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Research Article

Utility of Point-of-Care Blood Testing During Cardiac Arrest: A Survey of Advanced Cardiac Life Support Team Leaders

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Abstract

Background: Point-of-care blood testing for multiple parameters (POCT) during cardiac arrests is routinely practiced at many hospitals, though it is not included in Advanced Cardiac Life Support (ACLS) guidelines.

Objective: We aimed to study the perceived utility of POCT to ACLS team leaders.

Methods: An electronic survey was administered to ACLS team leaders at two teaching hospitals – Mayo Clinic, Rochester, MN (MCR), where POCT is routinely used, and Mount Sinai St. Luke's-Roosevelt, New York, NY (SLR), where POCT is not used. Questions included participants' current role, experience as ACLS leaders and prior experience with POCT, as well as questions on perceived positive and negative aspects of POCT use during ACLS. For SLR providers, questions were framed as hypothetical situations if POCT results were provided two minutes after drawing blood.

Results: Complete responses were received from 45 and 27 respondents at MCR and SLR, respectively. Mean number of ACLS events led were similar (48.2 vs 64.6, p=0.29), prior experience with POCT was higher at MCR (58% vs 19%, p=0.001). Out of all 11 POCT results, MCR providers perceived more parameters to be useful (6.2 vs 4.8, p=0.047). MCR providers felt POCT changed management more often and improved patient care overall (p<0.001 for both), and POCT would not cause distraction (p=0.001) or information overload (p<0.001).

Conclusions: ACLS providers differed significantly in their perceived utility of POCT during cardiac arrests. The bias introduced by the practice setting and prevalent culture regarding POCT likely explains the differences between the two groups.

Introduction

Annually, there are an estimated 200,000 in-hospital cardiac arrests (IHCA) in the United States with approximately 20% of patients surviving to hospital discharge [1]. Cardiac arrests with initial rhythms of pulseless electrical activity (PEA) or asystole are associated with higher mortality than those with an initial rhythm of ventricular fibrillation or ventricular tachycardia [2]. The American Heart Association and European Resuscitation Council 2010 guidelines [3,4] on advanced cardiac life support (ACLS) specify a set of potentially treatable conditions, commonly known as the "Hs and Ts," to consider while managing cardiac arrests. These include hypovolemia, hypoxemia, hydrogen ion (acidosis), hyper- or hypokalemia, hypothermia, hypoglycemia, toxins, cardiac tamponade, tension pneumothorax and thrombosis (including myocardial infarction and pulmonary embolism). Several of these "Hs and Ts" are not evident on clinical examination and require blood testing to confirm, which may not always be available in a timely manner to guide management during resuscitation.

Point-of-care blood testing for multiple parameters (POCT) has become more prevalent as technological improvements have resulted in portable, reliable devices once relegated only to a laboratory. The equipment currently in use at our center consists of a handheld device that processes blood samples. Once blood is collected from the patient, a few drops are placed into a cartridge that contains biosensors on a silicon chip, which perform specific biochemical analyses. The cartridge is then inserted into the handheld device and results are displayed on the screen in approximately 2 minutes. Depending on the type of cartridge used, a variety of tests can be performed on the same handheld device. Such devices have become more common in emergency departments, intensive care units and prehospital settings where timely biochemical assessments of rapidly-

deteriorating patients are commonly seen. Similarly, these devices have been increasingly utilized to guide management during IHCAs. Such testing can potentially minimize the delay in recognizing an easily-reversible etiology resulting in a potential change in management. Though there have been recent surveys on management of resuscitation for IHCA [5], the utility of POCT to ACLS providers has not been studied till date. We aimed to study the perceived utility of POCT to ACLS providers.

Methods

This institutional review board-approved study was performed using an anonymous survey administered to medical professionals who serve as ACLS team leaders at their hospital. The surveys were sent via email during September and October 2013 using REDCap Survey Software Version 1.3.10 (Vanderbilt University, Nashville, TN). Providers were surveyed from two large multispecialty tertiary-care teaching hospitals, Mayo Clinic, Rochester, MN (MCR) and Mount Sinai St. Luke's-Roosevelt, New York, NY (SLR). At MCR, POCT has been routinely employed during IHCA for a number of years, while at SLR POCT is not used during IHCA. Point-of-care testing for blood glucose is available at SLR and this is often utilized during management of IHCA; however, other blood parameters as described below are not tested. The POCT used at MCR is the i-STAT™ system (Abbott Point of Care Inc., Princeton, NJ; www.abbottpointofcare.com), which returns test results approximately 2 minutes after an arterial blood draw and provides the following results: hematocrit, glucose, sodium, potassium, ionized calcium, bicarbonate, base excess, pH, partial pressures of oxygen and carbon dioxide (PaO2 and PaCO2 respectively), and lactate.

Table 1: Distribution of all surveyed participants from MCR and SLR with their training background

Surveyed Participants	MCR	SLR
Critical care attending physicians	41	12
- Critical care and anesthesiology	19	0
- Internal medicine, pulmonary and critical care	21	12
- Internal medicine, nephrology and critical care	1	0
Critical care or pulmonary and critical care fellowship trainees	37	10
- Anesthesiology residency	3	0
- Internal medicine residency	27	10
- Internal medicine residency, nephrology fellowship	4	0
- Internal medicine residency, infectious diseases fellowship	1	0
- Internal medicine and pediatrics residency, pulmonary fellowship	1	0
- Emergency medicine residency	1	0
Other ACLS team leaders	25	52
- Internal medicine senior residents (third year)	0	47
- Internal medicine chief residents (fourth year)	0	5
- Anesthesiology senior residents (fourth year)	18	0
- Critical care nurse practitioners and physician assistants	7	0
Total surveys sent	103	74

MCR, Mayo Clinic, Rochester, MN; SLR, Mount Sinai St. Luke's-Roosevelt, New York, NY; ACLS, advanced cardiac life support

There were 103 ACLS team leaders at MCR who received surveys, including 41 critical care attending physicians, 37 critical care fellowship trainees, and 25 other members eligible to serve as ACLS team leaders (Table 1). There were 74 ACLS team leaders at SLR who received surveys, including 12 critical care attending physicians, 10 pulmonary and critical care fellowship trainees, and 52 other members eligible to serve as ACLS team leaders.

All had an active ACLS provider certificate and were eligible to lead ACLS teams at their respective hospitals. The survey (Table 2) asked participants about their current role, experience as ACLS leaders, experience with POCT and details of how useful they find POCT while leading ACLS teams. They were asked if they felt overloaded or distracted by these results and if POCT improved patient care. MCR providers were asked to estimate the time required to obtain a POCT result after chest compressions had been initiated. For SLR providers, questions were framed as hypothetical situations, and providers were asked about their perceived utility of POCT if the results were made available two minutes after a blood draw.

Table 2: Survey questions and results from providers at MCR and SLR

Question	MCR	SLR	P value
Response rate	45/103	27/74	0.4
Duration in current role Less than 6 months 6 months to 1 year 1 to 2 years Greater than 2 years	 8/45 2/45 8/45 27/45	 5/27 3/27 4/27 15/27	0.8
Ratio of Attending physicians : Fellows : Others*	23:16:6	12:6:9	0.11
Estimate of ACLS events as leader (or supervisor to the leader)†	48.2 ± 60.7	64.6 ± 67.0	0.3
Have you used POCT in your training prior to your current role?	Yes: 26 (58%)	Yes: 5 (19%)	0.001
Which specific POCT parameter(s) do you find useful to alter management during an ACLS event?			
Sodium	2/45 (4%)	2/27 (7%)	1.0
Potassium	38/45 (84%)	23/27 (85%)	1.0
Ionized calcium	18/45 (40%)	14/27 (52%)	0.5
Haematocrit	40/45 (89%)	10/27 (37%)	<0.001
Partial pressure of carbon dioxide ($PaCO_2$)	28/45 (62%)	8/27 (30%)	0.01
Partial pressure of oxygen (PaO_2)	26/45 (58%)	5/27 (19%)	0.001
pH	38/45 (84%)	13/27 (48%)	0.001
Bicarbonate or Base Excess	20/45 (44%)	11/27 (41%)	0.8
Glucose	27/45 (60%)	18/27 (67%)	0.6
Lactate	13/45 (29%)	8/27 (30%)	1.0
None of the above	0/45 (0%)	2/27 (7%)	0.1
Number of POCT parameters found useful†	6.2 ± 2.6	4.8 ± 3.4	0.047
How often will POCT change management? (%)†	33.3 ± 26.6	13.8 ± 16.2	<0.001
Do you feel overloaded by POCT results?†‡	4.6 ± 0.7	3.6 ± 1.0	<0.001
Do you find POCT results distracting? †‡	4.3 ± 0.8	3.6 ± 1.0	0.001
Overall, do you think POCT improves patient care? †‡	1.8 ± 0.8	3.1 ± 1.0	<0.001

POCT, point-of-care blood testing for multiple parameters; *ACLS*, advanced cardiac life support
MCR, Mayo Clinic, Rochester MN; *SLR*, Mount Sinai St. Luke's-Roosevelt
* "Others" refers to residents, nurse practitioners and physicians at MCR; and residents at SLR
† Responses are represented as mean ± standard deviation.
‡ Responses were in the form of a 5-point Likert-type scale: 1 = Always, 2 = Often, 3 = Sometimes, 4 = Never.

Responses from MCR and SLR were compared using chi-square tests for proportional data and Student's t-test for continuous data. All reported P values are two-tailed and $p<0.05$ was used to determine statistical significance. All calculations were performed using JMP 10 (SAS Institute, Cary, NC).

Results

Complete responses were received from 45 providers at MCR and 27 providers at SLR. Since the survey was administered early in the academic year, many of the ACLS providers who were in training programs had not had the opportunity to serve as ACLS team leaders and this number was not known. The crude response rate was 45/103 (44%) at MCR and 27/74 (36%) at SLR. Details of responses to each question are presented in Table 2. When asked if POCT would cause information overload, MCR respondents were more likely to answer "never" or "rarely" compared to SLR respondents (42/45 vs 15/27, $p<0.001$). When asked if POCT would be distracting, providers from MCR were more likely to answer "never" or "rarely" compared to providers from SLR (37/45 vs 14/27, $p=0.008$). Finally, when asked whether POCT improves patient care overall, MCR respondents were more likely to answer "always" or "often" compared to SLR respondents (38/45 vs 6/27, $p<0.001$). MCR providers reported that a POCT result is usually available an average of 7.7 (SD 3.9) minutes after chest compressions have been initiated.

Discussion

Our study presents the first data on the perceived utility of POCT in cardiac arrests to ACLS team leaders. We surveyed ACLS providers in two hospital settings, one that routinely uses POCT during IHCA to guide management (MCR) and another that does not use POCT during IHCA (SLR). This selection of sites helped us to understand inherent biases caused by the prevailing practice at each institution.

Providers at both sites had a similar level of experience, distribution of attending physicians, critical care fellows and other providers, and the estimated number of ACLS events led. A greater proportion of MCR providers reported experience with POCT in prior training, which may be expected given that some providers probably completed their training at MCR. MCR providers were more likely to find POCT useful in changing ACLS management, while being less likely to perceive this information as distracting or overloading.

Examining the perceived utility of individual parameters, potassium and glucose levels were felt to be useful by a high proportion of both groups of providers, probably because hypo- or hyperkalemia, and hypoglycemia are relatively common and easy to treat. On the other hand, sodium and lactate levels were uniformly felt to be less useful by both groups, probably because the sodium level offers little value in guiding therapy during IHCA and an abnormally high lactate may be expected in this clinical setting. Providers at MCR reported finding certain other parameters, such as hematocrit and pH, as much more useful compared to SLR providers. While this finding does not directly suggest that POCT is useful in guiding management of IHCA, it certainly provides a direction for future research. In the absence of clinical data or guidelines, decision-making in medicine can often be influenced by the prevalent culture and practice at a provider's institution, and these cultural differences could possibly have a regional variation. Our study indicates that this likely explains the differences we observed in perceived utility of POCT during IHCA. Providers at MCR reported that, overall, POCT was useful in guiding management during IHCA. While it can be argued that the survey-based design tends to favor a bias towards one's own practice style (as in the case of providers at MCR), it could also be argued that providers at SLR may underestimate the utility of POCT in IHCA management owing to lack of experience with such testing. This may be especially true in situations where the absolute value of certain parameters may be useful despite being in the normal range. For example, in the right clinical setting, a normal hematocrit may help in moving the suspicion away from hemorrhagic shock and steering providers towards an alternative explanation for the decompensation. These survey data show that objective clinical data are required to assess whether POCT does indeed affect clinical decision-making during IHCA and if the costs are justified by the degree of clinical benefit. The significant difference in opinion at both sites suggests that, once clinical data on POCT use are available, there will be a potentially large impact on practice.

Our study has several limitations. First, as stated in the results, the true response rate could not be computed because an unknown number of fellows, residents and mid-level providers had not led ACLS events and were, therefore, not eligible to take the survey. Residency and fellowship academic years begin in July and our survey was administered in September and October 2013. In order to maintain compliance with prevailing regulations, the academic year has been divided into 26 equal 2-week blocks and internal medicine residents assume ACLS team leader responsibilities on a rotation basis [6,7]. A sizeable proportion of residents and fellows may have not had the opportunity to serve as the ACLS team leader given that they had been in their academic role for just about 2-3 months. For example, at SLR, there were 52 residents who received surveys but we received only 9 responses. Of these 52 residents, 5 chief residents and probably an additional 10 third-year residents had served as ACLS team leaders at the time of the study. Thus, the true response rates (i.e. responses from providers who had served as ACLS team leaders) were probably much higher than 44% from MCR and 36% from SLR. In retrospect, an additional survey question specifically asking respondents if they had

ever served as ACLS team leaders would have helped in providing an accurate response rate. Second, our sample size was relatively small, comprising providers from only two institutions. Third, our questions did not specifically ask respondents whether they would find a certain parameter useful by virtue of its being normal or abnormal.

Conclusion

The perceived utility of POCT during IHCA is significantly different amongst ACLS team leaders depending on the hospital in which they practice. This is most likely related to physicians' prior experiences and cultures within the institutions they have trained and practiced in. Clinical studies are needed to further explore the utility of such testing to ascertain its role in the management of IHCA. The significant differences in opinion suggest that clinical data will have a large impact on practice regarding POCT use during IHCA.

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