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Effects of calcium changes during the first 24 hours of resuscitation after major trauma: A preplanned subanalysis from a multicenter prospective study

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Introduction

Calcium is a key factor for multiple clotting factors and cardiac contractility.

Previous retrospective data suggests that hypocalcemia may be detrimental in the setting of trauma.

A multicenter prospective study found that calcium derangements – both high and low – are detrimental with hypercalcemia on arrival being associated with worse outcomes than hypocalcemia on arrival after major trauma.

Objectives

The objective is to understand the effects of calcium changes over the course of 24 hours after major trauma.

Methods

Patients were prospectively enrolled at three level 1 trauma centers – Brooke Army Medical Center, University Hospital at the University of Texas Health San Antonio, and the University of Colorado Hospital at the University of Colorado Anschutz Medical Campus.

Ionized calcium measurements were captured immediately upon arrival to the emergency department (ED) and at 3, 6, 12, 18, and 24 hours after trauma center arrival.

We used a normal reference range of 1.10 – 1.30 mmol/L.

Results

Table 1: Participant characteristics

Variable	1 Always eucalcemic (n=259)	2 Start eucal only hypocal change (n=333)	3 Start eucal only hyper change (n=56)	4 Start eucal both change (n=67)	5 Always hypocal (n=33)	6 Start hypocal only eucal change (n=141)	7 Start hypocal only hyper change (n=11)	8 Start hypocal both change (n=67)	9 Start hypercal, only eucal change (n=23)	10 Start hypercal - all others (n=28)
Male sex	214 (82.6%)	255 (76.6%)	45 (80.4%)	57 (85.1%)	22 (66.7%)	105 (74.5%)	7 (63.6%)	57 (85.1%)	18 (78.3%)	22 (78.6%)
Age	38 [26-56]	35 [26-51]	35 [21-51]	32 [24-46]	44 [32-62]	35 [26-48]	32 [20-52]	30 [22-49]	41 [22-62]	33 [18-48]
Mechanism of injury										
MVC	87 (33.6%)	164 (49.3%)	26 (46.4%)	38 (56.7%)	11 (33.3%)	51 (36.2%)	4 (36.4%)	22 (32.8%)	9 (39.1%)	16 (57.1%)
GSW*	69 (26.6%)	45 (13.5%)	15 (26.8%)	20 (29.9%)	6 (18.2%)	51 (36.2%)	6 (54.6%)	32 (47.8%)	8 (34.8%)	5 (17.9%)
Other penetrating	44 (17.0%)	30 (9.0%)	4 (7.1%)	4 (6.0%)	7 (21.2%)	13 (9.2%)	1 (9.1%)	7 (10.5%)	3 (13.0%)	2 (7.1%)
Fall	40 (15.4%)	44 (13.2%)	7 (12.5%)	2 (3.0%)	7 (21.2%)	14 (9.9%)	0 (0.0%)	3 (4.5%)	2 (8.7%)	2 (7.1%)
Other blunt	8 (3.1%)	30 (9.0%)	2 (3.6%)	1 (1.5%)	1 (3.0%)	6 (4.3%)	0 (0.0%)	2 (3.0%)	1 (4.4%)	1 (3.6%)
All others	11 (4.3%)	20 (6.0%)	2 (3.6%)	2 (3.0%)	1 (3.0%)	6 (4.3%)	0 (0.0%)	1 (1.5%)	0 (0.0%)	2 (7.1%)
Composite ISS*	10 [5-22]	18 [10-27]	24 [14-33]	26 [17-34]	12 [5-26]	21 [12-29]	28 [17-34]	22 [17-30]	14 [9-25]	28 [19-41]
AIS by body region										
Head	3 [1-5]	3 [1-4]	4 [1-5]	3 [0-5]	1 [1-4]	4 [1-5]	4 [1-5]	1 [0-4]	1 [0-4]	3 [1-4]
Neck	1 [0-2]	0 [0-1]	0 [0-3]	0 [0-0]	0 [0-0]	0 [0-3]	0 [0-0]	0 [0-1]	0 [0-1]	0 [0-2]
Face	1 [1-2]	1 [0-2]	1 [1-2]	1 [0-2]	1 [1-2]	1 [1-2]	1 [0-2]	1 [0-1]	1 [0-1]	1 [1-2]
Chest	2 [1-3]	3 [2-3]	3 [2-3]	3 [2-4]	2 [1-4]	3 [2-3]	1 [0-3]	3 [0-3]	2 [1-3]	3 [2-4]
Abdomen	1 [0-2]	2 [1-3]	2 [0-4]	3 [1-4]	2 [1-4]	2 [1-3]	4 [0-5]	3 [1-4]	2 [2-3]	2 [2-4]
Upper extremity	1 [1-2]	1 [1-2]	1 [0-2]	2 [1-2]	1 [1-2]	1 [1-2]	1 [0-2]	2 [1-2]	1 [0-2]	2 [1-2]
Lower extremity	2 [1-3]	2 [1-3]	2 [0-3]	2 [1-3]	2 [1-3]	3 [1-3]	1 [0-2]	2 [1-3]	1 [1-2]	3 [1-3]
Spine	2 [0-2]	2 [0-2]	2 [1-2]	1 [0-2]	2 [2-2]	2 [0-2]	0 [0-0]	1 [0-2]	2 [0-3]	2 [0-2]
External/skin	1 [0-1]	1 [0-1]	1 [0-1]	0 [0-1]	1 [0-1]	1 [0-1]	1 [0-1]	0 [0-1]	0 [0-0]	1 [0-1]
Interventions										
Calcium*	56 (21.6%)	139 (41.7%)	42 (75.0%)	42 (62.7%)	9 (27.3%)	83 (58.9%)	6 (54.6%)	46 (68.7%)	9 (39.1%)	15 (53.6%)
Any blood	2 [1-3]	2 [1-3]	3 [2-4]	2 [2-4]	2 [1-8]	2 [1-3]	5 [3-11]	3 [2-6]	3 [2-3]	6 [4-6]
>/=3 units of any product*	0 [0-0]	0 [0-1]	2 [1-3]	2 [0-4]	0 [0-1]	1 [0-2]	1 [0-3]	2 [0-5]	0 [0-1]	3 [0-6]
>/=10 units of any product*	56 (21.6%)	139 (41.7%)	42 (75.0%)	42 (62.7%)	9 (27.3%)	83 (58.9%)	6 (54.6%)	46 (68.7%)	9 (39.1%)	15 (53.6%)

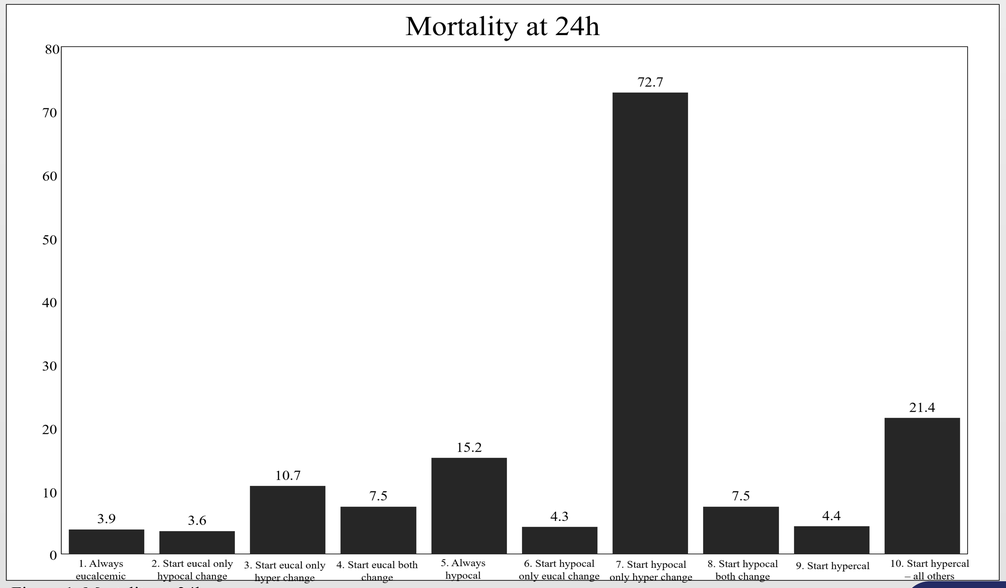

Figure 1. Mortality at 24h

Table 2: Participant survivability

Variable (per patient)	Survived to 30 days Median [IQR] (n=845)	Died within 30 days Median [IQR] (n=173)	p
Number of Ca measurements	6.0 [3.0-8.0]	7.0 [4.0-10.0]	0.0010*
Percent change from previous Ca value	5.4 [2.9-9.0]	7.0 [3.5-13.5]	<.0001*
Number of Ca readings <1.1 mmol/L	1.0 [0.0-2.0]	1.0 [0.0-3.0]	0.7318
Number of Ca readings >1.3 mmol/L	0.0 [0.0-0.0]	0.0 [0.0-2.0]	<.0001*
Number of Ca readings high or low	1.0 [0.0-3.0]	2.0 [1.0-5.0]	0.001*
Percent of Ca readings <1.1 mmol/L	20.0 [0.0-44.4]	16.7 [0.0-41.7]	0.5233
Percent of Ca readings >1.3 mmol/L	0.0 [0.0-0.0]	0.0 [0.0-25.0]	<.0001*
Percent of Ca readings high or low	28.6 [0.0-50.0]	36.4 [12.5-66.7]	0.0022*

Conclusions

Serum calcium derangements upon arrival and during the first 24 hours conferred worse survival.

Arrival hypocalcemia with subsequent hypercalcemia conferred the lowest survival.

Our findings suggest that perturbations – high or low – may be detrimental.

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