

ELECTROLYTE REPLACEMENT: INTRAVENOUS

PURPOSE: To outline the management of the patient receiving electrolytes for the purpose of routine electrolyte replacement. (It does not apply to electrolyte administration for other therapeutic uses).

SUPPORTIVE DATA: Electrolyte imbalances may result in cardiovascular and neuromuscular disturbances. Electrolytes should be replaced cautiously in patients with renal insufficiency/failure.

If electrolyte imbalance is critical (see below) or the patient is manifesting signs and/or symptoms (s/s) of electrolyte imbalance, the provider must be notified to evaluate for potential transfer to a monitored area.

Critical Values	
Bicarbonate: less than 14 mEq/L and pH less than 7.2 and with s/s	Phosphate: less than 1.5 mg/dL < 4.5 mg/dl for neonates
Corrected Calcium: less than 7 mg/dL (or ionized calcium less than 2.5 mg/dL) and with s/s Ionized calcium <4.5 mg/dl for neonates	Potassium: less than 3 mEq/L
Magnesium: less than 1.2 mg/dL or <1.7 mg/dL for neonates	Sodium: less than 120 mEq/L or < 130 mEq/L for neonates

Electrolyte replacement **MUST** be administered via infusion pump with Guardrails and preferably through a central line, if indicated in guide below.

- ASSESSMENT:**
1. Evaluate serum electrolyte levels prior to infusion.
 2. Assess the following prior to initiating infusion and a minimum of every 2 hours during infusion (ICU, ED, Progressive Care Unit); every 4 hours (acute care units):
 - Clinical Signs:
 - Alteration in level of consciousness (LOC)
 - Irregular/fast/slow pulse
 - Palpitations
 - Neuromuscular changes: muscle weakness, paresthesias, spasms, tetany, seizures
 - Dysrhythmias and electrocardiogram (ECG) changes (ICU/ ED/ Progressive Care Unit/ Telemetry Unit)

Electrolyte	High	Low
Ca ⁺⁺	Short ST	Prolonged ST and QTI
K ⁺	Peaked T Widened QRS Prolonged PRI Flat/absent P Depressed ST	Prominent U and P Flat T Depressed ST Prolonged PRI and QT PVCs
Mg ⁺⁺	Peaked T	Flat/inverted T Depressed ST Prolonged QTI PVCs Torsade de pointes
PO ₄ ⁻	Prolonged ST and QTI	Short ST

3. Assess ALL possible sources for electrolyte additives including the following:
 - IV infusions
 - PO/enteral tube intake
4. Assess peripheral infusion site for infiltration/phlebitis every 2 hours (Peds, neonates every hour).
5. Re-evaluate serum electrolyte values as ordered by provider. The following are recommendations for re-evaluation in the ICU:
 - 2 hour post infusion for calcium, potassium, phosphate
 - 4 hour post infusion for magnesium
 - One hour post infusion for sodium and bicarbonate. Bicarbonate may be monitored using a blood gas
6. Ensure order includes:
 - Dose
 - Route
 - Parameters, if any
 - Weight
 - Complete drug name, e.g., Sodium Phosphate vs Potassium Phosphate
Calcium Chloride vs Calcium Gluconate
 - Duration of infusion
7. Administer pharmacy-prepared solutions. See table as reference for administration.
 - Neonatal and Pediatric administration is highly individualized; consult appropriate clinical resources:
 - Neo Fax (Neonatal)
 - Pharmacists
 - Pediatric Dosage Handbook

PREPARATION/
ADMINISTRATION:

SAFETY:

8. Refer to the Electrolyte Administration Guidelines for MAXIMUM TOTAL HOURLY Electrolyte Infusion.
9. Administer electrolyte replacement via infusion pump with Guardrails.
10. Check drug compatibility with other medications infusing through the same line prior to administration.
11. Observe the following:
 - **Calcium**
 - Do NOT infuse IV calcium and phosphorus simultaneously through the same port/line or separate ports of the same central line (Exception: Total Parenteral Nutrition)
 - If hypocalcemia and hypophosphatemia occur together, infuse calcium first before phosphorus
 - DO NOT infuse calcium and bicarbonate or calcium chloride and magnesium in the same line (Except TPN; check IV

- compatibility).
 - Do NOT infuse calcium with ceftriaxone
 - Calcium Chloride: Extravasation may result in severe tissue necrosis and sloughing
 - **Phosphate**
 - See calcium section.
 - Monitor phosphorous and calcium levels. Induced hyperphosphatemia may result in hypocalcemia
 - **Potassium**
 - Central line is preferred
 - If peripheral line, use large vein, administer concentration of 20 mEq/250 mL and infuse simultaneously attached to maintenance infusion if possible to prevent burning sensation
 - **Sodium**
 - Monitor intake and output every hour (ICU/ Progressive Care Unit)
- REPORTABLE CONDITIONS:
12. Notify the provider immediately for:
 - Alteration in LOC
 - Irregular/fast/slow pulses
 - ECG changes, dysrhythmias
 - Palpitations
 - Neuromuscular weakness/paresthesias, spasms, tetany, seizures
 - Persistent abnormal lab values
 - Infiltration
- PATIENT/FAMILY TEACHING:
13. Instruct on the following:
 - Purpose of electrolyte replacement
 - To report to the RN
 - Any discomfort of IV site
 - Any cardiovascular / neuromuscular symptoms
- ADDITIONAL STANDARDS:
14. Refer to the following as indicated:
 - Intravenous Therapy
- DOCUMENTATION:
15. Document in accordance with documentation standards.

ELECTROLYTE REPLACEMENT GUIDELINES, ROUTINE ADULT PATIENTS

The following are standard recommendations:

Electrolyte	Concentration	Dose	Rate
Bicarbonate	50 mEq, 100 mEq or 150 mEq/1000 mL	1 amp (50) mEq Sodium Bicarbonate) 2 amps (100) mEq Sodium Bicarbonate) 3 amps (150 mEq Sodium Bicarbonate)	Start at 2 mEq/Kg over 4-8 hours (ICU/ED: over 4 hours) ICU/ED only: <i>Rate per provider order based upon bicarbonate level.</i> Adult Hematology/Oncology Acute Care Unit & Infusion Center only: <i>Titrate per provider's order according to treatment plan, e.g., tumor lysis, urine pH</i>
Calcium Gluconate	1 gm/50 mL 2 gm/100 mL 3 gm /250 mL	1 - 4 grams (1 gram Calcium Gluconate = 93 mg = 4.65 mEq elemental Calcium)	1 gram/hour
Calcium Chloride <i>Restricted to ICU/ED only</i>	1 gm/50 mL 2 gm/100 mL 3 gm/250 mL	1-4 grams (1 gram Calcium Chloride = approximately 3 grams Calcium Gluconate)	1 gram/hour <ul style="list-style-type: none"> • For emergency or • Via central line during Continuous Renal Replacement Therapy or for post cardiac surgery patients only
Magnesium Sulfate	2 gm/50 mL 4 gm/100 mL 5 gm/ 250 mL	2-6 grams (1 gram Magnesium Sulfate = 8 mEq Magnesium)	Maximum: 1 gram/hour
Phosphate (Potassium *or Sodium Phosphate)	15 mMol/250 mL 30 mMol/250 mL (Central line only) 30 mMol/500 mL	15 - 30 mMol Phosphorus <i>Potassium Phosphate:</i> 3 mMol Phosphate and 4.4 mEq Potassium per ml <i>Sodium Phosphate:</i> 3 mMol Phosphate and 4mEq Sodium per ml Acute Care Units: Maximum 30 Mmol/ 24 hours	15 mmol over 4 hours 30 mmol over 6 hours Maximum for severe hypophosphatemia: ICU only: 7.5 mmol/hour (via central line only)

<p>* If potassium chloride and potassium phosphate are being administered at the same time, the MAXIMUM TOTAL AMOUNT of potassium with both infusions remains at:</p>
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<ul style="list-style-type: none"> • Peripheral line - 10 mEq K+/hour • Central line - 20 mEq K+/hour 			
Potassium (Potassium Chloride) *	20 mEq/250 mL (Peripheral line) 40 mEq/500 mL (Peripheral line) 20 mEq/50 mL (Central line)	20 - 40 mEq (usually up to 1 mEq/kg or 80 mEq/dose)	10 mEq/hour ICU/ED only: Central Line: 20 mEq/hour (for severe hypokalemia)
Sodium Chloride (Hypertonic Solutions) <i>ICU/ED Only</i>	3% Premixed (250-500 mL)	Based on provider order, patient's sodium level, and signs and symptoms	Usually IV bolus over 15-30 min Central line is preferred. If peripheral line is used, IV site must be changed every 12 hours or the maximum infusion rate is 15 mL/hr.
The Wards are not approved to administer saline solutions greater than 0.9% for routine replacement. If the patient is hyponatremic, the physician must be notified to evaluate for consideration for transfer to a monitored area.			

**ELECTROLYTE REPLACEMENT GUIDELINES, ROUTINE
PEDIATRIC ACUTE CARE UNIT PATIENTS**

Serum Level	Electrolyte/Dose	Amount/Diluent		Rate
		Peripheral Infusion	Central Infusion	
Ionized Calcium of less than 4.5 mg/dL (Asymptomatic)	Calcium Gluconate 50-100 mg/Kg Maximum 2.5 grams	Dilute to 50 mg/mL (D5W or NS)		- IV over 4 hours
Magnesium of less than 1.7 mg/dL	Magnesium Sulfate 25-50 mg/Kg Maximum 2 grams	40 mg/ml (D5W or NS)		- IV over 4 - 6 hours - Do not exceed 125 mg/kg/hour
Phosphorus of 1.1 - 2.3 mg/dL	Potassium Phosphate 0.08 mmol/Kg	Dilute to 0.05 mmol/mL (D5W or NS)	Dilute to 0.12 mmol/mL (D5W or NS)	- IV over 6 hours <u>Central Infusion:</u> - Maximum rate 0.05 mmol/Kg/hour
Phosphorus of 0.5 - 1 mg/dL (Cardiac Monitoring)	Potassium Phosphate 0.16-0.24 mmol/Kg			
Phosphorus of less than 0.5 mg/dL (Cardiac Monitoring)	Potassium Phosphate 0.36 mmol/Kg			
Potassium of less than 3.5 mmol/L (Cardiac Monitoring)	Potassium Chloride 0.5-1 mEq/Kg IV Maximum dose 40 mEq Cardiac Monitor is required for infusion rate greater than 0.25 mEq/Kg/hr or greater than 10mEq/hr	Maximum dilution 0.08 mEq/mL in D5W or NS	20 mEq in 50 mL sterile water Premade bag. Or 0.4 mEq/mL in NS or D5W.	Peripheral infusion: - Maximum rate 0.25 mEq/Kg/hour - Not to exceed: 10mEq/hour
				<u>Central Infusion:</u> - Maximum rate 1 mEq/Kg/hour - Not to exceed: 40 mEq/hour

**ELECTROLYTE REPLACEMENT GUIDELINES, ROUTINE
PEDIATRIC ICU/ED**

Indications	Electrolyte/Dose	Amount/Diluent	Rate
Serum Ionized Calcium less than 4.5 mg/dL	Asymptomatic: Calcium Gluconate 50-100 mg/Kg, maximum 2.5 grams	Dilute to 50 mg/mL (D5W or NS)	IV over 4 hours
	Symptomatic: Calcium Chloride 10mg/kg, maximum 1 gram	*Do NOT infuse with Phosphate containing IV fluids	IV over 10 minutes.
Serum Magnesium less than 1.7 mg/dL	Magnesium Sulfate 25-50 mg/Kg/dose Maximum single dose: 2 grams	40 mg/mL in D5W or NS, or use premade bag 2 gm in 50 mL sterile water	- IV over 4-6 hours - Do not exceed 125 mg/kg/hr
Serum Phosphorus 1.1 - 2.3 mg/dL	Potassium Phosphate (low dose) 0.08 mmol/Kg	Peripheral Infusion: - Dilute to 0.05 mmol/mL (D5W or NS) Central Infusion: - Dilute to 0.12 mmol/mL (D5W or NS) *Do NOT infuse with Calcium-containing IV fluids	Peripheral Infusion: - IV over 6 hours Central Infusion: - Maximum rate: 0.05 mmol/Kg/hour
Serum Phosphorus 0.5 - 1 mg/dL Cardiac Monitoring	Potassium Phosphate (intermediate dose) 0.16-0.24 mmol/Kg Maximum 30 mmol		
Serum Phosphorus less than 0.5 mg/dL Cardiac Monitoring	Potassium Phosphate (high dose) 0.36 mmol/Kg Maximum 40 mmol		
Serum Potassium less than 3.5 mmol/L	Potassium Chloride 0.5-1 mEq/Kg IV Maximum dose 40 mEq	Peripheral Infusion: - Maximum dilution: 40 mEq in 500 mL (D5W or NS) Central Infusion: - Dilute to 15 mEq in 100mL (D5W or NS) - Maximum concentration 20 mEq/50 mL (Premixed from manufacturer)	Maximum rate: 40 mEq over 1 hour Normal rate is 1 mEq/kg/hr up to 40 mEq/hour Peripheral Infusion: - Maximum rate: 10 mEq/hr

Indications	Electrolyte/Dose	Amount/Diluent	Rate
<p>Serum Sodium - less than 130 mEq/L & initial treatment of Acute Serious Symptomatic (i.e. Seizures) Hyponatremia - as a salt replacement solution in severe salt losing conditions (i.e. cerebral salt wasting)</p>	<p>Dose is based upon calculated provider's order</p> <p>*For Hyponatremic Seizures as an initial estimate give 6 mL/kg of 3% NaCL over 60 min. 3% NaCL ~ 0.5 meq/mL</p>	<ul style="list-style-type: none"> 3% NaCl 500 mL premade bag. Central line preferred 	<p>Maximum rate of infusion: 1 mEq/kg/hour</p> <p>Usual rate: over 15 – 30 min</p>
<p>Bicarbonate - less than 10 mmol/L & pH < 7.10 (Metabolic Acidosis)</p>	<p>Sodium Bicarbonate (1 mEq/mL NaHCO₃ 8.4%)</p> <ul style="list-style-type: none"> Dose is based upon calculated provider's order Subsequent doses should be based on patient's acid-base status 	<p>Maximum Concentration : 0.5mEq/mL or 1 mEq/mL in D5W or NS (Solution is hypertonic - avoid infiltration or extravasation)</p>	<p>Infuse over 2-4 hours</p> <p>- Maximum rate of infusion: 1 mEq/kg/hour</p> <p>Rate per provider order based upon bicarbonate level.</p>

ELECTROLYTE REPLACEMENT GUIDELINES, NICU

Indications	Electrolyte/Dose	Amount/Diluent	Rate
Serum Ionized Calcium less than 4.5 mg/dL	Asymptomatic: Calcium Gluconate 50-100 mg/Kg	Dilute to 50 mg/mL (D5W) *Do NOT infuse with Phosphate containing IV fluids	IV over 1 hour
Serum Magnesium less than 1.7 mg/dL	Magnesium Sulfate 25-50 mg/Kg/dose	40 mg/mL in D5W	IV over 1-4 hours Do not exceed 125 mg/kg/hr
Serum Phosphorus 1.1 - 2.3 mg/dL	Potassium or Sodium Phosphate (low dose) NICU: 0.15 – 0.2 mmol/kg	Peripheral Infusion: - Dilute to 0.05 mmol/mL (D5W)	Central and peripheral infusion rate 0.05 mmol/Kg/hour
Serum Phosphorus 0.5 - 1 mg/dL Cardiac Monitoring	Potassium or Sodium Phosphate (intermediate dose) 0.2-0.25 mmol/Kg Maximum 30 mmol	Central Infusion: - Dilute to 0.12 mmol/mL (D5W or NS) *Do NOT infuse with Calcium-containing IV fluids	
Serum Phosphorus less than 0.5 mg/dL Cardiac Monitoring	Potassium or Sodium Phosphate (high dose) 0.25-0.35 mmol/Kg		
Serum Potassium less than 3.5 mmol/L	Potassium Chloride or Potassium Acetate 0.5-1 mEq/Kg IV	Peripheral Infusion: 0.1 mEq/ mL (D5W) Central Infusion: 0.4 mEq/mL (D5W)	Peripheral and central infusion Maximum rate 0.25 mEq/Kg/hour

Indications	Electrolyte/Dose	Amount/Diluent	Rate
<p>Serum Sodium</p> <ul style="list-style-type: none"> - less than 130 mEq/L & initial treatment of Acute Serious Symptomatic (i.e. Seizures) Hyponatremia - as a salt replacement solution in severe salt losing conditions (i.e. cerebral salt wasting) 	<p>Dose is based upon calculated provider's order</p> <p>*For Hyponatremic Seizures as an initial estimate give 6 mL/kg of 3% NaCL over 60 min. 3% NaCL~ 0.5 mEq/mL</p>	<p>Peripheral Infusion:</p> <ul style="list-style-type: none"> - Dilute to 0.25 mEq/mL in D5W <p>Central Infusion:</p> <ul style="list-style-type: none"> - Dilute to 0.5 mEq/mL in D5W 	<p>IV over 4 hours (maximum rate of infusion: 1 meq/kg/hr)</p>
<p>Bicarbonate</p> <ul style="list-style-type: none"> - less than 10 mmol/L & Ph < 7.10 (Metabolic Acidosis) 	<p>Sodium Bicarbonate (0.5 meq/ml 4.2% or 1 mEq/mL 8.4% NaHCO₃)</p> <ul style="list-style-type: none"> • Dose is based upon calculated provider's order • Subsequent doses should be based on patient's acid-base status 	<p>Maximum Concentration : 0.5mEq/mL or 1 mEq/mL (for bigger older babies with fluid restriction only) in D5W</p> <p>(Solution is hypertonic – avoid infiltration or extravasation)</p>	<p>Infuse over 30 mins to 1 hour</p> <ul style="list-style-type: none"> - Maximum rate of infusion: 1 mEq/kg/hour <p>Rate per provider order based upon bicarbonate level.</p>

References:

LAC + USC Medical Center. Unit Structure Standards Manual Pediatric Intensive Care- C8D: Addendum QQ – Use of 3% Normal Saline in the PICU. Department of Nursing Services and Education, 2014.

LAC + USC Pediatrics Handbook, 13th ed, 2017-2018. Pages 73-83

Taketomo, C.K., Hodding, J.H., Kraus, D.M., Pediatric Dosage Handbook, 24th ed, Hudson, OH: Lexi-Comp, Inc, 2017-20

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