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Base excess and lactate as prognostic indicators for patients treated by extra corporeal life support after out hospital cardiac arrest due to acute coronary syndrome☆

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ABSTRACT

Objective: To examine whether values of arterial base excess or lactate taken 3 h after starting ECLS indicate poor prognosis and if this can be used as a screening tool to follow Extra Corporeal Life Support after Out Hospital Cardiac Arrest due to acute coronary syndrome.
Design: Single Centre retrospective observational study.
Setting: University teaching hospital general adult intensive care unit.
Patients: 15 consecutive patients admitted to the intensive care unit after refractory Out Hospital Cardiac Arrest due to acute coronary syndrome treated by Extra Corporeal Life Support.
Interventions: Arterial base excess and lactate concentrations were measured immediately after starting ECLS and every 3 h after.
Results: Both base excess and arterial lactate measured 3 h after starting ECLS effectively predict multi-organ failure occurrence and mortality in the following 21 h (area under the curve on receiver operating characteristic analysis of 0.97, 0.95 respectively). The best predictive values were obtained with a base excess level measured 3 h after starting ECLS of less than −10 mmol/l and lactate concentrations greater than 12 mmol/l. The combination of these two markers measured 3 h after starting ECLS predicted multiorgan failure occurrence and mortality in the following 21 h with a sensitivity of 70% and a specificity of 100%.
Conclusions: Combination of base excess and lactate, measured 3 h after starting ECLS, can be used to predict multiorgan failure occurrence and mortality in the following 21 h in patients admitted to an intensive care unit for refractory Out Hospital Cardiac Arrest due to acute coronary syndrome treated by Extra Corporeal Life Support. These parameters can be obtained simply and rapidly and help in the decision process to continue ECLS for refractory CA.

1. Introduction

Extra Corporeal Life Support (ECLS) is the use of a mechanical device to temporarily replace the heart or lung function during cardiopulmonary failure, leading to organ recovery or replacement. Improvement of survival was noted with ECLS for in-hospital cardiac arrest (IHCA).[1–3] ECLS is used for the treatment of refractory cardiac arrest (CA), and pre-hospital implantation has been suggested.[4,5] However, despite attempts to reduce the time from arrest to ECLS implantation, the prognosis of refractory CA treated by ECLS remains dismal. Furthermore, ECLS is a time consuming and expensive therapeutic method. Selection of patients is therefore necessary.

The value of clinical markers such as blood pressure, urine output is limited in this setting. Direct arterial blood gas analysis at admission with examination of base excess (BE) and serum lactate

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concentration is easily performed and has been used in shock to predict survival.

In a study on patients with refractory CA and implantation of ECLS, Megarbane et al. demonstrated that lactate concentration ≥21 mmol/l predicted premature ECLS discontinuation with a specificity of 1.[6]

The aim of our study was to assess in patients with refractory CA treated with ECLS the level of BE and/or lactate at admission which are best correlated with survival in order to identify patients in whom ECLS should be continued.

2. Methods and patients

Unselected, consecutive admissions of patients with refractory cardiac arrest to Necker Hospital General Intensive Care Unit (ICU) were retrospectively entered into this study. The General ICU at Necker Hospital caters for general medical patients. Blood samples were taken from indwelling intra-arterial access for the BE and lactate levels on admission (immediately after starting ECLS (H0) and then every 3 h (3 h after starting ECLS (H3)). Blood samples were immediately analysed on a standard based arterial blood gas analyser (ABL 800 FLEX Radiometer©), which underwent daily calibration and quality control checks.

2.1. Therapeutic management of patients

All patients in the study were treated by the same group of critical care physicians. Protocols for management of critically ill patients did not change over the period study, thus ensuring that there were no major discrepancies amongst patients in terms of organ supports and therapies. All patients presented a refractory CA according to the definition used in France (persisting CA after 30 min of advanced life support (ALS).[7]

Haemodynamic support was achieved by Extra Corporeal Life Support (ECLS – ECLS CardiohelpMaquet©) done through a femoral venous arterial cannulation at admission by two experienced ICU physicians, fluid challenges (fluid administration 30 ml/kg/day of isotonic saline) and vasoactive agents: dobutamine 5 μg/kg/min and norepinephrine adjusted to obtain a mean blood pressure between 50 and 60 mmHg. Dobutamine was administered to prevent pulmonary oedema. Sedation was started as soon as possible. $ScVO_2$ was continuously monitored with the aim of achieving a $ScVO_2$ >70%. If return of spontaneous circulation occurred, the haemodynamic status was monitored by echocardiography and continuous cardiac output monitoring devices (Vigileo©, Edwards©).

Ventilation was adjusted to obtain a $PaCO_2$ of 40 mmHg and a PaO_2 between 100 and 200 mmHg; minimum lung ventilation was maintained to avoid pulmonary collapse with a tidal volume of 5 mL/kg, a respiratory rate of 8/min and positive end-expiratory pressure of 5 cmH_2O. Blood transfusion was done to achieve a target of 10 g/100 ml haemoglobin, 100,000/mm^3 platelets, a fibrinogen greater than 1.5 g/l and a prothrombine rate greater than 50%. To prevent coagulation of the ECLS membrane oxygenator, unfractionated heparin was intravenously administered at low dose during ECLS with repeated controls to maintain the activated clotting time (ACT) ratio >2.0. Continuous venovenous haemodiaflitration was performed during the first 3 h after ICU admission. In case of inhalation, amoxicillin was administered before documentation.

All patients were sedated during hypothermia using midazolam 0.1 mg/kg/h and sufentanyl 0.2 μg/kg/h and paralysed with atracurium 0.1 mg/kg/h (dose adjusted to obtain a neuromuscular response less or equal than 1 with "trend of four"). Mild hypothermia was performed during the first 12–24 h. Corporeal temperature was maintained between 32 and 34 °C using external cooling (ice packs placed on femoral and humeral vessels and the thermoregulatory device of ECLS). Sedation status was monitored using Bispectral Index (BIS monitor – Covidien©).

2.2. Data collection and statistical analysis

The IGS II (index gravity score)[8] was established for each patient 24 h after ICU admission.

Data are presented as absolute numbers, medians with a range (min and max values) or percentages. Statistical variance between groups was assessed by Fisher's exact test for discrete variables and the Mann–Whitney *U* test for continuous variables. Receiver operator characteristic (ROC) curves were constructed from standard formulae to determine the values of BE and lactate at each time period (H0 and H3 after starting ECLS) which were the best predictors of 28-day mortality in terms of sensitivity and specificity. The desired effect was to predict patients who were to have a poor global outcome. The most predictive values were then used to stratify patients into high- and low-risk groups.

3. Results

A total of 15 patients with refractory CA were enrolled in the study between January 2011 and April 2013. 12 (80%) were male; mean age was 52 (range 27–69). All CA were due to an acute coronary syndrome (ACS) documented by a coronary angiogram which was performed and was positive in 5 (33%) patients, or by ST-segment changes (ST-segment elevation AMI (STEMI)) on the ECG after return of sinus rhythm in 10 (67%) (Table 1). These 10 patients were not able to go to angiogram for haemodynamic reasons (Tables 2 and 3).

Table 1
Documentation of the cause of CA. Data are expressed as absolute numbers (percentage).

Coronary angiogram	5 (33%)
ST-segment changes	10 (67%)

Table 2
Patients' demographic and clinical characteristics, by base excess values at H3 after starting ECLS. Data are expressed as medians with a range (value min–value max) and as absolute numbers with percentage.

Base excess at H3 after starting ECLS		
	≤−10 mmol/l (*n* = 9)	>−10 mmol/l (*n* = 6)
Age (years)	51 (27–69)	52 (46–69)
Sex (M:F)	7:2	5:1
Base excess (mmol/l)	−11.8 (−18.2 to −10.1)	−0.8 (−9.4 to 3.9)
Lactate (mmol/l)	17 (8–25)	11 (11–14)
IGS II	93 (76–110)	81 (76–106)
Mortality *n* (%)	8 (88%)	2 (33%)

Table 3
Patients' demographic and clinical characteristics, by lactate levels at H3 after admission. Data are expressed as medians with a range (value min–value max) and as absolute numbers with percentage.

Lactate at H3 after starting ECLS		
	>12 mmol/l (*n* = 10)	≤12 mmol/l (*n* = 5)
Age (years)	53 (27–69)	52 (46–69)
Sex (M:F)	8:2	4:1
Base excess (mmol/l)	−11.3 (−18.2 to 3.9)	−9.8 (−11.8 to 0.8)
Lactate (mmol/l)	17 (11–25)	11 (8–12)
IGS II	93 (76–110)	81 (76–91)
Mortality n (%)	8 (80%)	2 (40%)