

High Dose IV Vitamin C Pharmacology: Ascorbate and Electrolytes

Paul S. Anderson

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Interventional Study: HDIVC and Electrolyte Shifts

In an interventional study associated with BIORC and AMSA we attempted to answer the questions regarding electrolyte shifts and HDIVC administration.

Anderson P., Naydis E., Standish L. (2011, November). *High Dose IV Ascorbic Acid Therapy: the Bastyr Experience*. Poster session presented at the Society for Integrative Oncology, Cleveland, OH.

Electrolyte shift Concerns with HDIVC:

- Hypocalcemia
- Hypokalemia
- Hyponatremia
- Hypochloremia

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Support?

- Hypocalcemia
 - Ugh...
 - ASC is a “weak Ca⁺⁺ chelator” (Plasma →Urine) ...
 - Cheraskin E; Nutritional aspects of urolithiasis; South Med J. 1981 Jan;74(1):41-3, 46.

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Support?

- Hypokalemia
 - Up-regulated GLUT transport = Up-regulated Na/K ATPase activity → Rapid cellular K⁺ Uptake
 - Li and Schellhorn; New Developments and Novel Therapeutic Perspectives for Vitamin C; J. Nutr. 137: 2171–2184, 2007.

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Support ?

- Hyponatremia
 - Without other additives the 'stock' C-500 generally carries a higher sodium load due to the sodium hydroxide used for USP buffering.
- 25 Gram
 - Calculated Na⁺: 2750 mg
- 50 Gram
 - Calculated Na⁺: 5500 mg
- 75 Gram
 - Calculated Na⁺: 8250 mg

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Support ?

- Hypochloremia:
- With infusion generally high in Na without compensating Cl- we expect a shift in Cl downward while the Na increases.

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Expectations:

- Post IVC electrolytes:
 - Na Increase
 - Cl Decrease
 - Ca Decrease
 - K Decrease

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Questions:

- How much change?
- How long does it last?
- How potentially dangerous is this?
- How can we mitigate these effects?

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Base IVC Formula

- For research purposes we were attempting to emulate the 'modified Drisko protocol' which had minimal additives:

Carrier Solution:	Sterile Water
Vitamin C:	C-500 (commercial 500 mg / mL)
Magnesium Sulfate:	50% MgSO ₄

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High Dose IVC and Electrolyte changes data:

Baseline:

- Na (N=135-145)
 - Mean = 140
- Cl (N=98-111)
 - Mean = 102
- Ca (N=8.5-10.5)
 - Mean = 9.1
- K (N=3.5-5.4)
 - Mean = 4.1

Directly post IVC:

- Na
 - Mean = 147.3 (**HIGH**)
- Cl
 - Mean = 90.25 (**LOW**)
- Ca
 - Mean = 8.4 (**LOW**)
- K
 - Mean = 4.58 (**Normal**)

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Study Conclusions

- After informed consent, and a number of interventions to discover an improved formula:
 - We altered the constituents of the HDIVC formulae to negate most of these electrolyte shifts.
 - We ran a crossover group once the new formulae were in place. The crossover group returned to the original imbalances, and these resolved when we crossed the patients back to the new formula.
- Those study validated formulae are included below.

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High Dose IVC and Electrolyte changes data - New Formula

Baseline:

- Na (N=135-145)
 - Mean = 140
- Cl (N=98-111)
 - Mean = 102
- Ca (N=8.5-10.5)
 - Mean = 9.1
- K (N=3.5-5.4)
 - Mean = 4.1

Directly post IVC:

- Na
 - Mean = 144.93 (**Normal**)
- Cl
 - Mean = 94.59 (**LOW**)
- Ca
 - Mean = 8.64 (**Normal**)
- K
 - Mean = 4.70 (**Normal**)

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High Dose IVC and Electrolyte changes data - New Formula

Na /Cl Ratio

- **Ideal: $(140/104) = 1.35 = \text{range } 36$**
- **Old Formula: $(146/90)$**
 - **Range = 56 – Likely increases cardioactive side effects.**
- **New Formula: $(145/94)$**
 - **New formula diminishes the ratio after IV by 14%**

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- The following four IV Vitamin C formulas are used for oxidative therapies.
- The additional minerals have been adjusted and calculated to decrease any blood chemistry changes inherent in high dose IVC therapies and were derived through pre and post IVC blood chemistry analysis (see previous data).
- **The chloride form of the mineral additives is critical to this balance.**
- **pH on these formulas generally runs 6.0 – 6.5: but should be checked periodically.**

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Rx: 25 Gram IVC

500 mL	SWI	
50 mL	C-500 (25 grams)	
1	Calcium Chloride (1.36 mEq)	
2	Magnesium Chloride (3.94 mEq)	
1	Potassium Chloride (2 mEq)	

Total Volume: 554 mL

Osmolarity: 545 mOsm/L

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Rx: 50 Gram IVC

500 mL	SWI
100 mL	C-500 (50 Grams)
3	Calcium Chloride (4.08 mEq)
5	Magnesium Chloride (9.85 mEq)
4	Potassium Chloride (8 mEq)

Total Volume: 612 mL Osmolarity: 1001 mOsm/L

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Rx: 75 Gram IVC

750 mL	SWI
150 mL	C-500 (75 grams)
4	Calcium Chloride (5.44 mEq)
7	Magnesium Chloride (13.79 mEq)
6	Potassium Chloride (12 mEq)

Total Volume: 917 mL Osmolarity: 1006 mOsm/L

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Rx: 100 Gram IVC

1000 mL	SWI
200 mL	C-500 (100 Grams)
5	Calcium Chloride (6.8 mEq)
10	Magnesium Chloride (19.7 mEq)
8	Potassium Chloride (16 mEq)

Total Volume: 1223 mL Osmolarity: 1007 mOsm/L