

Evaluation of electrolyte imbalances in patients receiving massive transfusion protocol

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Introduction

- Hemorrhagic shock management may require activation of a massive transfusion protocol (MTP) to administer large volumes of blood products quickly.
- MTP can lead to complications, such as electrolyte abnormalities and coagulopathy, with hypocalcemia being the most common.¹
- Hypocalcemia can cause further complications, such as QT_c prolongation, hypotension, pulseless electrical activity (PEA), and ventricular fibrillation (VF).
- Carilion Clinic has implemented an MTP; however, calcium repletion is provider-driven, using varying doses and dosage forms.

Methods

Objective

- To evaluate the incidence of electrolyte imbalances within 48-hours post MTP

Study Design

- Single-center, retrospective review of all MTP patients
- Health Care Delivery Improvement Project
- Time period: January 2020 – December 2021
- Carilion Roanoke Memorial Hospital, a 763-bed tertiary care facility located in Roanoke, VA

Study Endpoints

- 1^o endpoint: Incidence of hypocalcemia within 48-hours post MTP
- 2^o endpoints: Individual incidence of hyperkalemia, hypokalemia, hypomagnesemia, hypernatremia, and hyperchloremia; incidence of coagulopathy (defined as having at least one of the following, PT or PTT greater than 1.5 times the upper limit of normal (ULN) or an INR greater than 1.5); median number of blood product units administered; total amount of calcium chloride-equivalent repletion; and the incidence of adverse events, QT_c prolongation and cardiac arrest.
- All end points evaluated within 48-hours post MTP

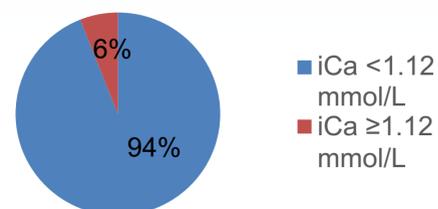
Data Collection and Statistics

- EPIC electronic medical record chart review
- Descriptive and inferential statistics with Microsoft Excel

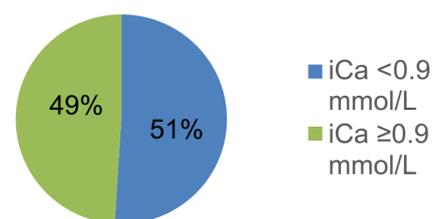
Results

Baseline Characteristics	N=100
Age, years, median (IQR)	53 (33-67)
Male gender, n (%)	68 (68%)
Race (Caucasian), n (%)	74 (74%)
Source of bleed, n (%)	
Trauma	56 (56%)
GI bleed	18 (18%)
Operative bleeding	10 (10%)
Other	16 (16%)
PTA anticoagulants, n (%)	10 (10%)
Hospital length of stay, median (IQR)	7.9 (3.3-16.2)
ICU length of stay, median (IQR)	3.8 (1.2-6.4)
In-hospital mortality, n (%)	38 (38%)
≤48hrs Post-MTP	22 (57.9%)

Rates of Hypocalcemia ≤48hrs Post-MTP



Rates of Severe Hypocalcemia ≤48hrs Post-MTP



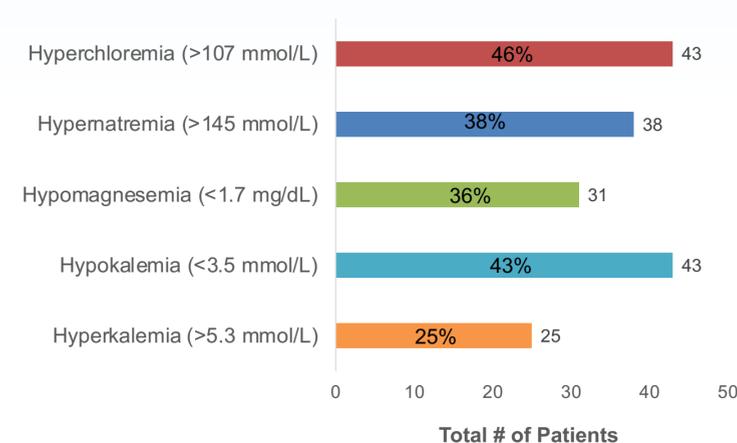
Calcium monitoring and replacement ≤48hrs post-MTP

Received calcium replacement, n (%)	88 (88%)
No calcium replacement, n (%)	12 (12%)
Calcium repletion before iCa results, n (%)	37 (42%)
Calcium repletion after iCa results, n (%)	51 (58%)
Total calcium, CaCl ₂ (g), median (IQR)	2.0 (1.0-3.0)
CaCl ₂ (g), median (IQR)	1.0 (0-2.0)
Ca Gluc (g), median (IQR)	0 (0-2.0)

Results

Blood product administration	
Total blood product units, median (IQR)	13 (8.8-21.3)
Total whole blood units, median (IQR)	0 (0-2)
Total pRBC units, median (IQR)	6 (4-10.5)
Total FFP units, median (IQR)	5 (2-7)
Total platelets units, median (IQR)	1 (1-2)
Total cryoprecipitate units, median (IQR)	0 (0-1)
Reversal agents given	
Kcentra, n (%)	12 (12%)
Tranexamic acid, n (%)	28 (28%)
Protamine, n (%)	7 (7%)

Rates of Additional Electrolyte Abnormalities ≤48hrs Post-MTP



Additional Secondary Endpoints ≤48hrs post-MTP

Coagulopathy , n (%)	35 (42.7%)*
PT >1.5 ULN, n (%)	15 (18.8%)
PTT >1.5 ULN, n (%)	19 (26.0%)
INR >1.5, n (%)	29 (36.3%)
QT_c ≥500 (msec), n (%)	9 (9.0%)
QT _c ≥500, median (IQR)	516.5 (507.5-543)
Hypocalcemia, n (%)	9 (100%)
Severe hypocalcemia, n (%)	5 (55.6%)
Cardiac arrest , n (%)	21 (21%)
Hypocalcemia	20 (95.2%)
Severe hypocalcemia, n (%)	16 (76.2%)

* n=82

Discussion

- MTP was most often activated in trauma patients (blunt, 34%; penetrating, 22%), followed by patients with GI bleeding.
- There were high rates of hypocalcemia (94%) and severe hypocalcemia (51%) within 48 hours of MTP.
 - 88% received calcium repletion.
 - This most often occurred after serum ionized calcium levels resulted (58%)
 - In those who received calcium supplementation, 2g of CaCl₂ was most often administered
- Most patients received a median of 13 units of blood products, with pRBC and FFP being utilized the most.
- Adverse events occurred in 9% and 21% for QT_c prolongation and cardiac arrest, respectively.
 - Higher ADE rates seen in those with electrolyte imbalances (hypocalcemia, hyperkalemia, and hyperchloremia).
- Patients received approximately 1.5g CaCl₂ for every 12 units of blood product received, still resulting in high rates of hypocalcemia.

Conclusions

- Our findings suggest that calcium repletion should occur more proactively and aggressively.
- Formal calcium repletion guidance in our MTP may be beneficial and should be considered.
- Based on this study, 1g of CaCl₂ or 2g of calcium gluconate will be recommended to be supplemented for every 4 units of pRBC and/or FFP administered.
- Other electrolytes should be monitored closely and repleted/treated, as necessary.
- Limitations:** Lack of baseline iCa values, retrospective data collection, small sample size.

Disclosure

Authors of this presentation have the following to disclose concerning possible financial or personal relationships with commercial entities that may have a direct or indirect interest in the subject matter of this presentation:
Names: Nothing to disclose

References

1. Sihler K, Napolitano L. Complications of Massive Transfusion. CHEST. 2010; 137 (1): 209-220.

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