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## Original Research

### The Use of Bedside Ultrasound in Cardiac Arrest

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#### ABSTRACT

**BACKGROUND:** The decision to terminate resuscitative measures in the setting of cardiac arrest is based on several criteria, some of which are subjective. Ultrasound in the emergency department has potentially added an objective data point to assist in this decision. **OBJECTIVE:** We sought to determine if emergency physicians who were trained in the use of ultrasound use it in cardiac arrest scenarios and if so, what effect they believe it has on the duration of the resuscitative event. **Our hypothesis was that emergency physicians terminate resuscitative efforts sooner with visualization of cardiac standstill and feel more comfortable in doing so. METHODS:** The ultrasound training program at Los Angeles County + University of Southern California Medical Center began in 1995. We surveyed all graduates of the residency program since that date about their use of ultrasound in cardiac arrest. **RESULTS:** Surveys were mailed to 154 practicing emergency physicians. One hundred and sixteen surveys (75%) surveys were returned. During residency, the majority of individuals (68%) reported that they had used ultrasound during at least 10 cardiac arrests. It was used to search for a reversible cause of cardiac arrest (pericardial effusion) or for documentation of cardiac standstill. Ninety-one percent of individuals used the ultrasound result as an aid in deciding when to terminate resuscitative efforts and 59% believed it shortened their resuscitation time. After graduation, only

53% of individuals in this study have ultrasound available in their daily clinical practice. For these individuals, 60% use it in more than 50% of their cardiac arrest situations. Ultrasound was used to shorten the code time (63%) as well as to reassure and confirm the presence of cardiac standstill for the physician (88%) and the resuscitation team (59%). **CONCLUSION:** Most emergency physicians in this cohort who have access to ultrasound use it in cardiac arrest cases and believe that it shortens code times.

#### INTRODUCTION

The decision to terminate resuscitation in the setting of cardiac arrest is a difficult one and is based on several factors. Both the American Heart Association and the European Resuscitation Council have published guidelines to assist the clinician with the decision to cease resuscitative efforts, but many of the criteria described are judgment based.<sup>1,2</sup> (Table 1) Even with such guidance, the emergency physician is often unsure of when and how to stop.<sup>3</sup> A study by de Vos et al. in 1998 examined the factors that lead to cessation of resuscitative events as well as the duration of the resuscitation and reported an average resuscitation length of 30 minutes with a large range (8 – 81 minutes).<sup>3</sup> The factors most frequently cited in the literature for prolonged, obviously futile resuscitation are the fear of litigation and criticism from members of the staff.<sup>4</sup>

The introduction of ultrasound into the emergency department has potentially allowed the addition of an extra data point in the decision about when to cease cardiopulmonary resuscitation (CPR). The utilization of emergency department bedside echocardiography performed by emergency physicians in the setting of cardiac arrest has been described in the literature previously.<sup>5,6</sup> It has been reported that practicing emergency

**Table 1. Guidelines for terminating resuscitative efforts (AHA and ERC)<sup>1,2</sup>**

American Heart Association	European Resuscitation Council
<ul style="list-style-type: none"> <li>• Decision to terminate rests with the team leader based on:               <ul style="list-style-type: none"> <li>○ Time to CPR</li> <li>○ Time to defibrillation</li> <li>○ Comorbid disease</li> <li>○ Prearrest state</li> <li>○ Initial arrest rhythm</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Presence of advanced directive</li> <li>• Asystole for more than 20 minutes in the absence of reversible causes</li> <li>• Patients with primary out-of-hospital cardiac arrest who require ongoing CPR without return of pulses during transport to the hospital</li> <li>• Team leader's clinical judgment</li> </ul>

physicians who are trained in ultrasound may use it during cardiac arrests to visualize potentially reversible causes of cardiac arrest (e.g. pericardial tamponade) and to document cardiac standstill.<sup>5,6,7</sup> When the emergency physician notes the absence of cardiac motion through echocardiography, the decision to terminate resuscitative efforts may become easier for all the providers.

In this study, we sought to determine how emergency physicians trained in the use of ultrasound used it in cardiac arrest scenarios as well as how the findings affected the duration of the resuscitative efforts. Our hypothesis was that emergency physicians terminate resuscitative efforts sooner with visualization of cardiac standstill and feel more comfortable in doing so.

## METHODS

This was an IRB-approved study. We sampled all graduates of the Los Angeles County + University of Southern California Emergency Medicine residency training program since 1995, the year of the inception of ultrasound training in our program. Our major clinical teaching site, Los Angeles County + USC Medical Center, has a PGY 2 - 4 residency program and graduates of our program are trained in ultrasound during their initial year of residency. Training consists of a 16-hour course on emergency ultrasonography that includes one hour of didactic instruction and four hours of practical training dedicated solely to echocardiography. The echocardiography portion of the course provides specific instruction in visualizing pericardial effusions as well as using cardiac standstill to potentially predict arrest course. We use ultrasound in virtually all cardiac arrest cases at our institution.

We estimate that 80-85% of our graduates enter community practice, and the other graduates enter full-time academic positions. Surveys were mailed to those for whom we had contact information, a total of 154 practicing emergency physicians.

The survey consisted of 17 questions pertaining to the physician's use of ultrasound in the setting of cardiac arrest during residency training and their experiences after graduation. Three mailings were conducted over a period of six months. Data were entered into a customized version of Microsoft Excel (Microsoft Corporation, Redmond, WA).

## RESULTS

Of 154 surveys mailed, 116 (75%) were returned. In order to confirm that all graduates had experience with ultrasound in cardiac arrest scenarios during residency, respondents were asked how many cardiac arrest cases involved the utilization of bedside cardiac ultrasound during their residency. Thirty-seven respondents (32%) stated they had used ultrasound in approximately 1-10 cases, 37 (32%) used it in 11-20 cases, 19 (16%) used it in 21-30 cases and 23 (20%) used it in greater than 30 cases. We also asked if they had used the results of those same ultrasounds during residency training as an aid in the decision to terminate resuscitative efforts and 105 respondents (91%) reported using it as a decision point.

Respondents were asked if they believed ultrasound affected the length of the resuscitation during those cases in which it was used during residency training. Sixty-nine individuals (59%) stated that it had shortened code time, 27 (23%) stated that they believed that code time was unchanged and seven (6%) stated code time was longer due to the use of ultrasound. Thirteen respondents did not answer the question.

The survey also queried the respondents about the purpose of their bedside echocardiography. They were asked whether they were looking for cardiac tamponade/pericardial effusions (i.e. reversible causes) or cardiac standstill, or both. One hundred and fourteen (98%) stated that they were looking at both aspects of cardiac status on their ultrasounds.

The physicians were next asked about their current practice. Our survey revealed that only 53% of our program's graduates currently have access to ultrasound in their emergency

department. Of those physicians who have access to ultrasound, 90% stated that they use ultrasound in cardiac arrest cases. Most physicians (60%) use it in at least 50% of their cardiac arrest cases and said that they use it for several reasons. Thirty-five respondents (63%) use it to shorten code time, 49 (88%) use it for reassurance for themselves, and 33 (59%) use it to reassure the team.

Of those that do not have access to ultrasound in their daily practice (47% of physicians surveyed), respondents were asked to reveal the primary reason that prevented the implementation of ultrasound in their department. Thirty-six respondents answered "interdepartmental politics," 12 answered "machine cost," six respondents have "never tried," 16 stated their colleagues were not interested in implementing it or not trained, and 19 respondents indicated they had other reasons not specified.

## DISCUSSION

The decision to terminate resuscitative efforts is influenced by many factors, both medical and social, and is unique to each scenario and patient. The AHA and the ERC provide very loose guidelines to assist physicians in the decision to terminate. This difficult decision becomes even more challenging when the fear of litigation or peer review becomes the primary concern as opposed to the relative benefit or futility of continued care.<sup>4</sup>

The use of ultrasound has become widespread in the emergency department. However, to date, there is little literature describing its utility in the decision to cease CPR. There are some limited studies that address related issues. One study performed in 2001 looked at patients who arrived in the emergency department with CPR in progress. These patients were subject to immediate and brief subxiphoid or parasternal cardiac ultrasound examination. Of the 136 patients who had cardiac standstill on initial echocardiogram, 71 had identifiable electrical rhythms on the monitor. No patient with sonographically-identified standstill survived to leave the ED, regardless of their initial electrical activity.<sup>8</sup> This study was limited by its small sample size and may have been biased, because ultrasound results were not blinded (visualization of cardiac standstill may have led to a shortened resuscitation). Additionally, cases of ventricular fibrillation were also included, and it is possible that cardiac motion in these cases would be hard to assess.

A similar outcome was seen in a more recent study published in 2005 that looked at patients in asystole and PEA. Patients presenting without evidence of cardiac kinetic activity did not have return of spontaneous circulation. This study, however, contained only 70 patients and results of the ultrasound were not blinded to the physicians during the codes leading to possible investigator bias.<sup>9</sup>

Salen et al. in 2001 examined cardiac ultrasound

as well as capnography to predict resuscitation outcomes. One hundred and two cardiac arrest patients in the emergency department who underwent cardiac sonography during their resuscitation were studied. Of those 102 patients, only 41 had the presence of sonographic activity at any time during the resuscitation and 11 of those 41 patients survived to hospital admission (27%). Interestingly, of the 61 patients recorded as having had cardiac standstill, two patients survived to admission (3%). It can be questioned whether survival to admission is a meaningful clinical outcome. The conclusion was made that sonographic detection of cardiac activity was associated with an increased probability of survival to admission.<sup>10</sup> Limitations of this study include the fact that a small sample size was used and there may have been investigator bias since the results of the ultrasounds were not blinded.

This same 2001 study also examined the utility of capnography in their cohort of patients. Fifty-three of the 102 patients had ETCO<sub>2</sub> monitoring during their resuscitation, and it was noted that those who survived to admission had higher ETCO<sub>2</sub> values than those who died. It is possible that those higher values were due to superior CPR in those patients and this was the associated factor leading to higher rates of survival to admission.<sup>10</sup> However, the combination of capnography and echocardiography findings may be a useful combination in assisting the physician in the decision to terminate cardiac arrest resuscitations and deserves future study with a larger cohort of patients.

One interesting finding of our survey was the number of emergency physicians who are still practicing without access to ultrasound. Forty-seven percent of respondents stated that they did not have an ultrasound machine in the ED that could be used during a cardiac arrest situation. The reasons included interdepartmental politics, machine cost and lack of interest and training on the part of their colleagues. These reasons are similar to those published in a recent study, which also examined the current status of availability of ultrasound in emergency departments across the country.<sup>11</sup> In terms of machine use during resuscitations, the majority of physicians felt that access to an ultrasound machine would shorten code times, but at the same time they believed that the level of care delivered during cardiac arrest scenarios was no different without the use of ultrasound technology.

Three main limitations exist in this study. First, we sampled graduates of only one training program leading to potential selection bias. Second, the survey sought to elicit physicians' opinions as well as examine their practice patterns, and the value of this may be limited. A third limitation is recall bias; since graduates are simply relying on their memories of how code length was affected by ultrasound, their recall can be questioned. Further research with medical arrest cases randomized to ultrasound use or to no ultrasound use with accurate code times recorded could further document the value of ultrasound in shortening medical code times.

## CONCLUSION

In this survey of graduates of a large emergency medicine residency, we found that only 53% of graduates have access to ultrasound in their daily practice; when available, ultrasound was used by the majority of these physicians to assist in the decision to cease resuscitative efforts in cardiac arrest.

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