PREHOSPITAL CARE

Witnessed arrest, but not delayed bystander cardiopulmonary resuscitation improves prehospital cardiac arrest survivial

R B Vukmir and the Sodium Bicarbonate Study Group

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Introduction: This study correlated the effect of witnessing a cardiac arrest and instituting bystander CPR (ByCPR), as a secondary end point in a study evaluating the effect of bicarbonate on survival.
Methods: This prospective, randomised, double blinded clinical intervention trial enrolled 874 prehospital cardiopulmonary arrest patients encountered in a prehospital urban, suburban, and rural regional emergency medical service (EMS) area. This group underwent conventional advanced cardiac life support intervention followed by empiric early administration of sodium bicarbonate (1 mEq/l), monitoring conventional resuscitation parameters. Survival was measured as presence of vital signs on emergency department (ED) arrival. Data were analysed using χ^2 with Pearson correlation and odds ratio where appropriate.
Results: The overall survival rate was 13.9% (110 of 792) of prehospital cardiac arrest patients. The mean (SD) time until provision of bystander cardiopulmonary resuscitation (ByCPR) by laymen was 2.08 (2.77) minutes, and basic life support (BLS) by emergency medical technicians was 6.62 (5.73) minutes. There was improved survival noted with witnessed cardiac arrest—a 2.2-fold increase in survival, 18.9% (76 of 402) versus 8.6% (27 of 315) compared with unwitnessed arrests ($p<0.001$) with a decreased risk ratio of mortality of 0.4534 (95% CI, 0.0857 to 0.1891). The presence of ByCPR occurred in 32% (228 of 716) of patients, but interestingly did not correlate with survival. The survival rate was 18.2% (33 of 181) if ByCPR was performed within two minutes and 12.8% (6 of 47), if performed >two minutes ($p=0.3752$).
Conclusions: Survival after prehospital cardiac arrest is more likely when witnessed, but not necessarily when ByCPR was performed by laymen.

The efficacy of various prehospital healthcare providers to intervene in acute cardiac emergencies has historically been a focus of emergency care.

Eisenburg reported the results of an evaluation of prehospital care by emergency medical technicians (EMTs) compared with that delivered after the addition of paramedic skills, such as defibrillation, endotracheal intubation, and drug administration to the resuscitation armaterium. They reported an improved rate of survival to the coronary care unit (CCU) (19% to 34%) and rate of hospital discharge from 7% to 17%, which they related to a decrease in time delay to advanced care delivery that was decreased to one third from 27.5 to 7.7 minutes. Proportionally more lives were saved in the paramedic (EMT-P) than EMT provider areas with 8.4% and 1.3% mortality reduction respectively, a sixfold increase in survivorship.[1]

However, Dean reported on the outcome of 134 patients who received mobile paramedic unit care compared with control patients without paramedic intervention showing no change in outcome by multiple logistic regression analysis.[2] Defibrillation was the only beneficial intervention identified, but also added a 29 minute delay to hospital arrival, suggesting the need for more streamlined care.

Later, Shuster went on to evaluate 15 prehospital studies over the early years of emergency medical care suggesting no benefit of prehospital administration of any of a number of commonly administered prehospital drugs.[3] Qualitatively, there have been few studies that have examined the specific use of such agents as albuterol, bicarbonate, bronchodilator agents, diazepam, dobutamine, dopamine, glucose, isoproterenol, naloxone, or nitrous oxide for their prehospital efficacy.[4]

Paramedic efficacy has been described for advanced cardiac life support (ACLS) intervention with a 92% success rate of obtaining intravenous access and 91% for intubation; however, drug administration found practitioners only compliant with 43% of recommendations by intravenous route and 37% by endotracheal route.[5] Stricter compliance with national ACLS guidelines facilitation entailing extended refresher training courses may improve effectiveness.

The ''early defibrillation'' controversy has once again raised interest in use of first responders or EMT in a two tier response system. Wilson evaluated 126 patients, whose care was limited to basic life support (BLS): mask oxygen, intravenous fluids, closed chest massage, and artificial respiration.[6] The survival rate was 22% (28) to hospital admission and 9% (11) to hospital discharge. A favourable prognosis group was identified to include those with initial rhythm of ventricular fibrillation or tachycardia, initial blood pressure >90 mm Hg and pulse rate >50 bpm. However, if the patient was in cardiac arrest, the start of cardiopulmonary resuscitation (CPR) did not change outcome.

This study attempted to clarify the benefits of early emergency provider notification compared with bystander CPR timing and effectiveness.

METHODS

This prospective, randomised multicentre clinical trial involved cardiac arrest patients encountered by bystanders,

Abbreviations: CPR, cardiopulmonary resuscitation; CCU, coronary care unit; EMS, emergency medical service; ACLS, advanced cardiac life support; EMT, emergency medical technician; BLS, basic life support

EMTs, and paramedics (EMT-Ps) in a prehospital setting, and transported to hospitals within the study area, usually within a 5–30 minute transport radius.

Inclusion criteria were subjects suffering from cardiac arrest refractory to defibrillation in whom intravenous access was obtained. Exclusion criteria included those subjects suffering from overt respiratory or traumatic arrest, children (<18 years) and those without intravenous access. Patients received standard ACLS, standard protocol including chest compressions, ventilation, defibrillation, epinephrine (0.01 mg/kg), atropine (0.01 mg/kg), and antiarrhythmics or vasopressor agents as warranted. Patients were individually randomised to a treatment group receiving empiric dose of bicarbonate (Abbott, USA) 1 ample (50 mEq/l) early in the arrest cycle. The control group received an equal amount of normal saline in a double blinded fashion to clarify the benefits of the osmolar load compared with base deficit correction.

The treatment and placebo doses were manufactured and blinded by Abbott (Chicago, IL) to both the investigator and the drug administrator with the only key code held by the data manager. The data were analysed for adverse survivorship by the data manager at 25%, 50%, and 75% of cases without inspection by the investigator with no withdrawal criteria met.

Routine demographic and clinical variables related to outcome were analysed including patient characteristics, response to bicarbonate administration, scene factors, response time, cardiopulmonary variables, procedures, and duration of arrest (box). Patient outcome was recorded as the return of spontaneous circulation, measured as palpable pulses and initial emergency department survival as a primary end point.

Specifically, resuscitation intervention times were recorded as a secondary end point by the EMT-P as estimated time of arrest (ET arrest), time until institution of bystander CPR (ET ByCPR), basic life support (ET BLS), advanced cardiac life support (ET ACLS), return of spontaneous circulation (ET ROSC), and scene to hospital transport time (ET TT). In addition, ByCPR intervention time is subcategorised into immediate (0–2 min) and delayed (>2 min) response for further analysis.

Administration of an FDA approved agent (sodium bicarbonate) in the emergency setting for moderate to prolonged arrest may be the standard of care, and in conjunction with the above conditions that are met, consent could be waived. This study, was approved by the University of Pittsburgh Institutional Review Board, under this rationale and was modified to resolve Office for Protection from Research Risk issues concerning ''deferred consent''.[7]

Numerical data were represented as means and standard deviation, χ^2 with Pearson correlation, and odds ratio tests used for survivorship comparisons ($\alpha<0.05$) (SPSS/PC+, Chicago, IL). The study results were examined by the investigators at three month intervals (or 25% of projected patients) to verify early trends and outcome with capability of later modification.

The sample size of 1000 was sufficient to delineate a 50% difference in survival at 80% power and 95% confidence intervals between control and treatment groups for the primary end point. This estimate was based on a 12% rate of return of spontaneous circulation (ROSC) for prehospital arrests.

RESULTS

The overall survival rate was 13.9% (110 of 792) of prehospital cardiac arrest patients (fig 1). The mean (SD) time until provision of ByCPR was 2.08 (2.77) minutes and BLS support was 6.62 (5.73) minutes.

Prehospital correlates to survival

- Patient characteristics
  - Age, weight, sex
- Response time
  - ET arrest, ET ByCPR, ET BLS, ET ACLS, ET ROSC, ET Hosp
- Interventions
  - Bicarbonate (dose, weight based)
- Scene factor
  - Bystander CPR, witnessed
- Cardiopulmonary variables
  - Initial rhythm, initial systolic blood pressure (ISBP), IDBP
- Procedures
  - Intubation, intravenous, other
- Duration of arrest
  - Short (<5 min), moderate (5–15 min), long term (>15 min)
- EMS coverage
  - Urban, suburban, rural
- Medical history
  - MI, HTN, DM, CHF, COPD, CABG
- Drug
  - Cardiac, HTN, arrhythmia, pulmonary, haematological, GI, psychiatric, seizure

There was improved outcome noted with witnessed cardiac arrest, featuring a 2.4-fold increase in odds ratio of survivorship, 18.9% (76 of 402) compared with 8.6% (27 of 315) in unwitnessed arrests ($p<0.0001$). The risk ratio of mortality decreased significantly 0.4534 (95% CI, 0.0857 to 0.1891). However, the presence of early ByCPR that occurred in 32% (228 of 716) of patients did not correlate with survival (table 1).

The survival rate was 18.2% (23 of 181) if ByCPR was performed immediately within two minutes and 12.8% (6 of 47) if performed in a delayed fashion after two minutes and was not significant ($p = 0.3752$) (table 2).

DISCUSSION

It is commonly assumed that patients who have bystander CPR (ByCPR) provided early in arrest have improved outcome because of more rapid delivery of prehospital defibrillation and other interventions. However, Troiano in a retrospective analysis of 138 prehospital cardiac arrest survivors found no difference in outcome showing no positive correlation to provision of ByCPR with 55%–58% of patients who recovered found in the minimal disability category,

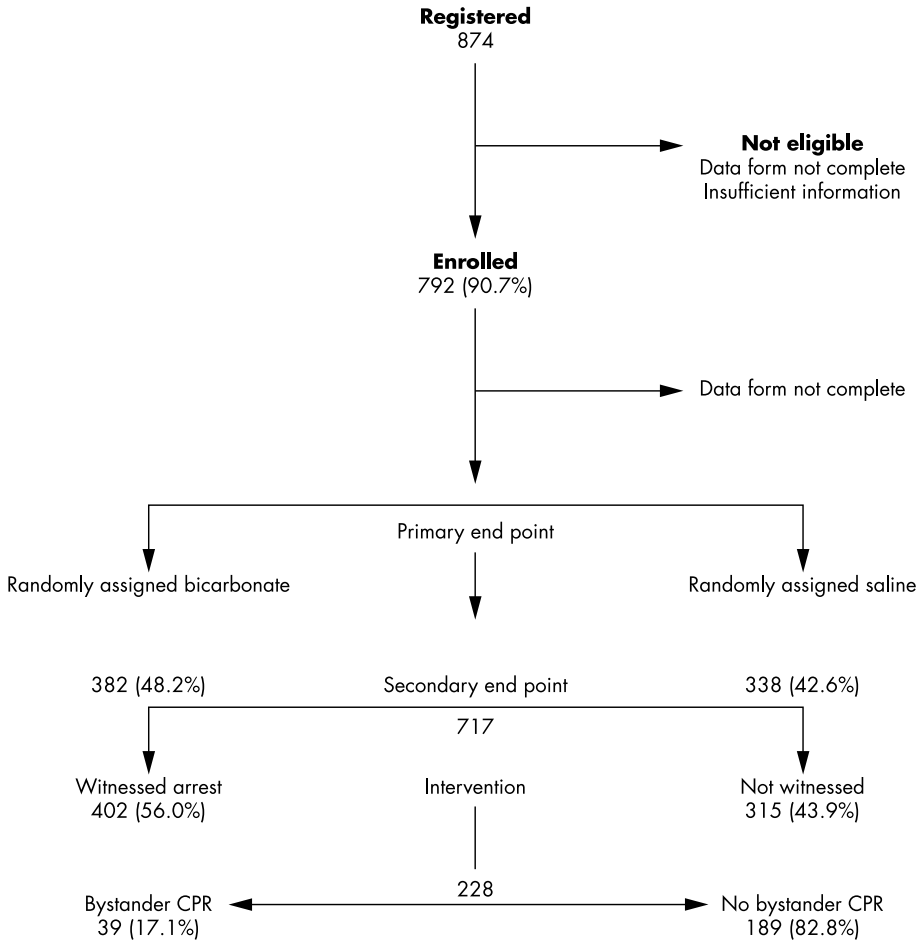

Figure 1 Trial profile.

16%–17% with moderate disability, while 4%–8% were discharged in a vegetative state.[8]

Education is a prominent component of any prehospital care plan for both professionals and lay rescuers. Dracup prospectively evaluated instruction in ByCPR in 83 families of high risk cardiac patients and found an 81% rate of successful instruction of these family participants.[9]

Bystander compared with EMS first responder CPR has also been a point of comparison to evaluate the efficacy of resuscitation. Swor performed a retrospective cohort analysis of 217 cardiac arrest victims, where 71% (153) received ByCPR and 29% (64) received first responder CPR.[10] Their follow up study of 772 patients found the presence of ByCPR was more often associated with the presence of ventricular fibrillation and subsequent live discharge (18.3% compared with 8.4%, $p<0.001$).[11]

The impact of the time interval and potential delay between cardiac arrest and ByCPR has not been established. Martens evaluated 1195 patients where good outcome was associated with ROSC (22.7%) and prolonged survival to hospital discharge (9.7%).[12] The mean (SD) time between the EMS request and layperson CPR was 2.5 (0.1) minutes with delay until intervention a crucial factor associated with worsened outcome.

The prevalence of ByCPR in Bossaert's analysis of 3053 arrest patients was 33% (998) and was performed by lay persons in 40.6% (406), 43.8% (178) by family members, 36.2% (228) by other lay people, and healthcare professionals in 39.4% (592). The healthcare component was performed predominantly by physicians in 86.5% (506) or nurses in 19.5% (86).[13] Interestingly, ByCPR is nearly as often performed by healthcare professionals as laypersons.

Table 1 Witnessed arrest correlation to survival and bystander CPR

	ER survival		
Witnessed	No	Yes	Total
No	288	27	315
%	(91.4)	(8.6)	(43.9)
Yes	326	76	402
%	(81.1)	(18.9)	(56.1)
Total	618	103	717
%	(85.6)	(14.4)	(100.0)

χ^2 Pearson correction ($p=0.0009$); odds ratio 2.5 (0.231/0.0938)

Table 2 Bystander CPR time interval compared with survival

	ER survival		
ET bystander CPR	No	Yes	Total
0–2 (min)	148	33	181
%	(81.8)	(18.2)	(79.4)
>2	41	6	47
%	(87.2)	(12.8)	(20.5)
Total	189	39	228
%	(82.9)	(17.1)	(100)

χ^2 Pearson correction ($p=0.3752$).

Common clinical scenarios encountered suggest that family members and laypersons applied CPR to younger victims, those found at public places, at roadside areas, and in the work place, where sudden infant death syndrome, and drowning figured predominantly as clinical scenarios; while healthcare professionals performed CPR on older patients and in public places.[13] However, those whose arrests were caused by trauma, haemorrhage, and intoxication were less likely to receive this intervention. There seems to be a late survival benefit conferred by ByCPR where these events are more frequently witnessed, and have shorter access time to EMS with decreased associated BLS and ACLS time.

Likewise in those with unwitnessed arrests, early and late survival are significantly improved in those receiving ByCPR. This was a glowing endorsement of ByCPR with effects most significant in those cases with prolonged (ALS>8 min) response time, and furthermore no adverse effects of suboptimal CPR were noted, so there was little reason to not perform this procedure.

However, Troiano evaluated 138 ByCPR patients and found no difference in cognitive outcome measured as cerebral performance category scale (CPC) functional level with most patients in the minimal disability group (1) 55.1%–58.0%, followed by moderate (2) 24.4%–18.0%, severe (3) 16.7%–16.0%, vegetative (4), brain stem dead (5) 3.8%–8.0% groups with and without ByCPR, respectively.[14] Clearly, the results were underwhelming regarding the benefits of ByCPR with little difference in outcome or actual worsening noted in the ByCPR group.

Our group has evaluated the effect of ByCPR in prehospital survival in 488 patients with an overall survival rate of 13.9%.[15] Improved survival was noted in the witnessed arrest group (717 patients) with a 2.2-fold increase (18.9%) increase in survival. However, the presence of the early (<2 min) ByCPR group (228 patients) did not correlate (18.2% compared with 12.8%) with improved survival raising questions of efficacy. This finding may be associated with a type II error because of smaller patient group size.

The overall survival rate of 13.9% (110 of 793) compares favourably to a average 3.8% (1.7%–13%) survival from pooled analysis of 3220 prehospital arrest patients suggesting improved prehospital outcome in this study. The mean time until provision of ByCPR of slightly over 2.1 minutes, which compares favourably to the two minute BLS time; but does not reach the four minute BLS target established by Roth *et al*.[16] This finding is probably related to the large rural EMS component with prolonged time to arrival at scene. However, the twofold increase in survival ratio for witnessed compared with unwitnessed events is significant and should encourage early intervention, such as EMS notification by families. Interestingly, there was not found to be an improvement in survival noted when immediate compared with delayed ByCPR was provided. Therefore, the improvement in survival noted with early patient discovery as in a witnessed arrest may be related to factors other than ByCPR.

It is plausible that one potential cause for the lack of improvement in survival associated with ByCPR may be ineffective performance by laypersons, and this should be an area of future education and training. Another explanation is decreasing efficacy as the arrest proceeds longer than a few minutes of ''no flow conditions.'' Likewise, excluding those without intravenous access could sub-select to a improved outcome population eliminating those least likely to be resuscitated. An additional explanation is that the overwhelming factor is the presence of EMS is usually felt to be related to early defibrillation. However, the actual deciding factor may be the entire EMS armaterium provided including early defibrillation, improved airway management, or drug administration.

This question may be further decided by comparing first responder programmes featuring early defibrillation to conventional single tier response systems assessing whether no improvement in survival is related to defibrillation alone, while a discrepancy may be noted if other interventions are contributory. In either event if it crucial to increase public awareness regarding early EMS notification and encouraging ''layperson'' CPR training.

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Conflicts of interest: none declared.

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