University of Michigan Hospitals and Health Centers

Policy 07-01-020
Intravenous Electrolyte Ordering and Administration in Adult Patients at UMHHC

(Formerly Policy 62-01-007)
Issued: 7/2002 Last Reviewed: 7/2004 Last Revised: 7/2004 Posted: 9/2004

I. POLICY STATEMENT

The University of Michigan Hospitals and Health Centers shall create and maintain Policy and Guidelines (Exhibit A) to provide standards for safe and effective ordering and administration of intravenous electrolytes including sodium, potassium, magnesium, calcium and phosphorus to adult patients.

II. POLICY PURPOSE

The purpose of this policy is to provide standards for the safe and effective ordering and administration of intravenous electrolytes including sodium, potassium, magnesium, calcium and phosphorus to adult patients. This policy addresses the ordering and administration of intravenous electrolytes for maintenance and replacement/supplementation. This policy is NOT meant to address the use of electrolytes in urgent or emergent situations, or in any other specific diseases or under specific clinical conditions that necessitate a deviation from these guidelines.

III. DEFINITIONS

IV PUSH: Any medication which is administered directly into a vein over a period of time less than or equal to 5 minutes.

INTERMITTENT INFUSION: Any medication that is administered directly into a vein over a prescribed **limited time period**. The medication is administered at set time intervals. The infusion rate is usually controlled by a mechanical infusion pump.

CONTINUOUS INFUSION: Any medication that is administered into a vein in an **uninterrupted manner**. The infusion rate is usually controlled by a mechanical infusion pump.

MAINTENANCE DOSE: Electrolytes provided on a daily basis to maintain normal balance - usually mixed in an intravenous hydration fluid or parenteral nutrition solution.

REPLACEMENT DOSE: Electrolytes provided to correct the serum **deficit** of a particular ion - usually infused over a limited time period. (NOTE: Replacement dose = total dose ordered over prescribed time period, not hourly dose.)

IV. POLICY STANDARDS

A. The absolute maximum concentrations and maximum rates of infusion listed in the guidelines shall not be exceeded without an order signed by an attending physician.

B. Concentrations listed in the guidelines represent final administration concentrations. Floor stock may require further dilution.

C. DO NOT give IV PUSH (except for magnesium and calcium).

D. Consider all sources of electrolytes when assessing electrolyte requirements and supplementation.

E. Physician orders for *maintenance* electrolytes must specify the name of the electrolyte, name of diluent, concentration, and infusion rate (e.g., D_5 0.45 NS with 20mEqKCl/L @ 20 mL per hour).

1. If the prescriber does not specify a volume for a large volume maintenance solution, a standard volume of 1000 ml will be dispensed.

F. Physician orders for *replacement* electrolytes must specify the name of the electrolyte, amount, and number of doses to be given (e.g., 10 mEq of KCl IV x 1). The standard duration of infusion shall follow the Guidelines for infusion time and rate specified for each electrolyte.

1. If the prescriber does not specify an infusion rate, a standard infusion rate appropriate for the specific electrolyte will be recommended by Pharmacy.

G. Whenever possible give electrolyte replacements via a central venous catheter. If a peripheral vein is used, monitor the patient for signs that may indicate tissue irritation/infiltration.

H. Use an infusion device to administer all *replacement* electrolytes.

I. Equipment: Continuous infusion device, appropriate syringes, tubing, diluents, electrolyte injection solutions and labels.

J. All *maintenance* intravenous solutions should be appropriately labeled with the total amount of electrolytes from all sources and total volume of diluent (e.g., 40 mEq KCl per 1000 mL of $D_{10}W$).

K. All *replacement* intravenous solutions should be appropriately labeled with the total amount of electrolyte, total volume of diluent, and rate of infusion (e.g., 10 mEq KCl in 100 mL of NS, infuse over 1 hour).

L. Documentation: Each dose administered will be charted on the Medication Administration Record (MAR).

M. Calcium chloride, potassium phosphate and concentrated potassium chloride (i.e. 2 mEq/mL) shall not be part of routine floor stock.

N. Contraindications/Precautions. See guidelines applicable to all electrolytes and individual electrolyte guidelines.

O. Preparation of patient. Encourage patient/family to notify nurse if there is pain, redness or swelling at the infusion site.

NOTES:

1. For more detailed information on the ordering and administration of the electrolytes covered under this policy, refer to the UMHHC Guidelines for Intravenous Electrolyte Ordering and Administration in Adult Patients (Exhibit A).

2. Deviation from this policy requires the order to be signed by an attending physician.

3. If any serious concerns are raised due to the deviation from this policy, the Chair of the Pharmacy and Therapeutic Committee should be contacted.

V. PROCEDURE ACTIONS

A. The prescriber shall write a strip order for the intravenous electrolyte specifying the electrolyte salt, dose, and dosing unit (e.g., g, mg, mEq, mmol, mM) as specified in the Guidelines and Policy.

B. If the prescriber does not specify the type of electrolyte salt, the pharmacist shall contact the prescriber to clarify the order and suggest the type of electrolyte salt according to the specifications listed for each electrolyte in the Guidelines and Policy.

C. If the prescriber does not specify the dosing unit, the pharmacist shall contact the prescriber to clarify the order.

1. Sodium phosphates or potassium phosphates should be ordered in units of millimoles of phosphate. If this is not the case, the pharmacist shall contact the prescriber to clarify the order and have the order specified in millimoles.

2. If the order is changed, the pharmacist shall rewrite a strip order based on verbal communication with the prescriber to clarify the changes.

D. The pharmacist shall dispense the medication compounded according to the standard diluents, volume, and rate specified for each electrolyte in the Guidelines and Policy.

1. If the order specifies a non-standard diluent, volume, or rate, the pharmacist shall contact the prescriber to clarify the order.

2. Non-standard solutions will be only compounded if clinically indicated and if deemed compatible and appropriate by the pharmacist.

3. If the order is changed, the pharmacist shall rewrite a strip order based on verbal communication with the prescriber to clarify the changes.

E. The medication label shall specify the dose amount, volume, and infusion rate for each electrolyte according to the specifications for each electrolyte in the Guidelines and Policy.

F. The nurse should infuse the medication over the time period specified on the label.

G. If a discrepancy related to these guidelines cannot be resolved by the physician, pharmacist, and nurse, the attending physician shall be contacted. If further assistance is required, the Chair of the Pharmacy and Therapeutics Committee shall be contacted.

H. The Pharmacy Department shall save and periodically review inappropriate orders for electrolytes and provide a report to the Medication Safety Committee. Prescribers who consistently write inappropriate orders shall be contacted by the Medication Safety Committee and provided education to improve prescribing habits.

I. Continuing Care

- Ongoing assessment for side effects of electrolyte administration
- Monitor IV site every one hour

VI. EXHIBITS

Exhibit A - Guidelines for Intravenous Electrolyte Ordering and Administration in Adult Patients at University of Michigan Hospitals and Health Centers

VII. REFERENCES

1. Schultz NJ and Chitwood-Dagner KK. Body electrolyte homeostasis. In: Dipiro JT, Talbert RL, Yee GC, Matzle GR, Wells BG, Posey LM (eds). Pharmacotherapy: A Pathophysiologic Approach, 4th ed. Stamford, CT: Appleton & Lange, 1999: 890-917.

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4. Clark CL, Sacks GS, Dickerson RN, et al. Treatment of hypophosphatemia in patients receiving specialized nutrition support using a graduated dosing scheme: results from a prospective clinical trial. Crit Care Med 1995; 23:1504-1511.

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VIII. AUTHORS

A. Department of Pharmacy Services

IX. APPROVED

Medication Use Process Improvement Committee - June 12, 2001;
Pharmacy & Therapeutics Committee - July 17, 2001;
Executive Committee of Clinical Affairs - July, 2002;
Executive Director, UMHHC - November 1, 2002

Revisions Approved:
Executive Committee of Clinical Affairs - July 27, 2004
Director and CEO, UMHHC - September 30, 2004

Policy 07-01-020, Exhibit A

University of Michigan Hospitals and Health Centers
Guidelines for Intravenous Electrolyte Ordering and Administration in Adult Patients

I. Statement of Purpose

The purpose of these guidelines is to provide standards for safe and effective ordering and administration of intravenous electrolyte supplements including sodium, potassium, magnesium, calcium and phosphorus to adult patients. These guidelines address the ordering and administration of intravenous electrolytes for maintenance and replacement/supplementation. These guidelines are NOT meant to address the use of electrolytes in urgent or emergent situations, or in any other specific diseases or under specific clinical conditions that necessitate a deviation from these guidelines.

II. Definitions

IV PUSH: Any medication which is administered directly into a vein over a period of time less than or equal to 5 minutes.

INTERMITTENT INFUSION: Any medication that is administered directly into a vein over a prescribed **limited time period.** The medication is administered at set time intervals. The infusion rate is usually controlled by a mechanical infusion pump.

CONTINUOUS INFUSION: Any medication that is administered into a vein in an **uninterrupted** manner. The infusion rate is usually controlled by a mechanical infusion pump.

MAINTENANCE DOSE: Electrolytes provided on a daily basis to maintain normal balance. Usually mixed in an intravenous hydration fluid or parenteral nutrition solution.

REPLACEMENT DOSE: Electrolytes provided to correct the serum deficit of a particular ion. Usually infused over a limited time period. (NOTE: Replacement dose = total dose ordered over prescribed time period, not hourly dose.)

III. GUIDELINES

FOR ALL ELECTROLYTES WITHIN THIS DOCUMENT:

- These guidelines are meant to supplement the University of Michigan Hospitals and Health Centers Electrolyte Policy.
- The absolute maximum concentrations and maximum rates of infusion listed in these guidelines shall not be exceeded without an order signed by an attending physician.
- Concentrations listed represent final administration concentrations. Floor stock may require further dilution.
- DO NOT give IV PUSH (except for magnesium and calcium).

- Consider all sources of electrolytes when assessing electrolyte requirements and supplementation.

- Physician orders for *maintenance* electrolytes must specify the name of the electrolyte, name of diluent, concentration, and infusion rate (e.g., D_5 0.45 NS with 20mEqKCl/L @ 20 mL per hour).

- Physician orders for *replacement* electrolytes must specify the name of the electrolyte, amount, and number of doses to be given (e.g., 10 mEq of KCl IV x 1). The standard duration of infusion shall follow the Guidelines for infusion time and rate specified for each electrolyte.

- Whenever possible give electrolyte replacements via a central venous catheter. If a peripheral vein is used, monitor the patient for signs that may indicate tissue irritation/infiltration.

- Use an infusion device to administer all *replacement* electrolytes.

- Equipment: Continuous infusion device, appropriate syringes, tubing, diluents, electrolyte injection solutions and labels.

- All *maintenance* intravenous solutions should be appropriately labeled with the total amount of electrolytes from all sources and total volume of diluent (e.g., 40 mEq KCl per 1000 mL of $D_{10}W$).

- All *replacement* intravenous solutions should be appropriately labeled with the total amount of electrolyte, total volume of diluent and rate of infusion (e.g., 10 mEq KCl in 100 mL of NS, infuse over 1 hour).

- Documentation: Each dose administered will be charted on the Medication Administration Record (MAR).

- Calcium chloride, potassium phosphate and concentrated potassium chloride (i.e. 2 mEq/mL) shall not be part of routine floor stock.

CALCIUM CHLORIDE

Indications

- Calcium chloride is to be used only for the *urgent* and/or *emergent* correction of hypocalcemia.

Note

Calcium *gluconate* is to be ordered for calcium maintenance and replacement (calcium chloride is three times more potent than calcium gluconate).

Route

Acceptable intravenous access includes central and peripheral venous catheters; however administration via a central venous catheter is preferred.

Ordering

- Doses should be ordered in milligrams (mg) of calcium chloride
- 100 mg calcium chloride = 26 mg elemental calcium = 1.4 mEq calcium

Infusion Rate

Emergency (non-cardiac arrest): May be administered as slow IV push, maximum of 100 mg calcium chloride over 1 minute (1.4 mEq calcium /min)

Emergency: Refer to UMHS Standard Emergency Medication Guidelines

Maximum Concentrations
Maximum concentration is calcium chloride 20 mg/mL.

Incompatibility
- Do not infuse calcium in the same intravenous line as parenteral nutrition solution.
- Do not infuse calcium in the same intravenous line as phosphate.
- Do not mix phosphate and calcium into any intravenous solution; calcium and phosphate should only be mixed in parenteral nutrition solutions per pharmacy protocols.
- Rapid infusion may cause arrhythmias and bradycardia.

Precautions
- Use caution when ordering calcium replacement to insure that the correct dose and salt form of calcium has been ordered (calcium chloride is three times more potent than calcium gluconate).
- Extravasation of calcium can cause serious tissue irritation and necrosis.
- Watch for signs and symptoms of extravasation, immediately discontinue administration if observed.

CALCIUM GLUCONATE

Indications
- Replacement: Hypocalcemia
- Maintenance: Maintaining normal calcium balance

Route
Acceptable intravenous access includes peripheral and central venous catheters.

Ordering
- Doses should be ordered in grams (g) of calcium gluconate.
- 1 g calcium gluconate = 90 mg elemental calcium = 4.56 mEq calcium.
- 1 ampul of calcium gluconate (10% calcium gluconate, 10 mL) = 1 g calcium gluconate.

Infusion Rate

Non-emergency: Administer doses up to 2 g calcium gluconate (9.12 mEq of calcium) over 30 minutes in 50 mL dextrose 5% in water.

Emergency:
- Replacement doses may be given as a continuous infusion or as a slow IV push.
- Maximum is 1 g calcium gluconate over 3 minutes (1.5 mEq calcium/min), slow IV push.
- May administer 1 g calcium gluconate over 5 – 10 minutes, slow IV push.

Maximum Concentrations
Maximum is 2 g of calcium gluconate in 50 mL of dextrose 5% in water (40 mg/mL).

Incompatibility
- Do not infuse calcium in the same intravenous line as parenteral nutrition solution.
- Do not infuse calcium in the same intravenous line as phosphate.

- Do not mix phosphate and calcium into any intravenous solution; calcium and phosphate should only be mixed in parenteral nutrition solutions per pharmacy protocols.

Precautions
- Use caution when ordering calcium replacement to insure that the correct dose and salt form of calcium has been ordered.
- Extravasation of calcium can cause serious tissue irritation and necrosis.
- Watch for signs and symptoms of extravasation, immediately discontinue administration if observed.
- Rapid infusion may cause arrhythmias and bradycardia.

MAGNESIUM SULFATE

Indications
- Replacement: Hypomagnesemia
- Maintenance: Maintaining normal magnesium balance

Route
Acceptable intravenous access include peripheral and central venous catheters.

Ordering
- Ordered in grams (g) of magnesium sulfate .
- 1 g of magnesium sulfate = 98.6 mg elemental magnesium = 8.1 mEq of magnesium.

Infusion Rate:

Non emergency:	1 g magnesium sulfate (8.1 mEq of magnesium) in 50 mL of dextrose 5% in water over one hour. Maximum of 2 g magnesium sulfate (16.2 mEq of magnesium) in 50 mL of dextrose 5% in water over one hour.
Emergency:	May be given IV push at a maximum rate of 150 mg/min (1.2 mEq/min) after dilution to < 20% (< 200 mg/mL) concentration as long as patient is not at risk for hypotension.

Maximum Concentrations
Magnesium sulfate should be diluted to < 20% (200 mg/mL) concentration before administration.

Precautions
- Rapid infusion especially if exceeding 150 mg/min (1.2 mEq/min) may cause hypotension and respiratory depression.
- Use with caution in patients with renal insufficiency with frequent monitoring of serum concentrations.

POTASSIUM CHLORIDE (KCl)

Indications
- Replacement: Acute treatment of hypokalemia
- Maintenance: Prevention or chronic treatment of hypokalemia

Route
Acceptable intravenous access include peripheral and central venous catheters. NEVER GIVE POTASSIUM I.V. PUSH or in UNDILUTED FORM.

Potassium Chloride Infusion Guidelines in Adults

PERIPHERAL	Recommended K Concentration	**Maximum K Concentration**	**Maximum K Infusion Rate***
Continuous infusion	10-80 mEq/L	80 mEq/L	10 mEq/hour
Intermittent infusion	10 mEq/100 mL D_5W	10 mEq/50 mL[†]	10 mEq/hour
CENTRAL			
Continuous infusion	10-80 mEq/L	80 mEq/L	10 mEq/hour[‡]
Intermittent infusion	10 mEq/100 mL D_5W	20 mEq/50 mL	20 mEq/hour

***•** Include all sources of potassium when calculating infusion rates.

*• Potassium infusion rates exceeding 20 mEq/hour require continuous cardiac monitoring in the intensive care unit.

*• In emergency, the maximum potassium infusion rate is 40 mEq/hour with continuous cardiac monitoring.

[†]• Infusion of KCl at a concentration of 10 mEq/50 mL via a peripheral vein increases the chances for localized pain and phlebitis. Patients should be monitored for signs and symptoms of pain and phlebitis at the infusion site.

[‡]• Higher infusion rates may be required under certain clinical conditions. Total dose of KCl should not exceed 240-400 mEq/day.

Infusion Devices
- An infusion device must be used on all replacement doses.

Maximum Concentrations
- Refer to above table for peripheral and central potassium infusion recommendations.
- When changing IV administration from central to peripheral route, the concentration dilution requirements must be reviewed and the electrolyte reconstituted as appropriate.

POTASSIUM PHOSPHATE

Indications
- Phosphate replacement: Hypophosphatemia
  Combined hypophosphatemia and hypokalemia
- Phosphate maintenance: Maintaining normal phosphate balance

Route
Acceptable intravenous access include peripheral and central venous catheters.

Ordering
- To be ordered in millimoles (mmol or mM) of phosphate.
- 1 mM of potassium phosphate contains 1.47 mEq of potassium.

Infusion Rate
- Limited by the total amount of potassium in the dose.
- Recommended infusion rate is 15 mM of phosphate/100 mL over 4 hours.
- Maximum of 7 mM of potassium phosphate/hour or 10 mEq/hour of potassium equivalent.

Maximum Concentrations
Maximum is 15 mM of potassium phosphate in 100 mL of dextrose 5% in water.

Incompatibility
- Do not infuse phosphate in the same intravenous line as parenteral nutrition solution.
- Do not infuse phosphate in the same intravenous line as calcium.
- Do not mix phosphate and calcium into any intravenous solution; calcium and phosphate should only be mixed in parenteral nutrition solutions per pharmacy protocols.

SODIUM PHOSPHATE

Indications
- Phosphate replacement: Hypophosphatemia
- Phosphate maintenance: Maintaining normal phosphorous/phosphate balance

Route
Acceptable intravenous access includes peripheral and central venous catheters.

Ordering
- Doses should be ordered in millimoles (mmol or mM) of phosphate.
- 1 mM of sodium phosphate contains 1.33 mEq of sodium.

Infusion Rates
- Limited by the total amount of phosphate in a dose.
- Recommended infusion rate is 15 mM of phosphate over 4 hours.
- Maximum of 7 mM of phosphate/hour.

Maximum Concentrations
Maximum is 15 mM of sodium phosphate in 100 mL dextrose 5% in water.

Incompatibility
- Do not infuse phosphate in the same intravenous line as parenteral nutrition solution.
- Do not infuse phosphate in the same intravenous line as calcium.
- Do not mix phosphate and calcium into any intravenous solution; calcium and phosphate should only be mixed in parenteral nutrition solutions per pharmacy protocols.

Precautions
Sodium phosphate must be diluted before being administered to a patient.

SODIUM CHLORIDE 3% HYPERTONIC (NaCl)

Indications
- Severe Hyponatremia

Route
Recommended to be infused via a central venous catheter due to its hypertonicity and potential for venous damage.

Ordering
To be ordered as hypertonic 3% sodium chloride in 500 mL.

Infusion rate
Infusion rate is dictated by the severity of clinical presentation and serum sodium concentrations. It is generally recommended that serum sodium concentrations be corrected at no more than 12 mEq/L/day.

Concentrations
3% NaCl in 500 mL equivalent to 256 mEq of Na/500 mL.

Precautions

- Hypertonic 3% NaCl may cause venous irritation and pain at the injection site if infused via a peripheral vein.
- In emergency situations when a central venous access is not available, infuse slowly with continuous monitoring for signs of extravasation, irritation, or localized pain.

IV. Contraindications/Precautions

See guidelines applicable to all electrolytes and individual electrolyte guidelines.

V. Preparation of Patient

Encourage patient/family to notify nurse if there is pain, redness or swelling at the infusion site.

VI. Procedure Actions

A. The prescriber shall write a strip order for the intravenous electrolyte specifying the electrolyte salt, dose, and dosing unit (e.g., g, mg, mEq, mmol, mM) as specified in the Guidelines and Policy.
B. If the prescriber does not specify the type of electrolyte salt, the pharmacist shall contact the prescriber to clarify the order and suggest the type of electrolyte salt according to the specifications listed for each electrolyte in the Guidelines and Policy.
C. If the prescriber does not specify the dosing unit, the pharmacist shall contact the prescriber to clarify the order.

    1. Sodium phosphates or potassium phosphates should be ordered in units of millimoles of phosphate. If this is not the case, the pharmacist shall contact the prescriber to clarify the order and have the order specified in millimoles.
    2. If the order is changed, the pharmacist shall rewrite a strip order based on verbal communication with the prescriber to clarify the changes.

D. The pharmacist shall dispense the medication compounded according to the standard diluents, volume, and rate specified for each electrolyte in the Guidelines and Policy.

    1. If the order specifies a non-standard diluent, volume, or rate, the pharmacist shall contact the prescriber to clarify the order.
    2. Non-standard solutions will be only compounded if clinically indicated and if deemed compatible and appropriate by the pharmacist.
    3. If the order is changed, the pharmacist shall rewrite a strip order based on verbal communication with the prescriber to clarify the changes.

E. The medication label shall specify the dose amount, volume, and infusion rate for each electrolyte according to the specifications for each electrolyte in the Guidelines and Policy.
F. The nurse should infuse the medication over the time period specified on the label.
G. If a discrepancy related to these guidelines cannot be resolved by the physician, pharmacist, and nurse, the attending physician shall be contacted. If further assistance is required, the Chair of the Pharmacy and Therapeutics Committee shall be contacted.
H. The Pharmacy Department shall save and periodically review inappropriate orders for electrolytes and provide a report to the Medication Safety Committee. Prescribers who consistently write inappropriate orders shall be contacted by the Medication Safety Committee and provided education to improve prescribing habits.

VII. Continuing Care

- Ongoing assessment for side effects of electrolyte administration.
- Monitor IV site every one hour.