Blood lactate after pre-hospital blood transfusion for major trauma by helicopter emergency medical services

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Background

- In the setting of trauma and suspected critical bleeding, indications to commence or continue blood transfusions remain unclear, with high rates of potentially avoidable transfusions.

- Prehospital vital signs can predict need for in-hospital blood transfusions.[1]

- Blood lactate measurements could help to predict the need for blood transfusions.

Aims and hypothesis

- The aims of this study were to:
- Evaluate, among patients who had pre-hospital blood transfusion, variables, including lactate levels, with ongoing transfusion in hospital.
- We hypothesised that higher lactate levels would be associated with ongoing blood transfusions.
- This would inform a prospective trial of measuring lactate levels prior to and after pre-hospital transfusion.

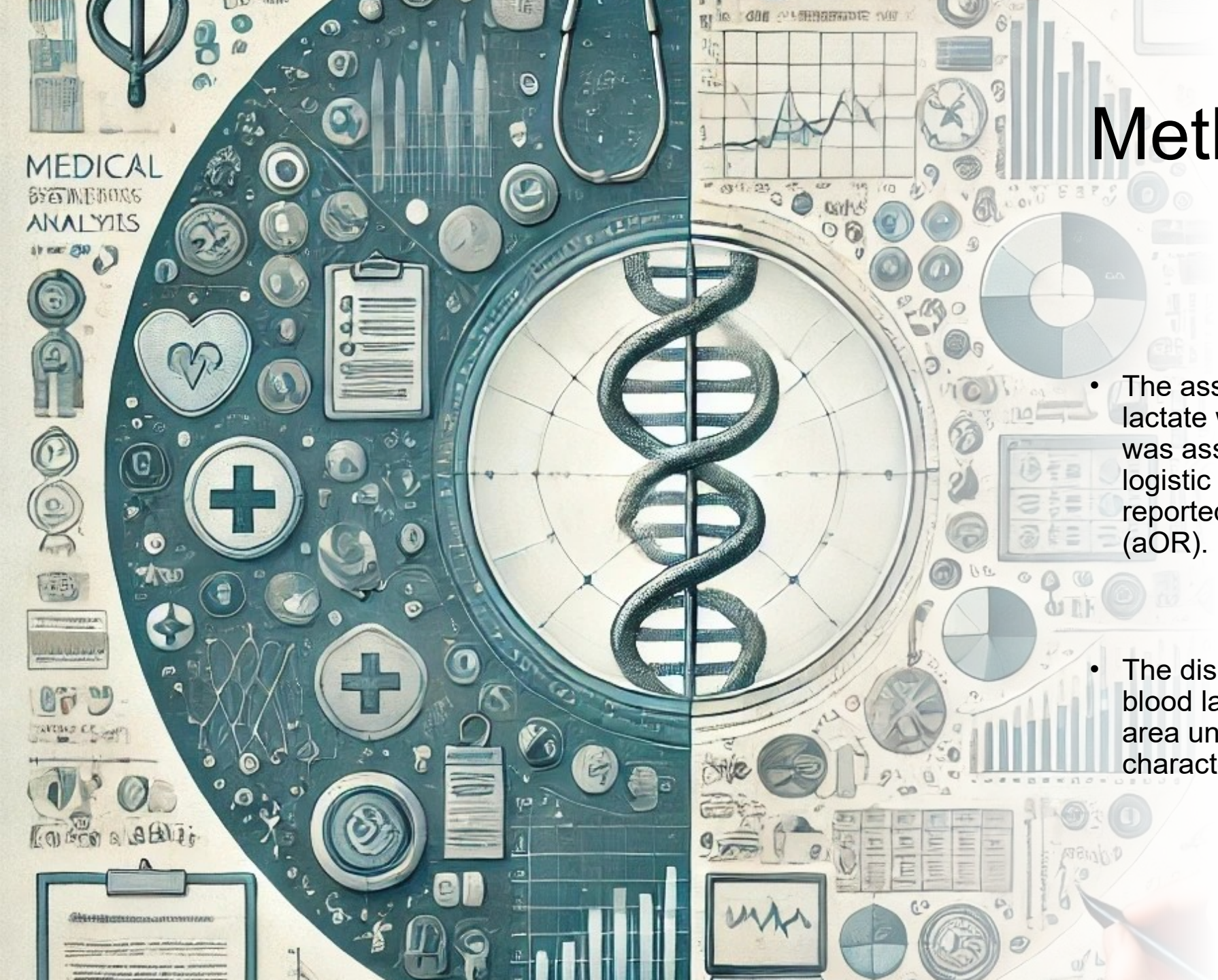
Methods

- The study was approved by The Alfred Hospital Human Research and Ethics committee (study ID 4/20) and Ambulance Victoria Research Committee (Project ID 20–009). The requirement to seek informed consent from patients was waived.
- Patients were eligible for inclusion into this study if transported by Ambulance Victoria Helicopter Emergency Medical Service to The Alfred Hospital, between 1 January 2016 and 15 May 2019 and received at least one unit of pre-hospital RBC.
- Patients were excluded if they could not be matched to hospital records, did not have a blood lactate recorded on arrival to the emergency department (ED) or died within 1 h of arrival to the ED and without any further transfusion.

Methods

- The primary outcome variable was transfusion of at least one unit of RBC within 4 h of arrival in hospital.

- The primary independent variable was a measure of venous blood lactate level measured immediately on hospital arrival. Blood lactate was not measured in the pre-hospital phase of care. First available vital signs were extracted. The heart rate and blood pressure were combined to calculate the shock index.



Methods

- The association of venous blood lactate with ongoing RBC transfusion was assessed using multi-variable logistic regression analysis and reported using adjusted odds ratios (aOR).
- The discriminative ability of venous blood lactate was assessed using area under receiver operating characteristics curve (AUROC).

Results

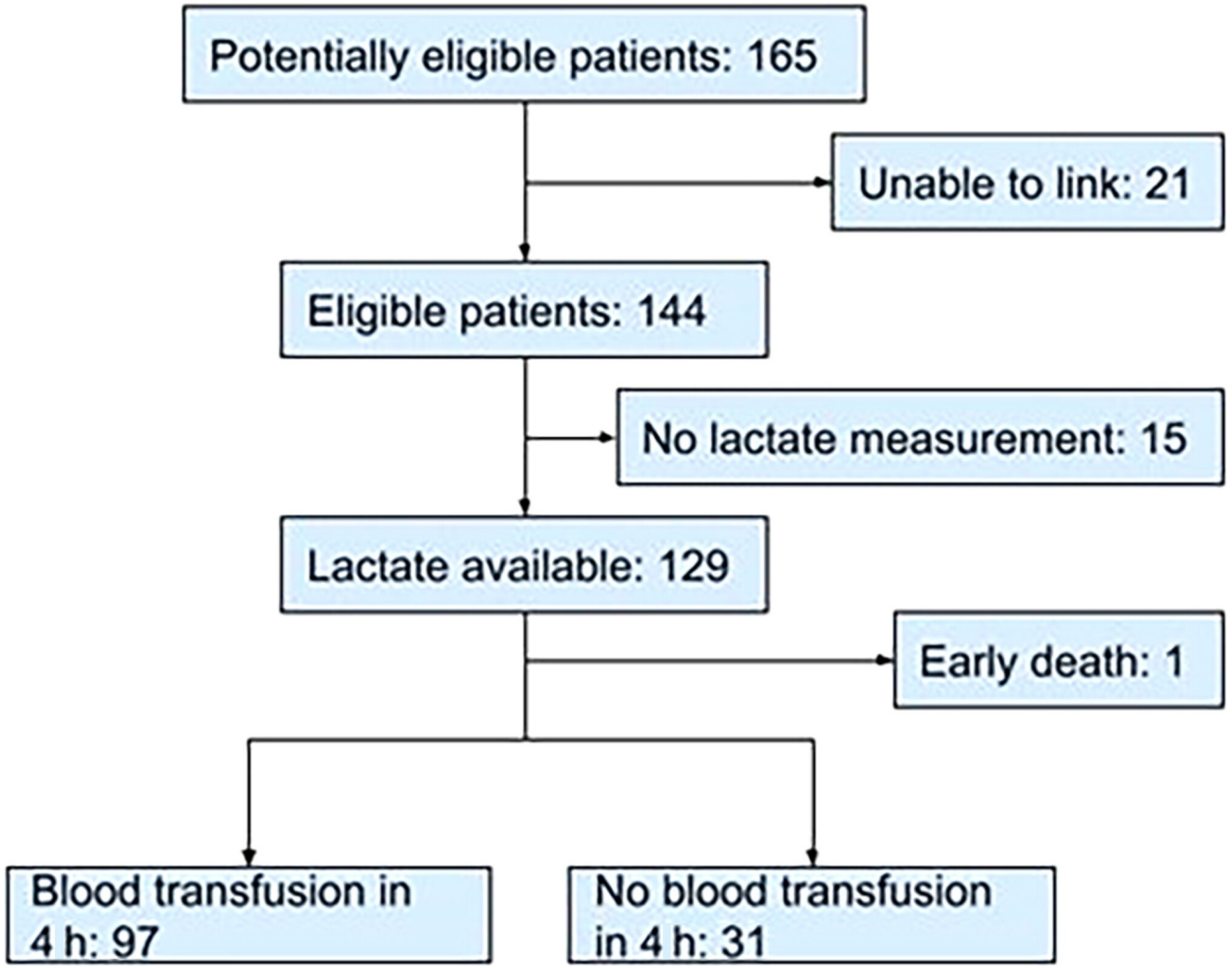
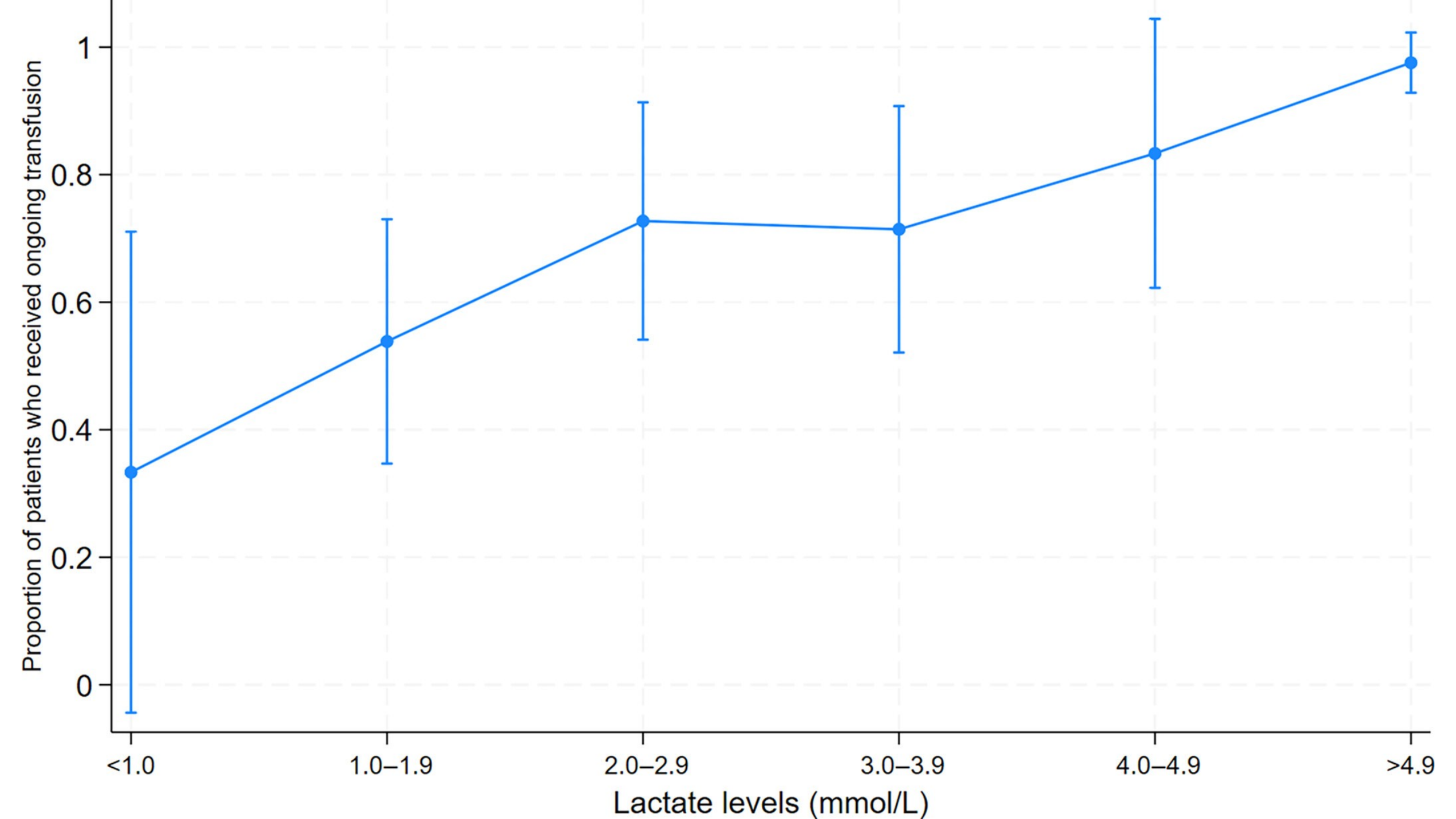

Potentially eligible patients: 165
Unable to link: 21
Eligible patients: 144
No lactate measurement: 15
Lactate available: 129
Early death: 1
Blood transfusion in 4 h: 97
No blood transfusion in 4 h: 31

TABLE 1. Pre-hospital patient characteristics sub-grouped by hospital transfusion.

	Ongoing hospital transfusion (*n* = 97)	No hospital transfusion in first 4 h (*n* = 31)	*p* value
Age			0.049
<25 years	20 (20.6%)	3 (9.7%)	
25–34 years	21 (21.7%)	3 (9.7%)	
35–49 years	24 (24.7%)	5 (16.1%)	
50–64 years	17 (17.5%)	10 (32.3%)	
≥65 years	15 (15.5%)	10 (32.3%)	
Sex			0.42
Male	76 (78.4%)	27 (87.1%)	
Female	21 (21.6%)	4 (12.9%)	
Total pre-hospital time, min; median (IQR)	147 (121–186)	170 (116–266)	0.08
Transport time, min; median (IQR)	32 (23–49)	45 (25–75)	0.07
Mechanism of injury			0.011
Motor vehicle crash	73 (75.3%)	17 (54.8%)	

Results

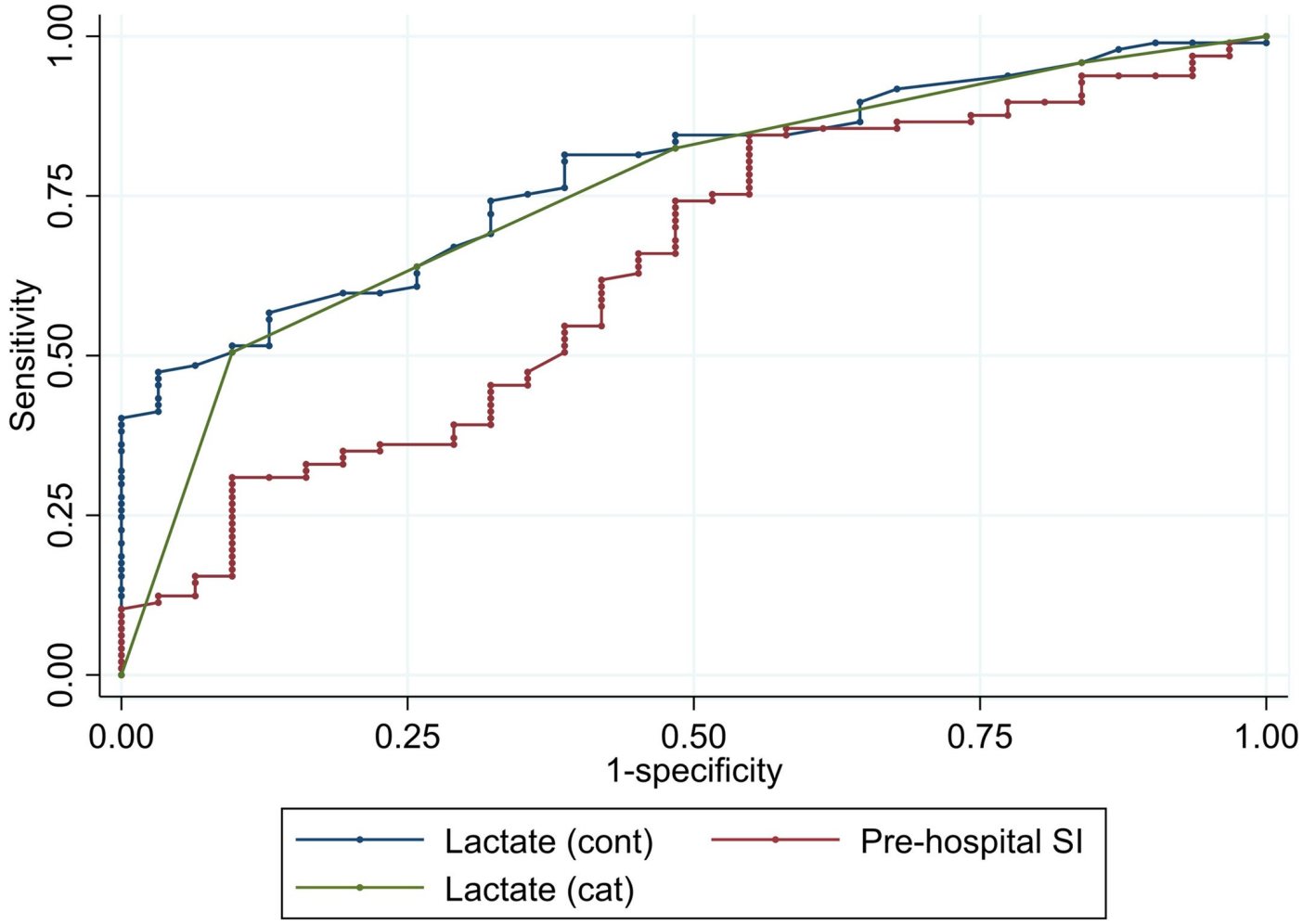
- From 1 January 2016 to 15 May 2019, there were 165 eligible patients, and 128 patients were included.
- In-hospital transfusion occurred in 97 (75.8%) of patients.
- Blood lactate was associated with ongoing RBC transfusion (aOR: 2.00; 95% confidence interval [CI]: 1.36–2.94).
- Blood lactate provided acceptable discriminative ability for ongoing transfusion (AUROC: 0.78; 95% CI: 0.70–0.86).


Proportion of patients who received ongoing transfusion
0
0.2
0.4
0.6
0.8
1
<1.0
1.0–1.9
2.0–2.9
3.0–3.9
4.0–4.9
>4.9
Lactate levels (mmol/L)

Results

- The AUROC for blood lactate (continuous) was 0.78 (95% CI: 0.70–0.86), which was similar to blood lactate (categorized) with an AUROC of 0.76 (95% CI: 0.66–0.85); $p = 0.06$.

- The AUROC for pre-hospital SI to discriminate patients administered hospital RBC was 0.63 (95% CI: 0.52–0.75), which was significantly poorer compared with the AUROC for blood lactate (continuous; $p = 0.008$).



Discussion

- Clinical gestalt appears to outperform most clinical scores, and this study generates the hypothesis that blood lactate levels could be considered in decision making for the initiation of major haemorrhage protocols

- Blood lactate should not be the only biomarker or indicator for pre-hospital transfusion. Current physiological markers of systolic blood pressure, combined with clinical assessment of ongoing haemorrhage are likely to have ongoing importance in transfusion decision-making

Limitations

- Selection bias of patients who arrived alive in hospital.
- It is possible that ongoing improvements in pre-hospital care using blood components, particularly for those with long pre-hospital times, could improve survival.
- In future studies, the addition of such critically bleeding patients who are expected to have high blood lactate could further improve specificity of lactate for transfusion.
- Data on clinical gestalt of paramedics were not collected and could provide better diagnostic capacity for ongoing blood product transfusion.

Conclusions

- After pre-hospital blood transfusion for major trauma, 97 patients (75.8%) received ongoing blood component therapy after hospital admission.
- Higher blood lactate, measured after pre-hospital blood transfusion, was associated with ongoing red blood cell transfusion.
- Lactate levels after pre-hospital transfusion could be used as a biomarker for activation of major haemorrhage protocols.
- Two further studies i) at journal, ii) underway

Acknowledgements

- TAC for their grant to support acquisition of equipment and support data analysis
- Alfred Hospital clinicians
- Ambulance Victoria for in-kind support
- Monash University Department of Paramedicine
- Emergency Research Unit, Monash University School of Public Health and Preventive Medicine

Take a picture of the QR code to read the full study

ORIGINAL ARTICLE

Vox Sanguinis ISBT

Blood lactate after pre-hospital blood transfusion for major trauma by helicopter emergency medical services

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Comparison of point-of-care and laboratory blood lactate levels in critically bleeding major trauma patients

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Background

- In the setting of trauma and suspected critical bleeding, indications to commence blood transfusions remain unclear, with high rates of potentially avoidable transfusions.

- Prehospital vital signs can predict need for in-hospital blood transfusions.[1]

- Prehospital blood lactate measurements could help to predict the need for blood transfusions.[2]

Background

- Hand-held, portable, lactate analysers are available. Such devices have been validated in healthy volunteers and in critically ill patients in the intensive care setting.

- However, the physiological derangements in the emergency setting of critical bleeding after trauma are vastly different.

- Prior to introduction to prehospital use, it was considered essential to establish that lactate measurements using POC devices correlate to formal laboratory lactate levels (gold standard).[3]

Aims and hypothesis

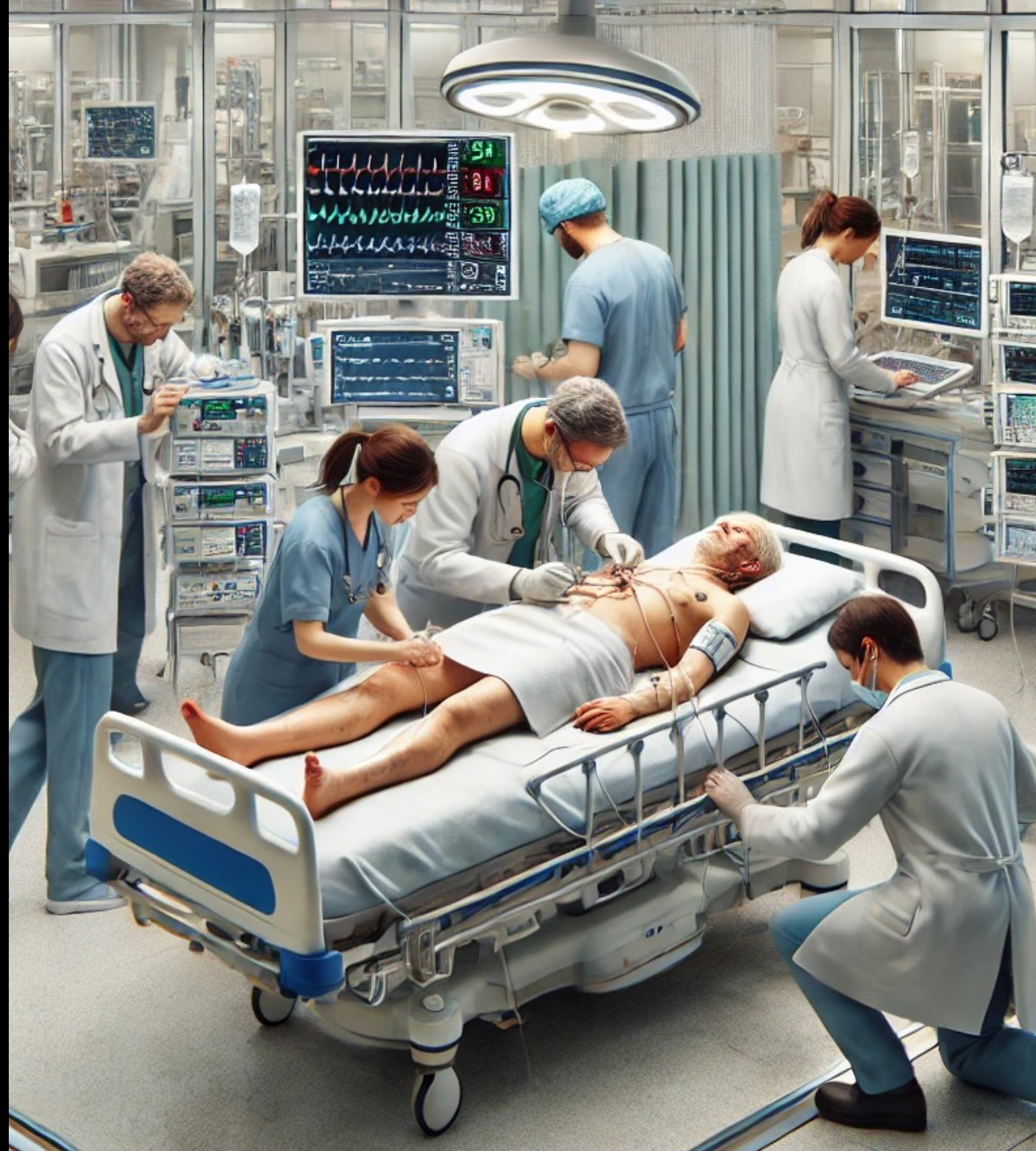
- The primary aim of this study was to compare measurements detected by a POC lactate device with laboratory measured lactate levels, when conducted using the same sample of blood.

- In addition, we aimed to report the association of lactate levels with blood transfusions.

- We hypothesised that there would be no significant difference between POC and lab lactate, and that lactate levels would be associated with blood transfusion.

Methods

- The study was approved by The Alfred Hospital Human Research and Ethics Committee (Project ID 260/23). The requirement to seek informed consent from patients was waived.
- This was a cross-sectional study conducted in the emergency department.
- Blood samples were collected from the patient in an untreated syringe during trauma reception, and a drop of blood was used to measure the lactate level using the POC device.
- At the same time, a sample was collected into a fluoride oxalate vacuum tube and forwarded to the pathology laboratory for lactate level testing.
- Arterial or venous samples were obtained, with the same sample tested in the laboratory.



Methods

- Patients were eligible for this study if suspected to have major trauma, were adults (age ≥18 years), transported or presented directly from the scene of trauma and had suspected critical bleeding. The suspicion of critical bleeding was based on a shock index ≥ 1.0,[4] or the activation of a major haemorrhage protocol.
- POC measurements of lactate levels were conducted using a StatStrip Xpress® lactate meter. The device has a reported measurement range of 0.3-20.0 mmol/L and is entered in the Australian Register of Therapeutic Goods (Identification number 197482).

Methods

- We aimed to detect a maximum 20% values outside the limits of agreement between lactate levels measured by the POC device and laboratory lactate levels. The estimated sample size was 67 patients using α of 0.05 and 80% power.
- The Bland-Altman plot was used to provide a measure of agreement for the two different methods.
- Using the POC measurements, we assessed the performance of POC lactate levels for transfusion of red blood cells. Area under receiver operating characteristic (AUROC), with specificity and sensitivity at each cut-off were reported. A p-value of <0.05 was defined to be statistically significant.

Results

- There were 72 patients enrolled, with paired data available for 70 patients.
- Samples were obtained at a median of 80 (IQR 55-154) minutes after injury.
- Most patients were male and injured by a blunt mechanism consistent with local trauma epidemiology.

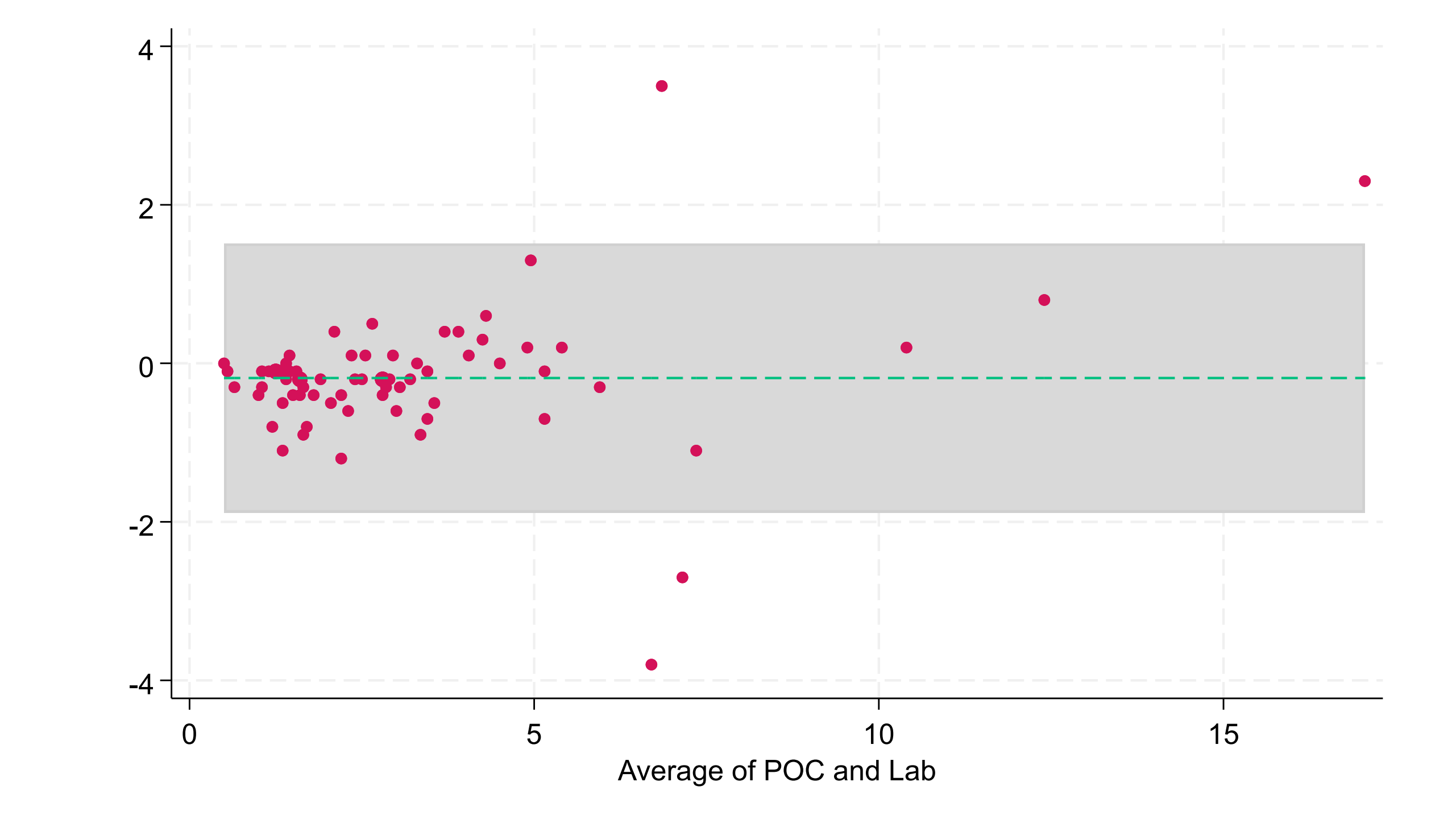
Baseline characteristics of patients

Variable	Summary
Age (years)- mean (SD)	47.4 (19.8)
Sex	
- Male	51 (72.9%)
- Female	19 (27.1%)
Injury Severity Score*	
- 0-12	39 (56.5%)
- 13-25	20 (29.0%)
- 26-45	5 (7.3%)
- >45	5 (7.3%)
Injury type†	
- Blunt	59 (84.3%)
- Penetrating	12 (17.1%)
Anticoagulant use prior to trauma	6 (8.6%)
Initial heart rate (beats/min)- mean (SD)	103.0 (26.4)
Initial systolic blood pressure (mmHg)-mean (SD)	97.5 (31.2)
GCS	
- 3-8	20 (28.6%)
- 9-12	8 (11.4%)
- 13-15	42 (60.0%)

* Missing data for 1 patient; †One patient had both types of injury

Results

- The average lactate measures were between 0.5 and 17.05 mmol/L.
- The mean difference between the two lactate results for each patient was -0.19 mmol/L, with limits of agreement at -1.9 and 1.5; that is, the POC device might deliver a lactate result 1.9 less or 1.5 greater than the laboratory lactate.
- Most measurements (n=66; 94.3%) were within the limits of agreement.


4
2
0
-2
-4
0
5
10
15
Average of POC and Lab

Results

- There were 37 (52.9%) patients who were managed with blood transfusions. Among those transfused, a median of 4 (IQR 3-8) units of red cells, 4 (IQR 2-6) units of fresh frozen plasma and 1 (IQR 0-2) pooled platelet units were transfused.

- The AUROC for POC lactate levels to predict any blood component transfusion was 0.70 (95%CI: 0.57-0.82).

- A POC lactate level of >3.3 mmol/L had >90% specificity for transfusion, whereas a level <1.4 mmol/L had 90% sensitivity to rule out a transfusion.

Discussion

- The unique pathophysiology of critical bleeding trauma patients and potential coagulopathy may have altered POC measurements. This, however, was not proven, and POC lactate measurements correlated strongly with laboratory values.
- Decisions to initiate blood transfusions are currently based mainly on clinical gestalt, despite a number of prediction scores available.
- Blood tests such as the initial haemoglobin concentrations are not useful due to potential circulatory volume contractions.
- An early POC lactate therefore presents an attractive variable to contribute to this complex decision making.

Discussion

- A single lactate level cannot provide optimal cut-offs of both specificity and sensitivity. Instead, the negative predictive value of a low lactate level would be the clinically relevant measure, to rule out the need for blood transfusion.
- This study is limited in assessing correlation between venous or arterial samples only. POC lactate devices could use blood from capillaries, but results of capillary lactate levels cannot be generalised from this study.
- The decision to transfuse or withhold prehospital transfusion requires further studies to ensure patient safety is optimised.
- Critically bleeding trauma patients have dynamic pathophysiology, and a single measure of lactate is not necessarily reflective of bleeding.

Conclusions

- Point of care lactate levels in trauma patients suspected to have critical bleeding were similar to laboratory lactate levels.
- These findings support the use of POC lactate devices in the prehospital phase of care.
- Clinical decision rules for prehospital transfusion that incorporate lactate levels are feasible but require further research.

Acknowledgements

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- Monash University Department of Paramedicine
- Emergency Research Unit, Monash University School of Public Health and Preventive Medicine

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