Resuscitation 119 (2017) 63–69

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Prehospital sodium bicarbonate use could worsen long term survival with favorable neurological recovery among patients with out-of-hospital cardiac arrest☆

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ARTICLE INFO

Article history:
Received 16 May 2017
Received in revised form 25 July 2017
Accepted 6 August 2017

Keywords:
Out-of-hospital cardiac arrest
Sodium bicarbonate
Prehospital management
Buffer therapy

ABSTRACT

Background: Sodium bicarbonate (SB) is widely used for resuscitation in out-of- hospital cardiac arrest (OHCA); however, its effect on long term outcomes is unclear.
Methods: From 2005–2016, we prospectively conducted a province-wide population-based observational study including adult non-traumatic OHCA patients managed by paramedics. SB was administered by paramedics based on their clinical assessments. To examine the association of SB administration and survival and favorable neurological outcome to hospital discharge, defined as modified Rankin scale of 3 or less, we performed a multivariable logistic regression analysis: (1) within propensity score matched comparison groups, and; (2) within the full cohort with missing variables addressed by multiple imputation techniques.
Results: Of 15 601 OHCA patients, 13,865 were included in this study with 5165 (37.3%) managed with SB. In the SB treated group, 118 (2.3%) patients survived and 62 (1.2%) had favorable neurological outcomes to hospital discharge, compared to 1699 (19.8%) and 831 (10.6%) in the non-SB treated group, respectively. In the 1:1 propensity matched cohort including 5638 OHCA patients, SB was associated with decreased probability of outcomes (adjusted OR for survival: 0.64, 95% CI 0.45–0.91, and adjusted OR for favorable neurological outcome: 0.59, 95% CI 0.39–0.88, respectively). The association remained consistent in the multiply imputed cohort (adjusted OR 0.48, 95 CI 0.36–0.64, and adjusted OR 0.54, 95% CI 0.38–0.76, respectively).
Conclusions: In OHCA patients, prehospital SB administration was associated with worse survival rate and neurological outcomes to hospital discharge.

Background

Sodium bicarbonate (SB) is still used in prehospital cardiac arrest resuscitations with 20% of patients with out-of-hospital cardiac arrest (OHCA) across North America receiving this therapy from

Abbreviations: SB, sodium bicarbonate; OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; BC, British Columbia; ROC, resuscitation outcomes consortium; BCAS, British Columbia Ambulance Service; BLS, basic life support; ALS, advanced life support; FD, fire department; AED, automated external defibrillators; DNR, do-not-resuscitation; CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation; ROC curve, receiver operating characteristic curve; SD, standardized difference; AHA, American Heart Association; IQR, interquartile range; OR, odds ratio; CI, confidence interval.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2017.08.008.

http://dx.doi.org/10.1016/j.resuscitation.2017.08.008
0300-9572/

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2011 to 2015 [1]. Although SB theoretically corrects metabolic acidosis, clinical studies have showed inconsistent results [2–5]. The effect of SB upon survival and neurological recovery in OHCA remains unknown.

Emergency medical services- (EMS) treated OHCA affect 134 per 100,000 adults in the US per year, with a survival rate between 3 and 16% [6,7]. While recognized mainstays of OHCA therapy include early recognition, EMS activation, and defibrillation, robust data supporting the use of pharmacological therapies within this bundle of care remains lacking.

The aim of this study is to investigate the association between prehospital SB use and both survival and favorable neurological recovery to hospital discharge among non-traumatic OHCA patients. In addition, we further intended to assess the effect of SB on those with a prolonged attempt at resuscitation.

Methods

Design and setting

We conducted a secondary analysis of prospectively collected consecutive EMS-treated OHCA patients within the in four major metropolitan regions of the province of British Columbia (BC): Victoria, Vancouver, the Fraser Valley, and Kelowna/Kamloops. The catchment area is approximately 3.3 million and accounts for over three quarters of the total provincial population [8]. This was a study site for the Resuscitation Outcomes Consortium (ROC) and the details, including approval by the University of British Columbia research ethics board, have been described previously [9–12]. Whereas survival outcome data is collected at hospital discharge for all patients, neurological outcome data was only collected during periods of enrollment for clinical trials [9,11–13]. These trials included patients with adult EMS-treated non-traumatic OHCA, none of which however, demonstrated statistical differences between groups, suggesting that the risk bias in post-hoc analyses of clinical trial data is low. Our analysis and manuscript were designed based on the recommendations from STROBE [14].

Interventions

EMS is provided by the British Columbia Ambulance Service (BCAS) basic life support (BLS) and advanced life support (ALS) paramedics, as well as individual municipal fire department (FD) through a province-wide coordinated 9-1-1 service. While FD personnel and BLS paramedics provide basic cardiopulmonary life-support including the use of automated external defibrillators (AED) [15], ALS paramedics provide advanced skills such as intubation, intraosseous access, and deliver intravenous drugs used in advanced cardiovascular life support resuscitations [16]. BCAS guidelines recommend SB as an optional treatment for "prolonged" cardiac arrest (the duration is not specified), suspected hyperkalemia, or overdose of tricyclic antidepressants or salicylates [17]. The guidelines emphasize that intubation and adequate ventilation should be established before SB use [17]. Guidelines also require ALS paramedics to administer epinephrine every 3 min throughout the resuscitation.

Patient selection

From December 2005 to March 2016, we identified all adult non-traumatic EMS-treated OHCA's. We excluded patients aged 17 and younger, those not treated by ALS, those who had written or verbal do-not-resuscitation (DNR) orders, or those regarded as legally dead at scene (see Supplemental Fig. 1 for criteria).

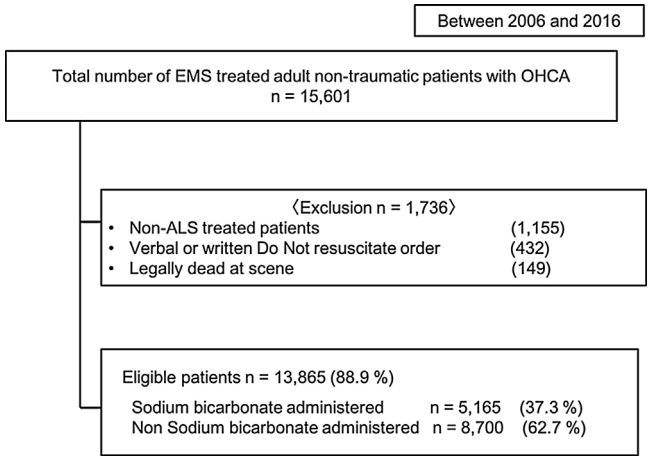

Fig. 1. Study diagram.

Measurement

Prehospital patient data were collected prospectively from paramedic and dispatch records as part of the BC ROC registry [11]. Trained research assistants, unaware of this study purpose or outcomes, reviewed neurological outcomes at hospital discharge using standardized forms as previously described [9,12]. The quality of the data was assured by the ROC data coordinating center [9–12].

The systemically collected data included patient demographics, initial EMS-recorded rhythm (shockable [ventricular fibrillation or pulseless ventricular tachycardia] or non-shockable [asystole, pulseless electrical activity, AED-advised "no shock" and unclassified]); witness status (bystander or EMS), bystander cardiopulmonary resuscitation (CPR); use of public AED, episode location (public or non-public); prehospital treatments (the total dose of epinephrine, prehospital electric defibrillation,and advanced airway placement [endotracheal intubation and supraglottic airway]); time from 9-1-1 call to paramedic scene arrival; time from call to ALS scene arrival; and the time from the start of paramedic CPR to the time of achievement of return of spontaneous circulation (ROSC) or termination of resuscitation.

Outcomes

The primary outcome of interest was survival, and the secondary outcome was neurological outcomes to hospital discharge. Favorable neurological outcome was defined as modified Rankin scale 0–3 [18,19].

Statistical analysis

Patients were dichotomized based on administration of prehospital SB. Microsoft Excel 2008 (Microsoft Corp, Redmond, WA, USA) and STATA version 13.1 (STATA Corp, College Station, TX) were used for data entry and analysis. We reported categorical variables as percentages with 95% confidence intervals (CI) and continuous variables as medians with interquartile ranges (IQR). All statistical analysis was 2-tailed with $P < 0.05$ considered significant except for when testing the subgroup analyses for which a Bonferroni adjustment for multiplicity was used ($P < 0.25$).

Two unconditional logistic regression models were conducted in the complete dataset (those who had no missing data) comparing the outcomes as dependent variables between SB and non-SB treated groups. Similarly, we also performed two multivariate logistic regression models to compare outcomes, adjusting for the following: patient age, sex, initial EMS-recorded rhythm (shock-