

Title: IONIZED HYPOCALCEMIA FOLLOWING FRESH FROZEN PLASMA ADMINISTRATION TO THERMALLY INJURED CHILDREN

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INTRODUCTION

Ionized hypocalcemia following i.v. citrated blood products is well known; however, no studies have examined the effects of fresh frozen plasma (FFP). Because FFP -- also stored in citrate preservative -- can be infused at more rapid rates than whole blood, the development of hypocalcemia is of special concern. Burned patients have a tendency toward chronically low ionized calcium values and may be particularly sensitive to the toxicity of citrate. We therefore undertook an institutionally approved prospective study of the response of burned children to infusions of FFP administered when clinically indicated.

METHODS

All children ≥ 10 kg body weight who had sustained more than 15% body burns, scheduled for excision and grafting, were considered candidates for study. Written informed consent was obtained from the parents of each child. Each patient was monitored with an arterial line, EKG, temperature, end-tidal CO_2 monitor, and, in most cases, CVP. Ventilation was controlled to maintain normal acid-base balance. Patients received either 1.0, 1.5, 2.0, or 2.5 ml/kg min FFP administered by constant infusion pump via peripheral vein for 5 min. Ionized calcium $[\text{Ca}^{++}]$ was determined at baseline, 1, 2, 3, 4, 5, 6, and 10 min; a continuous recording was made of BP, EKG, and, where possible, CVP. No other citrate-containing products were given during the study period. Some patients were studied on more than one occasion and some were pretreated with 5 mg/kg calcium chloride (CaCl_2) 1 min prior to FFP infusion.

RESULTS

Twenty-one patients were studied on 33 occasions. The mean age was 6.5 yr (range 1-17), weight, 26.8 kg (range 11.5-70) and percent burn, 48.6 (range 20-97). Twelve patients were anesthetized with $\text{N}_2\text{O}-\text{O}_2$, supplemented by morphine 0.2-0.5 mg/kg, while the remainder had halothane 0.25-0.75% (16), or enflurane 0.25-1.0% (5). Six patients received 1.0 ml/kg/min FFP, 8 received 1.5 ml/kg/min, 5 received 2.0 ml/kg/min, and 4 received 2.5 ml/kg/min. Ten patients were pretreated with CaCl_2 . There was a highly significant decrease in $[\text{Ca}^{++}]$, the nadir of which occurred at 5 min (Table). Pretreatment with CaCl_2 did not significantly alter this effect but did seem to prevent changes in BP. There was a wide variation in individual patient responses.

Although, in the entire group, changes in hemodynamic variables did not reach a statistically significant level, there were clinically important BP changes in some patients. These responses were very evanescent as were the $[\text{Ca}^{++}]$ values both of which increased within 1 min of ending the infusion.

TABLE

| FFP Rate (ml/kg/min) | N | MAP (Mean \pm SD) | | Greatest % Δ MAP | $[\text{Ca}^{++}]$ (mM/L) | |
|-------------------------|----|------------------------|-------------|----------------------------|------------------------------|-------|
| | | 0" | 5" | | 0" | 5" |
| 1.0 | 6 | 79 \pm 9 | 69 \pm 8 | 23.7 | 1.16 | 0.98* |
| 1.0 | 5† | 85 \pm 21 | 85 \pm 18 | 6.1 | 1.20 | 1.08* |
| 1.5 | 8 | 83 \pm 8 | 77 \pm 10 | 26.1 | 1.20 | 0.87* |
| 1.5 | 5† | 85 \pm 16 | 83 \pm 15 | 8.5 | 1.11 | 0.88* |
| 2.0 | 5 | 75 \pm 19 | 75 \pm 23 | 9.2 | 1.11 | 0.77* |
| 2.5 | 4 | 93 \pm 10 | 87 \pm 9 | 19.3 | 1.05 | 0.71* |

† = 5 mg/kg CaCl_2 pretreatment

* $P < 0.001$ compared to baseline

DISCUSSION

FFP contains the greatest amount of citrate per unit volume of any blood product and should cause the greatest change in $[\text{Ca}^{++}]$. Our studies have found greater decreases in $[\text{Ca}^{++}]$ in children following FFP compared to similar studies done in adults receiving citrated whole blood at similar administration rates.¹ Clinically significant cardiovascular effects, i.e., $> 20\%$ decrease in BP, were only occasionally observed during rapid short infusions of FFP. Pretreatment with calcium prior to FFP infusion did not significantly alter the decrease in $[\text{Ca}^{++}]$ produced by citrate, although it did blunt BP changes.

CONCLUSIONS

- (1) In this patient group responses to a citrate load were variable but always transient. Occasionally an important decrease in arterial blood pressure is observed.
- (2) Pretreatment with CaCl_2 (5 mg/kg) is helpful to avoid this change in blood pressure at these infusion rates.
- (3) Blood pressure correlated poorly with $[\text{Ca}^{++}]$.

Reference

1. Stulz PM, Scheidegger D, Drop LJ, et al: J Thorac Cardiovasc Surg 78: 185-194, 1979