Handheld Doppler to Improve Pulse Checks during Resuscitation of Putative Pulseless Electrical Activity Arrest

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THE difficulty in determining pulselessness *via* manual palpation in simulated cardiopulmonary resuscitation (CPR) has been well documented in the literature. Previous studies have suggested that trained medical personnel demonstrate a specificity of only 55% for the manual diagnoses of pulselessness.[1] Other research has confirmed the poor diagnostic accuracy of manual pulse checks in a wide spectrum of test subjects—from nonmedical personnel to critical care physicians.[1–4] These data, along with accumulating evidence for the importance of early, high-quality chest compression to improve outcomes from out-of-hospital cardiac arrest, have led the American Heart Association to eliminate pulse checks from their algorithm for bystander CPR.*

In this context, the Advanced Cardiac Life Support algorithm for the treatment of pulseless electrical activity (PEA) arrest presents an interesting dilemma, as the very diagnosis of the PEA condition is predicated, by definition, on the finding of pulselessness. Although unnecessary chest compressions during bystander CPR are considered a relatively benign intervention, the failure to promptly diagnose the return of spontaneous circulation during in-hospital PEA Arrest may delay the institution of more targeted and appropriate care modalities. Ambiguity about the presence of spontaneous circulation during resuscitation is among many factors that contribute to the challenging task of "running a code."

Therefore, to assess possibilities for improving the detection of the return of spontaneous circulation during in-hospital resuscitation, we conducted a prospective case series (N = 8) during which handheld Doppler pulse checks were performed in parallel with standard Advanced Cardiac Life Support procedures during resuscitation of adults with putative PEA arrest or on whom electrocardiogram pads had not yet been placed in an academic tertiary care hospital. The outcomes of interest were (1) to measure the incidence of Doppler-positive-palpation-negative pulse in patients undergoing resuscitation for putative PEA arrest and (2) to measure blood pressure in discordant cases of Doppler-positive-palpation-negative putative PEA arrest.

This prospective study was approved by the Yale Human Investigation Committee, including a waiver of informed consent. Investigators applied a portable Doppler (Dopplex Pocket Doppler D900 Vascular Ultrasound with 8 MHz probe; Huntleigh Healthcare Ltd. [Diagnostic Products Division], Cardiff South Glamorgan, Wales, United Kingdom) to an available femoral artery during in-hospital resuscitation attempts for putative PEA arrest or in situations of unknown cardiac rhythm before electrocardiogram lead placement. The Dopplex D900 with associated probes has been deemed by the Food and Drug Administration to be substantially equivalent to other portable ultrasound devices routinely used for blood flow monitoring. Although this technology has been in existence for several decades, the sensitivity and specificity of such devices for detecting pulsatile flow during CPR remain unknown.

For inclusion in the study, a putative PEA rhythm was defined as an organized rhythm in the absence of a manual pulse, excluding ventricular tachycardia and ventricular fibrillation.† To be included in the case series, subjects also had to meet the following criteria: (1) aged more than 18 yr,

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* Highlights of the 2010 American Heart Association Guidelines for CPR and ECC. American Heart Association, 2010. Available at: http://www.heart.org/idc/groups/heart-public/@wcm/@ecc/documents/downloadable/ucm_317350.pdf. Accessed August 16, 2013.

† 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Part 7.2: Management of Cardiac Arrest. American Heart Association, 2005. Available at: http://circ.ahajournals.org/content/112/24_suppl/IV-58.full. Accessed August 25, 2013.

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(2) ongoing CPR, and (3) availability of a peripheral site for application of a Doppler probe. For included subjects, audible Doppler pulse checks occurred in addition to standard Advanced Cardiac Life Support procedures simultaneously with manual pulse checks. The site of manual pulse checks was not dictated by the research protocol. Doppler pulse checks occurred at an available femoral location that was not being used for the manual pulse check. In the event of a discordant finding of Doppler-positive-palpation-negative pulse, a repeat pulse check and blood pressure measurement were requested, with all management decisions left to the discretion of the code-runner. The cases represent a convenience sample of codes that occurred during times that a study investigator was available to respond. Codes occurred at a tertiary care hospital at which approximately 24 codes are called per month overhead, of which approximately 15% are true cardiac arrests.

Description of Cases

Summary

A total of eight subjects underwent the protocol. Discordant Doppler-positive-palpation-negative pulse checks occurred in five of eight cases for an estimated incidence of 62.5% (95% CI, 29 to 96%). In three of the five discordant cases, manual pulse checks following the finding of Doppler pulsatility resulted in a positive manual pulse check. In one of the five discordant cases, a radial artery catheter was successfully placed before repeat manual pulse check occurred, confirming pulsatile flow. In the fifth discordant case, repeat manual pulse check was negative followed by a visually confirmed pulse from a bounding carotid artery. Systolic blood pressures in the discordant group ranged from 58 to 160 mmHg with a mean of 106 mmHg. Diastolic blood pressures ranged from 30 to 100 mmHg with a mean of 56 mmHg. Four of five Doppler positive/manual negative cases survived to intensive care unit (ICU) admission, and none of the three concordant cases lacking pulsatile flow survived to ICU admission.

Case 1

Investigators applied the Doppler to the femoral artery site of a 45-yr-old male undergoing chest compressions for lack of pulse and before placement of electrocardiogram leads. During CPR, manual and Doppler pulse checks occurred at both radial and femoral locations without discordance (lack of pulse was found in both locations by both modalities). After placement of electrocardiogram leads, asystole was identified. Despite the continuation of CPR, there was no return of spontaneous circulation, and resuscitation efforts were eventually halted.

Case 2

Investigators applied the Doppler to the femoral artery site of an 82-yr-old male undergoing chest compressions for a putative PEA rhythm. At the first Doppler pulse check, there was a concordant finding of pulselessness. At the second Doppler pulse check, there was a discordant Doppler-positive-palpation-negative pulse. Compressions resumed at the direction of the code-runner without a repeat manual pulse check. At the next pulse check, a discordant Doppler-positive-palpation-negative pulse again occurred. A repeat manual pulse check was again negative at which time a member of the code team visually recognized the presence of a pulse in the form of a bounding carotid artery. A noninvasive blood pressure was measured at 160/100 mmHg. The patient survived to ICU admission.

Case 3

Investigators applied the Doppler to the femoral artery site of a 72-yr-old male undergoing chest compressions for a putative PEA rhythm. During CPR, manual and Doppler pulse checks found no pulse throughout the code. There was no return of spontaneous circulation, and resuscitation efforts were eventually halted.

Case 4

Investigators applied the Doppler to the femoral artery site of a 79-yr-old male undergoing chest compressions for a putative PEA rhythm. At the first Doppler pulse check, there was a discordant Doppler-positive-palpation-negative pulse. Compressions resumed at the direction of the code-runner without a repeat manual pulse check. At the next pulse check, a concordant Doppler-positive-palpation-positive pulse occurred. A noninvasive blood pressure was measured at 58/30 mmHg. Resuscitation efforts continued, including intermittent chest compressions based on manual pulse checks, and the patient survived to ICU admission.

Case 5

Investigators applied the Doppler to the femoral artery site of a 72-yr-old female undergoing chest compressions for a putative PEA rhythm that developed during a surgical procedure. At the first Doppler pulse check, there was a concordant finding of pulselessness. At the second Doppler pulse check, there was a discordant Doppler-positive-palpation-negative pulse. A radial artery catheter was placed at this time demonstrating a blood pressure of 80/50 mmHg. In the presence of an arterial line, manual and Doppler pulse checks were no longer performed. The patient eventually expired before leaving the operating room.

Case 6

Investigators applied the Doppler to the femoral artery site of a 35-yr-old male undergoing chest compressions for a putative PEA rhythm. During CPR, manual and Doppler pulse checks confirmed pulselessness at multiple timepoints without discordance. There was no return of spontaneous circulation, and resuscitation efforts were eventually halted.

Case 7

Investigators applied the Doppler to the femoral artery site of a 54-yr-old male undergoing chest compressions for a putative PEA rhythm. At the first Doppler pulse check, there was discordance between a Doppler-positive pulse and an “ambiguous” manual pulse. A repeat manual pulse check was performed, and a pulse was identified. A noninvasive blood pressure was concurrently measured at 102/54 mmHg. The patient survived to ICU admission.

Case 8

Investigators applied the Doppler to the femoral artery site of a 59-yr-old male undergoing chest compressions who had been shocked from pulseless ventricular tachycardia into a putative PEA rhythm. At the first Doppler pulse check, there was a discordant Doppler-positive-palpation-negative pulse. A repeat manual pulse check was performed, and a pulse was identified. A noninvasive blood pressure was measured at 127/42 mmHg. The patient survived to ICU admission.

Discussion

The current case series suggests that during attempts at in-hospital resuscitation, standard manual pulse checks frequently lag behind the Doppler recognition of the return of spontaneous circulation. The failure to identify a pulse on manual palpation may occur across a wide range of blood pressures, including in the presence of significant systemic hypertension.

Previous studies have documented the difficulty in determining pulselessness *via* manual palpation. In one study, for example, investigators used a cardiopulmonary bypass model of pulselessness in a group of 206 emergency medical technician and paramedic trainees and practitioners.[1] They brought subjects into a cardiac operating room and asked them to determine the presence or absence of a pulse by palpation of the carotid artery without knowing the cardiopulmonary bypass status of the patient before them. The median time to diagnosis of pulselessness among study subjects was 30 s. When asked to evaluate the group of patients who were not on cardiopulmonary bypass, 45% of study subjects made an incorrect diagnosis of pulselessness despite systolic pressures greater than 80 mmHg. Conversely, when patients were on bypass, 10% of participants diagnosed a positive carotid pulse despite the absence of pulsatile flow. When pulsatile flow was found, it took a median of 15 s to make this determination.

A second group of investigators inserted aortic pressure catheters in patients undergoing CPR. They found that of 94 patients who were diagnosed clinically with electro-mechanical dissociation (since renamed PEA), 41% were found to have measurable aortic pulsations. Two of these patients were found to have systolic pressures greater than 90 mmHg.[5]

In the current case series, the observation that three of five discordant cases were subsequently found to have a manually palpable pulse suggests that the addition of a portable Doppler to resuscitation efforts may enhance the accuracy of manual pulse checks. The portable Doppler pulse check is a practical and easily performed intervention that may help to address the difficulty of assessing pulsatility in a reliable and timely manner. However several limitations of the current case series should be highlighted. Most importantly, the effects of increasing the sensitivity of pulse checks during CPR on patient outcomes are unknown. Given the small convenience sample reported in the current case series, the benefits of Doppler pulse checks remain speculative. Among the potential benefits includes the possibility that the addition of Doppler pulse checks could prevent premature abandonment of the resuscitation effort based on an incorrectly negative manual pulse check. Supporting this notion, recent evidence has described significant differences in resuscitation times between hospitals, with more favorable outcomes associated with institutions that continue resuscitation for longer periods.[6] It is also possible that of the three concordant cases, some may have had spontaneous circulation that was missed by both pulse-check modalities which, if true, could imply that Doppler pulse checks are not sufficiently sensitive to prevent premature abandonment of resuscitation efforts. Further study is needed to investigate whether Doppler pulse checks may prove a useful addition to future in-hospital resuscitation algorithms.

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Competing Interests

The authors declare no competing interests.

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