Prognostic value of lactate in prehospital care as a predictor of mortality and high-risk patients with trauma

FRANCISCO MARTÍN-RODRÍGUEZ[1,3], RAÚL LÓPEZ-IZQUIERDO[2,3]

1 Advanced Medical Life Support Valladolid I, Prehospital Emergency Medical Services, SACYL. Valladolid. Spain. fmartin@saludcastillayleon.es
2 Emergency Department. Hospital Universitario Rio Hortega, SACYL. Valladolid. Spain. rlopeziz@saludcastillayleon.es
3 Advanced Clinical Simulation Center. Faculty of Medicine. Valladolid University. Valladolid. Spain.

* Corresponding autor:
Raúl López-Izquierdo, MD, PhD
Emergency Department. Rio Hortega University Hospital of Valladolid, SACYL. C/Dulzaina 2. 47012. Valladolid, Spain
e-mail: rlopeziz@saludcastillayleon.es; Mobile: 646557285

ABSTRACT

Objectives. Major injury is a time-dependent illness in which the quantification of the life prognosis is fundamental for professionals. The objective of this study is to evaluate the capacity of prehospital lactic acid to predict mortality (2, 7 and 30 days) and the admission to the Intensive Care Unit (ICU) from the index event.
Methods. This is a longitudinal, prospective observational study, which included patients who were treated by an Advanced Life Support Unit and transferred to the Emergency Department between April 1 and September 30, 2018. We calculated sensitivity, specificity, and likelihood ratios. The main outcome variable was mortality from any cause (2, 7 and 30 days) and admission to ICU.
Results. 109 patients were included in our study. Eleven patients (10%) experienced early mortality before the first 48 hours after the index event, with an ICU admission rate of 28%. The sensitivity and specificity of the test to determine mortality in less than two days was 63.6% (95% CI, 35.4-84.8%) and 87.8% (95% CI, 79.8-92.9%). Conclusions. Prehospital lactic acid has an excellent capacity to predict the mortality and the admission of patients with major injury to the ICU, and it is a cheap, easy-to-obtain and reliable diagnostic tool that can help in clinical decision-making.

Key words: Critical care; emergency department; outcome; survival; intensive care

INTRODUCTION

Major injury (MI) represents the sixth cause of death and the fifth cause of disability worldwide, most frequently caused by traffic accidents and work accidents.[1]
Prehospital Emergency Medical Services (PEMS) have developed operational and functional procedures to manage this pathology quickly and efficiently, but even today, few diagnostic means exist in the prehospital setting. Point-of-care testing (POCT) is easy, safe and cheap. It includes the prehospital lactic acid (PLA) value[2] as a very reliable indicator of anaerobic metabolism.[3-4]
MI is a time-dependent pathology, in which the early identification of gravity and potential evacuation to the most appropriate trauma centre may affect a decrease in morbidity and mortality.[5-6]
The main objective of this study is evaluating the capacity of the PLA to predict mortality (2, 7 and 30 days) and the admission to the Intensive Care Unit (ICU) from the index event.

MATERIAL & METHODS

Study design and setting

This is a longitudinal, prospective observational study, which included patients that were attended by an Advanced Life Support Unit (ALSU) in the city of Valladolid (Spain) and transferred to the Emergency Department (ED), between April 1 and September 30, 2018.

Study population

We considered that a patient met criteria to be included in the study if their pathology was of traumatic origin, had been transferred by an ALSU to the ED and did not meet any exclusion criteria, which were: being a minor, having non-traumatic pathology, cardiorespiratory arrest or death before or during the transfer (Figure 1).

Data collection

At the time of prehospital care, the PLA was determined in venous blood. To determine the levels of lactic acid, the Accutrend® Plus meter by Roche was used. Demographic variables (sex and age), epidemiological variables (aetiology and injury mechanism) and prehospital advanced life support manoeuvres were collected, which included use of supplementary oxygen, advanced airway management and use of intravenous medication.
At the hospital level, we analysed the destination in the hospital (discharge or admission), the need for ICU, days of admission and mortality.

Outcome measures and analysis

The main outcome variable was mortality from any cause (2, 7 and 30 days).
All data was stored in an XLSTAT® BioMED database for Microsoft Excel® (version 14.4.0.). The area under the curve (AUC) of the receiver operating characteristic (ROC) of the PLA was calculated in terms of mortality at 2, 7 and 30 days and for the need to enter ICU, as well as the best score that offered in each case greatest sensitivity and specificity. We also calculated for these scores the positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR) and negative likelihood ratio (NLR).

Ethical issues

The study was approved by the Ethical and Clinical Research Committees of all participating centres. All patients (or guardians) signed informed consent. The study

Table 1. Cut-off points of sensitivity and specificity with best score (Youden index) in terms of mortality (2, 7 and 30 days) and admission to ICU for PLA.

	2MD	7MD	30MD	ICU
Number [n (%)]	11 (10)	14 (13)	17 (16)	28 (26)
LAP (mmol/L) [Median (IQR)]	6.4 (4.1-7.6)	6.1 (4.4-7.9)	5.9 (3.7-7.4)	5.3 (3.4-7.1)
AUC [95% CI]	0.813 (0.65-0.97)	0.836 (0.70-0.97)	0.805 (0.67-0.93)	0.774 (0.66-0.88)
p value	< 0.001	< 0.001	< 0.001	< 0.001
Cut-offs (mmol/L)	5.9	4.1	4.1	4.9
Youden's J index	0,5	0.6	0.5	0.4
Se % [95% CI]	63.6 (35.4-84.8)	85.7 (60.1-96.0)	76.5 (52.7-90.4)	57.1 (39.1-73.5)
Sp % [95% CI]	87.8 (79.8-92.9)	71.6 (61.8-79.7)	71.7 (61.8-79.9)	84.0 (74.5-90.4)
PPV [95% CI]	36.8 (19.1-59.0)	30.9 (18.6-46.4)	33.3 (20.6-49.0)	55.2 (37.5-71.6)
NPV [95% CI]	95.6 (89.1-98.3)	97.1 (90.2-99.2)	94.3 (86.2-97.8)	85.0 (75.6-91.2)
LR (+) [95% CI]	5.20 (2.60-10.39)	3.02 (2.05-4.43)	2.71 (1.78-4.11)	3.56 (1.97-6.44)
LR (-) [95% CI]	0.41 (0.19-0.92)	0.20 (0.05-0.73)	0.33 (0.14-0.79)	0.51 (0.32-0.81)
OR [95% CI]	12.54 (3.19-49.30)	15.11 (3.17-72.05)	8.25 (2.46-27.64)	6.97 (2.68-18.13)
DA [95% CI]	85.3 (77.5-90.8)	73.4 (64.4-80.8)	72.5 (63.4-80.0)	77.1 (68.3-84.0)

2MD: 2 mortality days; 7MD: 7 mortality days; 30MD: 30 mortality days; ICI: intensive care unit; LAP: lactate acid prehospital; AUC: Area Under the Curve; CI: confidence interval; Se: Sensitivity; Sp: Specificity; PPV: positive predictive value: NPV: negative predictive value; TP: true positive; FP: false positive; TN: true negative; FN: false negative; LR: Likelihood ratio; OR: Odds ratio; DA: diagnostic accuracy
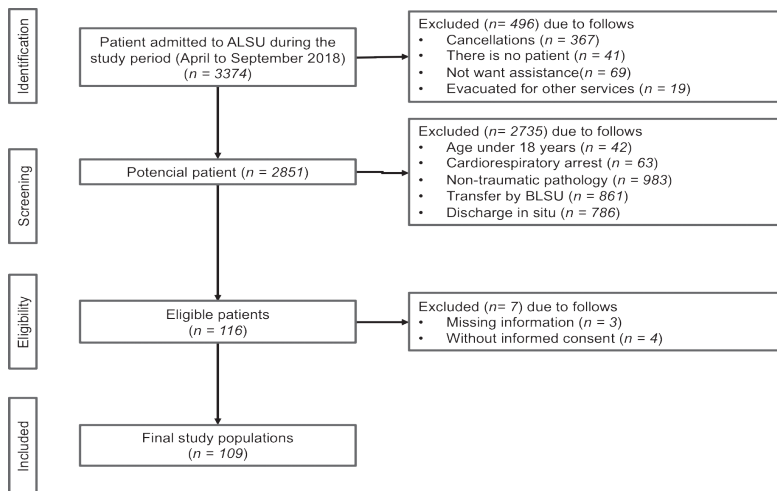

Figure 1. Flow chart of enrolled patients
ALSU: Advanced life support unit; BLSU: Basic life support unit

was registered in the international clinical trials registry platform of the World Health Organization (doi.org/10.1186/IS-RCTN17676798).

RESULTS

A total of 109 patients were included in our study. The median age was 53 years (IQR: 40-68), 39 patients (35.8%) were women. The most frequent aetiology was traffic accidents in 55 cases (50.5%), and the most common injury mechanism was closed trauma in 95 cases (87.1%).

The median PLA was 3.6 mmol/L (IQR: 2.6-5.1). Survivors had 3.3 mmol/L (IQR: 2.4-4.3), versus 5.9 mmol/L (IQR: 3.7-7.4) in non-survivors (p <0.05).

We observed that 88.2% of the non-survivors (at 30 days) required supplemental oxygen, 70.6% also needed advanced airway management and 94.1% needed intravenous medication (p <0.05 in all cases). The hospital admission rate was 53.2% (58 patients), with an ICU admission rate of 25.7% (p <0.05 in both cases).

Primary results

Eleven patients (10.1%) experienced early mortality before the first 48 hours after the index event, 14 patients (12.8%) within seven days and 17 patients (15.6%) within thirty days (see Table 1).

The AUC of the PLA to discriminate mortality at different time points was 0.81 (95% CI 0.65-0.97) at 2 days, 0.83 (95% CI 0.70-0.97) at 7 days, 0.80 (95% CI 0.66-0.88) at 30 days and 0.77 (95% CI 0.66-0.88) for hospitalization in ICU, all of which reached statistical significance.

The lactate value with greatest sensitivity and specificity to assess mortality at 2 days was 5.9 mmol/L. For determining mortality at 7 and 30 days, this value decreased to 4.1 mmol/L and for the assessment of ICU admission, to 4.9 mmol/L. Table 1 shows the values for sensitivity, specificity, PPV, NPV, PLR and NLR for these lactate values obtained in each case.

DISCUSSION

The obtained data suggests that PLA has an excellent capacity to predict mortality and the admission of patients with MI to the ICU, higher than that obtained in similar studies.[7] The best lactate values for determining 2-day mortality and admission to the ICU are higher than those associated with mortality at 7 and 30 days, which can

help us in the diagnosis and assessment of the hypoperfused patient very early in the prehospital setting.

Our results are comparable to the current literature on the use of PLA. A systematic review by Baxter8 substantiated how PLA levels are significantly higher in non-survivors than in survivors, while Lewis TL et al.9 advocate the use of this parameter for triage and initial resuscitation.10

LIMITATIONS

We have used mortality from any cause before 2, 7 and 30 days as the main outcome variable, excluding deaths that occurred outside this time window. Prospective multicenter studies with adequate power will be necessary to validate the use of lactic acid in a prehospital context.

CONCLUSIONS

In the prehospital context, PEMS professionals must be able to discriminate high-risk patients in cases with time-dependent diseases.

We believe that an objective and structured evaluation should be the fundamental basis for the evaluation of critical patients, but the use of PLA can complement that clinical decision-making, providing the most efficient and appropriate response in the shortest possible time.

CONFLICT OF INTEREST

Dr. Martín-Rodríguez has nothing to disclose.
Dr. López-Izquierdo has nothing to disclose.

TRANSPARENCY DECLARATION

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

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