ASCORBIC ACID (VITAMIN C) INFUSION IN THE RESUSCITATION OF BURN PATIENTS

SUMMARY

Free radicals have emerged as important mediators for burn injury at the cellular level. Continuous ascorbic acid (Vitamin C) infusion appears to be a useful adjunct in minimizing the effects of free radical injury and reduces fluid resuscitation requirements among burn patients.

RECOMMENDATIONS

- **Level 1**
  - **None**
- **Level 2**
  - **Consider a continuous ascorbic acid (Vitamin C) infusion (66 mg/kg/hr for 24 hours) among burn patients sustaining injury ≥ 30% total body surface area (TBSA).**
  - **Infusion should be begun within six (6) hours of burn injury.**
  - **The fluid volume associated with the ascorbic acid infusion should be included in the total volume of fluid resuscitation calculated according to the Parkland Formula.**
- **Level 3**
  - **Total fluid volumes should be adjusted to maintain a urine output of 50-100ml/hr.**
  - **Once ascorbic acid infusion is begun, point of care (POC) glucose testing results should be considered inaccurate for at least 36 hours after completing the infusion.**
  - **Blood glucose should be monitored using serum glucose levels whenever ascorbic acid infusions are in use.**
  - **Prior to resuming POC glucose testing, POC and serum glucose levels must be demonstrated to agree.**

INTRODUCTION

Effective fluid resuscitation of the burn patient is the cornerstone of initial patient management. As research has advanced concerning the biochemical basis of burn trauma, the role of free radicals in potentiating injury at the cellular level has been elucidated (1). Ascorbic acid (Vitamin C) has been investigated as a means to minimize free radical injury and consequently reduce fluid volume requirements during burn resuscitation.

LITERATURE REVIEW

The Role of Free Radicals

Following burn injury, an up-regulation of xanthine oxidase triggered by histamine leads to the formation of oxygen free radicals resulting in significant cell injury. This is enhanced by impairment in native antioxidant mechanisms and additional free-radical production by neutrophils (1, 2).

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

Ascorbic Acid Infusion - Animal Studies

A randomized, double-blinded study in sheep demonstrated a significant reduction in net fluid balance and plasma lipid peroxidation among sheep sustaining a 40% TBSA burn who were resuscitated with either Lactated Ringer's solution or hypertonic saline in conjunction with a high-dose infusion of ascorbic acid (3).

Ascorbic Acid Infusion – Human Studies

A randomized, prospective study by Tanaka et al. evaluated the use of continuous ascorbic acid infusion in burn patients using a group of 37 patients with greater than 30% TBSA burns. Investigators compared resuscitation fluid volume requirements and overall edema formation. A significant reduction in fluid volume requirements, weight gain, and wound edema was noted, along with an overall improvement in pulmonary function, demonstrated by a significant reduction in mechanical ventilation days (4).

Guidelines for Infusion

The available Class I data indicates ascorbic acid should be infused at 66mg/kg/hr for the initial 24 hours of burn resuscitation. The appropriate solution may be prepared by mixing 25 grams of ascorbic acid in 1000 mL of Lactated Ringer's solution (resulting in a 25 mg/mL concentration). The solution bag should be covered with a black bag to prevent light-induced auto-oxidation.

Expert Opinion

Experience with ascorbic acid at this institution demonstrates an apparent diuretic effect. It is recommended that intravenous fluid rates be adjusted to maintain a urinary output during the initial resuscitation period of 50 to 100ml/hr to compensate for any ascorbic acid-induced diuresis. Point of care (POC) testing for blood glucose levels has been shown to be inaccurate during the period of ascorbic acid infusion. Since significant levels of serum ascorbic acid have been noted in human subjects up to 36 hours after the initiation of vitamin C infusion, it is recommended that serum specimens be used for blood glucose monitoring for at least 36 hours following discontinuation of the ascorbic acid infusion (3). POC testing should not be resumed until POC glucose levels has been shown to correlate with serum glucose measurements.

REFERENCES

1. Till GO, Guilds Ls, et al. Role of xanthine oxidase in thermal injury of skin. *Am J Pathol* 1989;135:195-202.
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3. Dubick MA, Williams C, et al. High-dose Vitamin C infusion reduces fluid requirements in the resuscitation of burn-injured sheep. *Shock* 2005; 24:139-144.
4. Tanaka H, Takayoshi M, et al. Reduction of resuscitation fluid volumes in severely burned patients using ascorbic acid administration. *Arch Surg* 2000; 135:326-331.