20 YEARS OF ACUTE TRAUMATIC COAGULOPATHY

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Introduction: The term "Acute Traumatic Coagulopathy" (ATC) to describe post injury coagulation dysfunction was first published in 2003. Treatment of ATC has fundamentally changed in the last two decades with Major Hemorrhage Protocols – balanced resuscitation, pre-hospital transfusions and empiric tranexamic acid. However, the impact of contemporary trauma care on the incidence of ATC and associated outcomes has not been fully described. Our objective was to determine current rates of ATC and their relationship to ISS and clinical outcomes, for comparison with seminal data published 20 years earlier.

Methods: Retrospective study of adult patients at a Level 1 UK trauma centre (2012-21). Data was extracted from the trauma registry for all patients ISS and admission INR (excluded if no INR result; ATC INR>1.2) and compared with 2003 published data of 1088 HEMS trauma patients (57% ISS>15) admitted to the same centre (ATC = abnormal PT, aPTT or Thrombin Time). Multivariate analysis was performed to examine relationship of ATC and ISS with mortality.

Results: 19,025 patients (2012-21) were analyzed. Median age 36 years, 78% male, 26% penetrating injury, median ISS 9 (1-16) with 25% ISS>15. Overall ATC incidence was 9% and for ISS>15 ATC ranged from 11-21% (with no trend over time 2012-21) vs 33% (2003), p<0.05. Overall mortality was 4.8%, and for ATC was significantly lower compared to 2003: 23% vs 46%, p<0.05 (Figures 1A & 1B). For ISS>15, ATC was significantly associated with increased mortality x4 (2012-21) vs x3 (2003) and after adjusting for ISS in the 2012-21 cohort, ATC had OR 5.3 (4.5-6.3) for death (p<0.05). x

Conclusion: Contemporary trauma care has improved outcomes from ATC over the last 20 years with lower overall admission rates. Risk of death in ATC remains high despite modern empirical approaches to pre-hospital transfusion and antifibrinolytics. Further opportunities for improvement require more targeted and precision therapy for ATC.

WITHDRAWN

EARLY LIQUID PLASMA IS A SAFE ALTERNATIVE FOR BALANCED TRANSFUSION

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Introduction: Bleeding trauma patients benefit from early plasma administration with balanced transfusion ratios. Availability of plasma in the ED has been limited by the time needed to thaw fresh frozen plasma (FFP). Our institution adopted a liquid plasma (LQP) protocol to facilitate early plasma administration upon patient arrival. This study compares our pre- and post-protocol implementation transfusion outcomes.

Methods: This was a retrospective study evaluating a LQP protocol implementation one year pre- and post-implementation at a Level 1 trauma center. Patients 16 years or older who received blood in the ED were included. Patients with systolic BP <90mmHg received transfusions. Pre-LQP resuscitation protocol was transfusion of 2 units pRBCs, post-LQP protocol was 1U pRBC and 1U LQP, each could be repeated once before MTP initiation. The primary outcome was total blood products transfused in 24 hours. Secondary outcomes included death from exsanguination in 24 hours, 30-day mortality, and transfusion related complications (TRALI, ARDS, VTE). A subgroup analysis was performed for the primary outcome for patients who received massive transfusion, or >10 units in 24 hours. A negative binomial generalized linear model was used to assess the outcomes.

Results: 552 total patients were included in the study, 275 in the pre-LQP period (January 2018 to July 9th 2019) and 277 in the post-LQP period (July 11th 2019 to January 2020). There were no major differences in demographics across groups. Median ISS was 22 with primarily blunt injury (75%). There was no effect of LQP protocol on number of blood products transfused in first 24 hours in either the full (p=0.45) or MTP subgroup (p=0.91), and no differences in any secondary mortality outcomes or transfusion-related complications.

Conclusion: Early LQP had no impact on 24-hour blood product usage but is safe to use with no higher rates of mortality, VTE, TRALI or ARDS. LQP may be a more rapid, balanced transfusion alternative to FFP for centers without access to whole blood.

FLOW RATE OF 1:1:1 TRANSFUSION HAS A MODULATING AFFECT ON INFLAMMATORY RESPONSE FOLLOWING INJURY

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Introduction: Past research has shown that transfusion flow rate of PRBCs alone impacts the expression of multi-functional cytokines (IL-6, IL-8, IL-1ra, IL-10, IP 10, MIP1b, MCP-1 and RANTES) independent of injury burden. PRBC transfusion rarely happens in isolation in acute injury and FFP, platelets and cryo may also modulate the inflammatory response. The purpose of this study was to assess the flow rate of matched ratio transfusion strategies and their effect on the inflammatory response to trauma.

Methods: This study utilized severely injured patients from the PROPPR dataset. Volumes of PRBC, FFP, platelets and cryo were calculated for time increments over the first 24 hours after injury. Using linear growth models controlling for aspects of severe injury (mechanism, demographics, measures of injury and shock), key cytokines were modeled against incremental transfusion volumes /time (flow rate) of combined blood products.

Results: 538 patient were included. Expression of IL-6, IL-1ra, IP-10, MCP-1, MIP-1b, RANTES and PDGF were affected by transfusion flow rate (Table). Other cytokines were not affected.

Conclusion: The flow rate of multiple blood products, delivered in a matched fashion, modulates the immune response. This impact was particularly notable with pro-inflammatory IL 6 and chemokines. Though transfusion patterns may not be amenable to manipulation, awareness of the impact of such transfusion strategies on inflammatory response may allow opportunities to modulate the inflammatory response and impact patient care.

Cytokine	PRBC (SE)	FFP (SE)	Platelets (SE)	Cryo (SE)
Pro-Inflammatory				
IL 6	**1.47 (1.21, 1.79)** **p=0.0485**	**0.75 (0.67, 0.83)** **p=0.0073**	**2.42 (1.57, 3.71)** **p=0.0399**	1.11 (0.75, 1.64) p=0.7927
Anti-Inflammatory				
IL 1ra	**1.55 (1.29, 1.87)** **p=0.0160**	0.91 (0.82, 1.01) p=0.3450	**2.58 (1.75, 3.82)** **p=0.0155**	0.76 (0.53, 1.10) p=0.4609
Chemokines				
IP 10	0.89 (0.79, 1.02) p=0.3906	0.96 (0.89, 1.03) p=0.5593	**2.29 (1.72, 3.04)** **p=0.0037**	0.94 (0.73, 1.22) p=0.8160
MIP 1b	1.03 (0.90, 1.19) p=0.8180	1.00 (0.99, 1.01) p=0.9790	0.92 (0.70, 1.25) p=0.7968	**1.76 (1.32, 2.34)** **p=0.0473**
MCP 1	**1.41 (1.21, 1.65)** **p=0.0259**	0.90 (0.82, 0.98) p=0.1993	1.43 (1.02, 2.00) p=0.2899	1.45 (1.07, 1.97) p=0.2267
RANTES	**0.66 (0.57, 0.76)** **p=0.0037**	**1.18 (1.09, 1.28)** **p=0.0371**	0.77 (0.56, 1.06) p=0.4149	**0.51 (0.38, 0.67)** **p=0.0167**
Growth Factor				
PDGF	**0.57 (0.46, 0.71)** **p=0.0093**	1.09 (0.97, 1.22) p=0.4718	1.54 (0.98, 2.40) p=0.3385	0.49 (0.32, 0.75) p=0.0939

IMPACT OF EARLY WHOLE BLOOD VERSUS COMPONENT BLOOD RESUSCITATION ON OUTCOMES AND RESOURCE UTILIZATION IN PATIENTS WITH TRAUMATIC SHOCK

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Introduction: Recent military experience has led to a renewed interest in Whole Blood (WB) vs. Component Blood (CB) resuscitation for traumatic shock. Results of civilian studies examining mortality are mixed and there is paucity of studies evaluating morbidity and resource utilization. The current study compares in-hospital mortality, morbidity, and resource utilization for WB vs. CB resuscitation in patients with traumatic shock.

Methods: The National Trauma Data Bank (NTDB: 2020-21) was queried for adult patients receiving early (<4 hours) blood-based resuscitation. Only patients who received either WB or CB exclusively were included and compared by univariate and multivariate regression analysis. Outcomes of interest were in-hospital mortality, morbidity, and resource utilization.

Results: 89,676 patients met inclusion (WB: 6,101; CB: 83,575). WB patients had lower mortality, blood resuscitation volume, acute kidney injury (AKI), and resource utilization [need for Renal Replacement Therapy (RRT), ventilator, ICU, and hospital days – all p<0.05: Table]. On multivariate regression analysis, controlling for group differences, WB resuscitation was independently associated with decreased odds of mortality, AKI, RRT need, ventilator, and ICU days (Figure).

Table	WB	CB	p
Mean Age (years)	44.2	46.3	<0.05
Median ISS	17	20	<0.05
RTS	7.1	7.6	>0.05
Mortality (%)	10.7	17.8	<0.05
Blood Res. Vol. (ml)	912	2204	<0.05
AKI (%)	1.5	3.1	<0.05
RRT need (%)	1.0	1.7	<0.05
Ventilator days	6.3	6.7	<0.05
ICU days	7.4	8.0	<0.05
Hospital days	12.1	12.9	<0.05
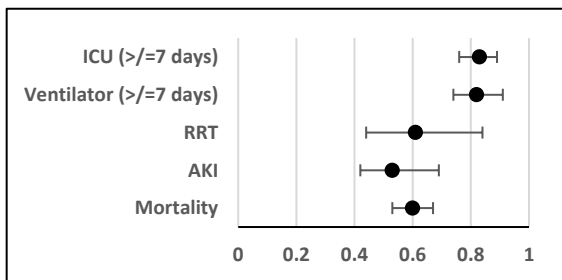
Conclusion: Early resuscitation with WB exclusively vs CB results in lower mortality, morbidity and resource utilization in patients with traumatic shock.

MIASURVIVEMTP: MACHINE LEARNING FOR IMMEDIATE ASSESSMENT AND SURVIVAL PREDICTION AFTER MASSIVE TRANSFUSION PROTOCOL

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Introduction: Trauma patients requiring massive transfusion (MTP) face high likelihood of mortality. Early identification of patient's chances of survival may help limit futile blood product administration in cases of exsanguinating hemorrhage and may assist in appropriate triaging of these patients.

Methods: Patients from the American College of Surgeons Trauma Quality Improvement Project database (TQIP) who received more than 5 units of red blood cells and/or whole blood within the first four hours of arrival were identified as MTP patients. Those receiving 10 or more units were identified as ultramassive transfusion (UMT) patients. Database variables that were not available immediately or within seconds of arrival were excluded. Machine learning (ML) models were created to predict 6-hour mortality. Models were trained and optimized using fivefold cross validation and a holdout testing set.

Receiver Operating Characteristic - 6 Hour Mortality

UMT (AUROC = 0.863)
MTP (AUROC = 0.900)

Results: Of 5,481,046 patients in TQIP from 2017 to 2021, 47,744 received MTP and 20,337 of these received UMT. 6-hour mortality was 21.9% in the MTP group and 29.9% in the UMT group. A gradient-boosted decision tree model performed best in both the MTP and UMT groups with area under the receiver-operator curve of 0.900 [95% CI 0.892-0.908] and 0.863 [95% CI 0.850-0.875] respectively (Figure 1), and an area under the precision recall curve of 0.76/0.75 respectively.

Conclusions: ML models reliably predict mortality in both MTP and UMT patients with data available immediately upon trauma center arrival. This is the most accurate ML MTP prediction model trained with the largest training data set described to date. This model is designed to be further improved over time as more patients are added to this national registry. Such an approach can help improve patient selection in MTP/UMT scenarios and optimize the distribution of this limited resource.
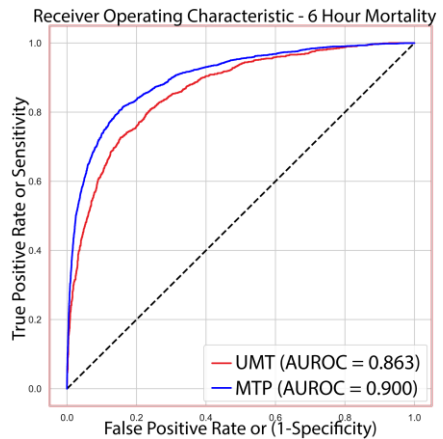
OCCULT HYPOPERFUSION IN TRAUMA PATIENTS: A SYSTEMATIC REVIEW ON AGE-SPECIFIC CLINICAL OUTCOME

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Introduction: Occult hypoperfusion (OH) is defined as normal vital signs and inadequate tissue oxygenation. OH is associated with poor outcome after trauma. However, the effect of age is unclear. The aim of this study is to determine the impact of OH on outcome in polytrauma in both middle-aged and geriatric patients.

Methods: Adult polytrauma patients (ISS >16) were extracted from our prospectively maintained trauma database. Two groups were composed and compared: a group of MIDdle-aged people (30-59yrs) and OLDer adults (60+yrs). We further distinguished between cases of OH: Lactate > 2 mmol/l plus SBP > 90 mmHg and PR < 120 bpm, shock-cases (SBP < 90 or PR > 120) and regular cases (all other patients). We analyzed the impact of hemodynamic status on outcome in both groups (MIDdle aged vs. OLDer adults). Outcomes included: Intensive Care Unit (ICU)-stay, length of stay (LOS), complication rates and mortality.

Results: A total of 1,782 patients were included. The group MID. Included 1,067 patients, whereas 715 individuals were selected for the OLD-group. In the MIDdle-aged study group, ICU-stay (P=0.43), LOS (P=0.80) did not differ between shock and OH patients. As anticipated, highest mortality rates were found in the shock patients (39%). Mortality was also significantly higher in the OH-group than in normal patients (20 vs. 8%, P >0.05). In the OLD-group mortality and hospitalization times were significantly higher higher upon shock than in the groups. However, no differences were observed between OH-patients and normal trauma patients.

Conclusion: This study shows that occult hypoperfusion is associated with increased mortality in middleaged patients. In older patients (>60yrs), however, no difference in morbidity nor mortality was found between OH and non-OH trauma patients. These findings contradict the literature. It is tempting to hypothesize that in the case of severe polytrauma, OH is an important risk factor for impaired outcome in middle-aged patients, but not in older patients. The role of OH in different age groups should be investigated in future prospective studies of severely injured trauma patients.

THE EFFECT OF PARTIAL REBOA CATHETERS ON HEMORRHAGE-RELATED DEATH: AN ANALYSIS OF THE AAST AORTA REGISTRY

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Introduction: Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a resuscitative adjunct used to temporize non-compressible hemorrhage. Partial aortic occlusion is a strategy used to mitigate ischemic complications by titrating flow across the aortic balloon. Next generation partial REBOA (pREBOA) catheters are designed to accurately titrate complete or partial aortic occlusion, and have been used across North American centers of excellence. This study evaluates whether the choice of catheter is associated with hemorrhage-related mortality, defined as death within 6 hours.

Methods: The AORTA registry was queried to identify all adult trauma patients undergoing successful endovascular aortic occlusion (AO) in the emergency department or operating room from Jan 2020 to Jan 2024. Patients identified as dead-on-arrival or with a shock index <0.6 were excluded. Primary outcome was 6-hour mortality. Multi-level cox regression was used, adjusting for institution, year, shock index, ISS, mechanism, and zone of AO.

Results: 273 cases across 26 institutions were included (n=142 REBOA vs. 131 pREBOA). There were no differences in sex, age, ISS (33 IQR 22-42), AO zone (65% zone 1), or time to AO (29 mins IQR 20-50). The use of pREBOA catheters increased by year and was associated with longer durations of AO (median 45 IQR 30-78 vs. 36 mins IQR 18-60, p=0.026), partial AO accounting for a substantial proportion of AO time (median 31 mins IQR12-65). Mortality at 6-hours was 22% (REBOA 28% vs. pREBOA catheters 16%, p=0.02). pREBOA catheters were independently associated with a 70% decreased risk-adjusted hazards of 6-hour mortality (HR 0.30, 95%CI 0.15-0.60).

Conclusion: The use of pREBOA catheters was associated with a decreased hazards of death from hemorrhage. These findings support the ongoing prospective study of pREBOA as a resuscitative strategy for select patients with hemorrhagic shock.
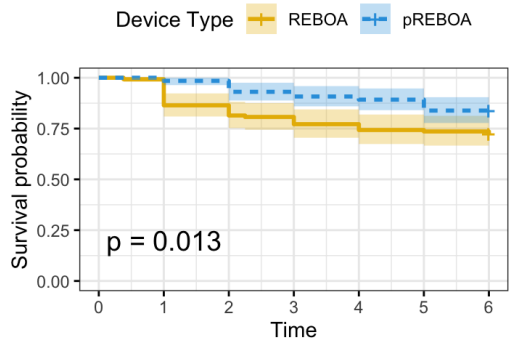
HR 0.30, 95%CI 0.15-0.60. Adjusted for institution, year, shock index, ISS, mechanism, and zone of aortic occlusion

TIME MATTERS: THE EFFECT OF PREHOSPITAL TXA AND TRANSPORT TIME ON MORTALITY

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Introduction: Current data on tranexamic acid (TXA) supports early use in hemorrhagic shock, yet the ideal population for pre-hospital TXA has not been elucidated. While timing of TXA administration has been thoroughly examined, the effect of total transport time (TTT) has not been studied in those that receive pre-hospital TXA. Therefore, we sought to evaluate the effect of pre-hospital TXA in patients with a long TTT.

Methods: The trauma registry at a large, mixed-catchment, level I trauma center was queried for patients who did and did not receive pre-hospital TXA over a 3.5 year period. Demographics, TTT, transfusions, complications, and mortality were evaluated. Univariate and multinomial analyses were utilized to evaluate predictors of mortality.

Results: During the study period, 8,352 patients were included with 5,833 having a short (≤1 hour) and 2,519 a long (>1 hour) TTT. Patients were primarily male (64%), with a blunt mechanism (85%), had a median TTT of 50 min, a median ISS of 9, and a mortality rate of 6%. There was no significant difference in transfusions, ISS, or mortality between patients with short or long TTTs. Multinomial logistic regressions were performed on groups with short and long TTTs with the primary outcome of mortality. Pre-hospital TXA in short TTT patients was not associated with a difference in mortality. However, pre-hospital TXA administration in those with a long TTT was associated with decreased mortality in patients receiving blood and who were severely injured (table).

Conclusion: In patients requiring transfusions and those that are severely injured with a TTT >1 hr, the use of pre-hospital TXA is associated with improved outcomes. TXA should be considered in bleeding or severely injured patients with a longer TTT, but may not provide benefit in those with quicker access to definitive care.

Impact of TXA on Mortality in Long TTT Patients			
	aOR	95% CI	P-Value
All Patients (N=2,519)	3.429	[0.907, 12.958]	0.069
Transfused Patients (N=358)	5.46	[1.158, 25.749]	0.032
ISS > 15 (N=757)	6.553	[1.266, 33.929]	0.025

WHOLE BLOOD TRAUMA RESUSCITATION IN CHILDBEARING AGE FEMALES: PRACTICE PATTERNS AND TRENDS

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Introduction: The use of low titer group O whole blood (LTOWB) in bleeding trauma patients is increasingly common. However, some centers do not administer RhD-positive LTOWB to females <50 due to concerns about RhD-negative patients becoming D-alloimmunized. This study examined practices related to LTOWB transfusion as they pertain to age and sex using a large prospectively collected database.

Methods: This was a secondary analysis of the Shock, Whole blood, and Assessment of TBI (SWAT) trial: a prospective, multicenter observational cohort study where outcomes following transfusion to 1046 injured patients were analyzed at 7 level 1 trauma centers between 2018-2021. The proportion of patients who received LTOWB or exclusively conventional components (CT) was examined over the course of the original study and stratified by age and sex. We characterized the RhD-types of females <50 and surveyed the RhD-blood product selection practices for trauma patients at these centers.

Results: A total of 1046 patients were evaluated; 130 females <50, 77 females ≥50; 661 males <50, and 178 males ≥50. Of females <50 13/128 (10.2%) were RhD-negative. Of females <50, 34/130 (26.2%) received LTOWB including 4/33 (12.1%) who were RhD-negative. In contrast, 587/916 (64%) of all other recipients received LTOWB. RhD blood product selection practices varied considerably between institutions, e.g., only 1/7 centers stocks RhD-negative LTOWB, and 1/7 centers does not transfuse RhD-positive LTOWB to adult females <50. Multiple strategies for deciding which patients should receive RhD-positive or negative LTOWB and CT in initial resuscitation as well as the use of D-alloimmunization prophylaxis for RhD-negative females <50 after receipt of RhD-positive blood were reported. Over the study period, the percentages of females <50 who received LTOWB between 2018-2021 were 0%, 28.3%, 35.1% and 25.0%.

Conclusion: There were fewer than the expected 15% of RhD-negative females <50 in this cohort of patients. Most institutions transfused LTOWB to females <50 but these patients were less likely to receive LTOWB than other recipients. As the understanding of safety of RhD-positive products in females <50 improves, the reasons why a lower proportion of females <50 compared to other patient groups received LTOWB need to be elucidated.