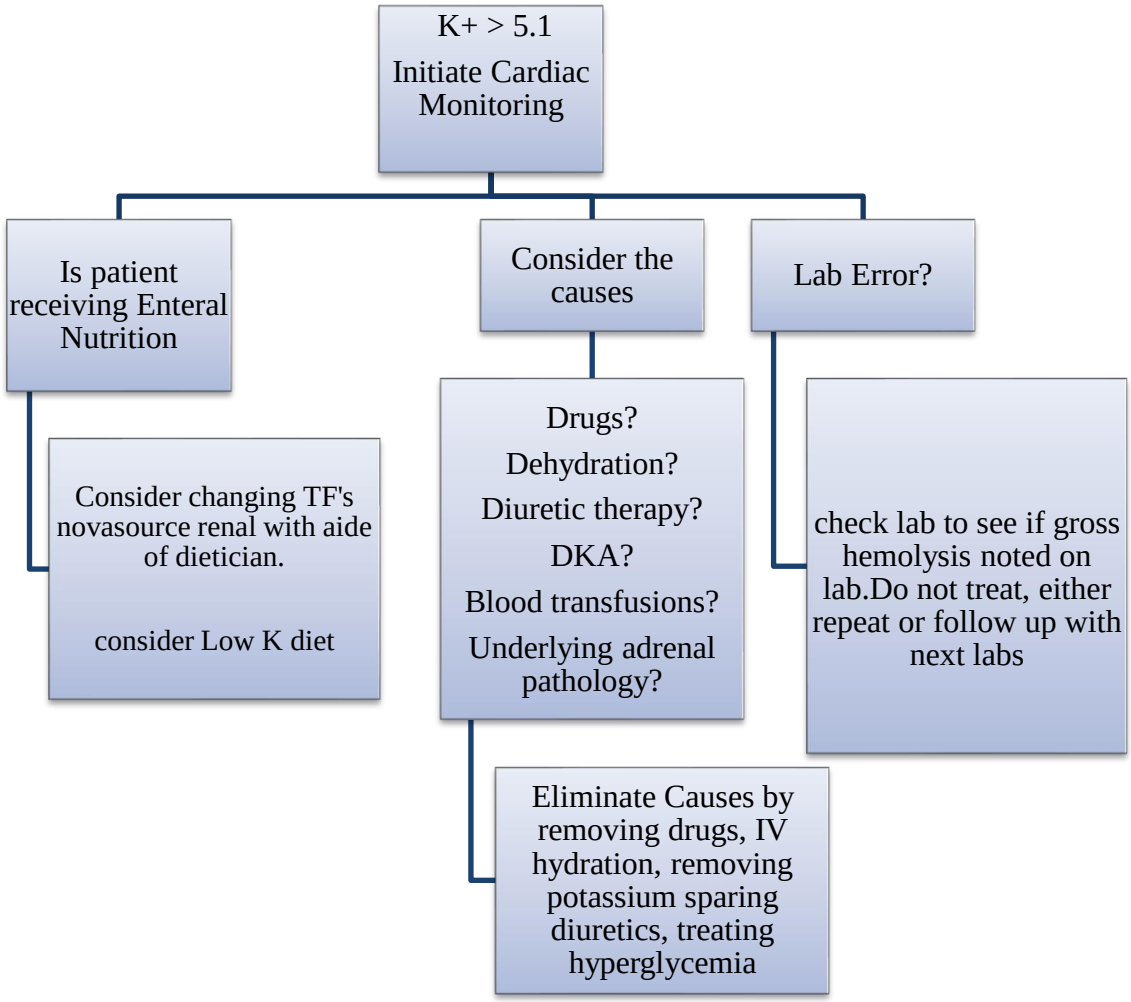
Step 6: Review severe symptoms algorithm



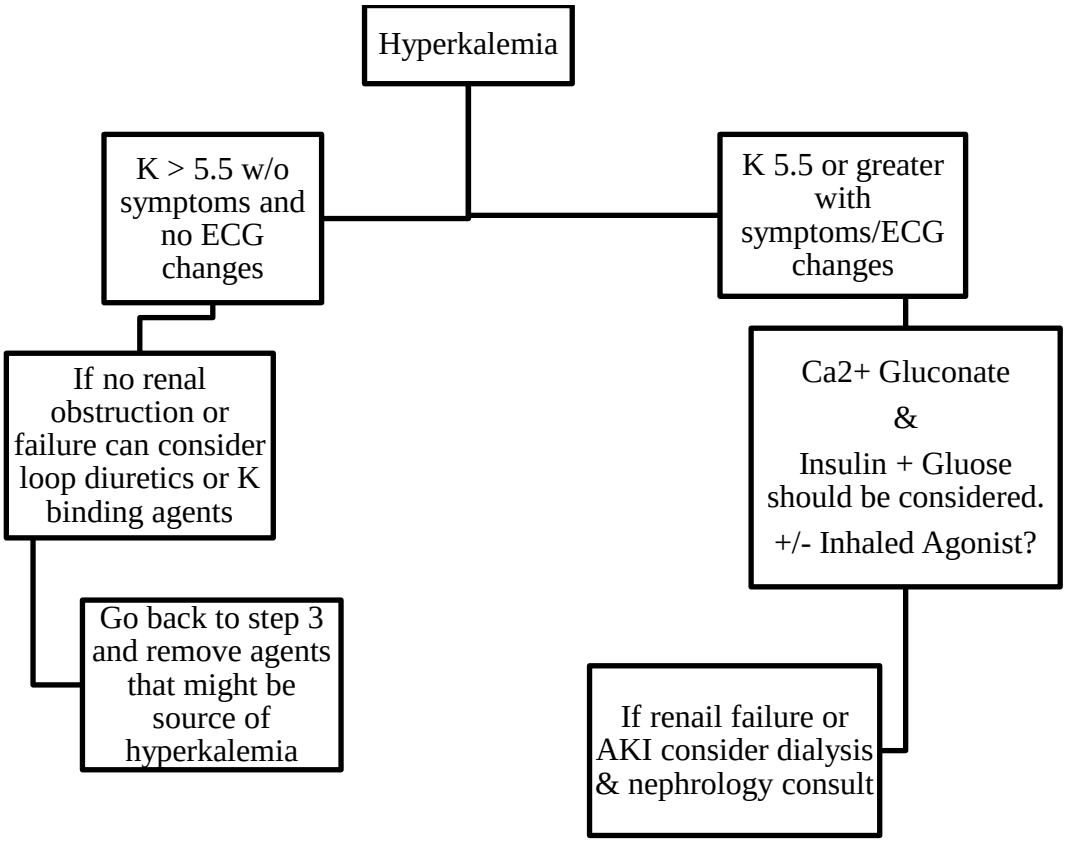
IX. Hyperkalemia Management Considerations

Exclusions: Patients with the following: hemodialysis/peritoneal dialysis, creatinine clearance <20ml/min, chronic adrenal insufficiency, or worsening acute renal failure or >20% TBSA undergoing fluid resuscitation (unless ECG changes or symptoms of hyperkalemia occur). Patients with renal failure or dialysis should have other ancillary teams involved for guidance of treatment unless ECG changes/life threatening arrhythmias develop then emergent treatment is indicated.

Algorithm
Step 1: Confirm that the lab is not result of gross hemolysis or error
Step 2 (Caution): always correct the underlying cause, work it up
Step 3: Proceed to simple algorithm below for basic considerations that can be made to general care if hyperkalemia has persisted for more than 48 hours or if level is potentially life threatening. **For life threatening levels, immediately review step 5 for further management considerations.**



Step 4 (Diagnostics): Urine lytes, BUN, Cr+, Serum K level, blood glucose levels, renin & aldosterone levels may be helpful in those that might have adrenal pathologies.
Step 5 Treatment Considerations: **Always treat the underlying cause.** The intensivist should guide the treatment portion/management section. See algorithm below for quick reference to accepted treatment. Symptoms pertain to ECG/Telemetry changes, and chest pain.



*Calcium gluconate should not be implemented in those with digitalis drug therapy unless otherwise specified by the intensivist.

X. References:

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