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Editorial

Time is running out for manual pulse checks as ultrasound races past

Evidence is mounting against the utility of manual pulse checks in cardiopulmonary resuscitation (CPR).[1–8] Our previous study showed the diagnostic accuracy was 54 % for detecting any arterial line waveform and 66 % for detecting a systolic blood pressure $\geq$ 60 mmHg.[1] Yet, manual pulse checks remain the standard of care for detection of return of spontaneous circulation (ROSC) for most CPR providers.[9–10] In addition to our previous study, other research demonstrated point of care ultrasound (POCUS) pulse checks improve the accuracy of pulse detection[1,11–12]; however, POCUS pulse checks may not be generalizable to most CPR providers because it requires image acquisition and interpretation skills. Additionally, there are still concerns technical skills like POCUS in the hand of inexperienced sonographers may increase chest compression interruption times, although previous studies found POCUS pulse assessments were completed in a similar time as manual palpation.[12–13] Manual palpation is also an experiential skill, where expertise improves pulse assessment and compression interruption times.[2,6] Prior to this research, there appeared to be equipoise between pulse assessment times for POCUS and manual pulse checks.

In this issue of *Resuscitation,* Kang and co-authors sought to determine whether POCUS carotid artery compression (POCUS-CAC) was associated with improved pulse assessment times in comparison to manual palpation.[14] This is the most robust study on POCUS-CAC in cardiac arrest patients to date. POCUS-CAC involves placing a linear ultrasound transducer over the carotid artery in the neck and pushing down with pressure to compress it. ROSC is present if the carotid artery does not compress completely or if pulsatility of the carotid artery is visualized on the ultrasound screen. In this prospective study of 25 cardiac arrest patients and 155 pulse checks in the Emergency Department (ED), 2 separate physicians performed 1) manual palpation of the femoral artery with electrocardiogram (ECG) rhythm interpretation and 2) POCUS-CAC. Timing techniques were similar between the two groups as both the fingers and ultrasound probe were on the skin evaluating for a pulse prior to the pulse check, and each assessor timed their technique independently with a stopwatch.

The median average pulse assessment time per patient with POCUS-CAC was 1.62 (Interquartile range 1.14–2.14) seconds versus 3.50 (2.99–4.99) seconds with manual palpation. The median overall pulse assessment time was 1.31 (1.00–2.12) seconds with POCUS-CAC and 3.00 (2.19–4.91) seconds with manual palpation. There were fewer pulse checks greater than 10 seconds and greater than 5 seconds in duration with POCUS-CAC than with manual palpation. Manual palpaters with more experience had faster pulse assessment times, but experience did not affect the POCUS-CAC times. Although the majority all rhythm checks were asystolic (65 %) and pulseless electrical activity (21 %), the pulse assessment times were shorter for each rhythm assessed. Of note, these pulse assessment times are remarkably fast, which is likely because of the independent, trained physicians performing timed assessments of the two techniques. Still POCUS-CAC pulse assessments were faster no matter how the researchers assessed the data. On the contrary, the observed POCUS-CAC pulse assessment times are too brief for detection of carotid artery pulsatility with bradycardic heart rates in the 30 s or slower, which may decrease the accuracy of this technique (which was not studied). Additionally, the longer pulse assessment times for manual palpation may be explained by the palpaters waiting for ECG activity prior to confirming the presence or absence of a pulse, whereas ultrasonographers were instructed not to use the ECG by research protocol. Nevertheless, this study alleviates concerns that POCUS-CAC pulse checks may prolong chest compression interruptions, and likely are faster because of the objectiveness of POCUS versus the subjectiveness of manual palpation.

POCUS pulse checks have now been studied using varying techniques including visualization of the arterial pulsations,[11,13] arterial compression,[13–14] and Doppler ultrasonography.[1,12] As someone who has researched Doppler POCUS pulse checks, this research raises an important question: which POCUS pulse check technique is the easiest to learn and perform, and therefore likely to be the most generalizable? An advantage to POCUS-CAC over Doppler ultrasound for POCUS pulse checks is the ease of the compression only technique without the need to learn more complex Doppler ultrasound skills, such as ensuring the correct angle of insonation for blood flow evaluation.[15] In this study, POCUS-CAC appeared to be easily teachable. The 4 POCUS-CAC physicians received 1 hour of training, and 44 % of POCUS-CACs were done by physicians with fewer than 10 prior POCUS-CAC evaluations. On the other hand, they were fellow or attending physicians, who likely had prior POCUS experience that hastened their uptake of this skill; so, the ease of POCUS-CAC training may not be translatable to a paramedic, nurse, or physician who has not performed POCUS previously.

Unfortunately, the biggest weakness of this study is the inability to assess the diagnostic accuracy of POCUS-CAC since only 8

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patients (32 %) had an arterial line in place to confirm the presence/absence of pulsatility. This is one of the biggest limitations to previous pulse assessment research. Since few studies include an arterial line for pulse confirmation, few studies report diagnostic accuracy of pulse assessments.[1,3–6,11] While it makes physiologic sense that a collapsed artery on POCUS-CAC has no blood flow, this research cannot tell us whether an artery with low blood flow collapses, or whether the accuracy may be influenced by variable carotid compression pressures. Since the researchers demonstrated POCUS-CAC is quickly and easily performed, I hope they pursue the important further diagnostic accuracy research on POCUS-CAC.

The authors bring up another potential benefit of POCUS for pulse detection: the ability to evaluate arterial blood flow during active chest compressions. In an interesting subgroup analysis, the authors found that 60 % of episodes of ROSC were predicted by non-compressibility of the carotid artery during chest active chest compressions prior to the pulse assessment. This is a promising area of future research because predicting ROSC during active chest compressions could eliminate the need for chest compressions pauses, should increase chest compression fraction, and hopefully would improve patient outcomes.

Every-one who manages cardiac arrest patients has been in the situation where they are uncertain of their manual pulse assessment. In the stress of a cardiac arrest, our fingers are too subjective and blood pressures are often too low to be confident in our manual palpation findings. This study by Kang et al. demonstrates that this is associated with longer manual pulse assessment times in comparison to an objective measure like POCUS-CAC. Non-invasive, objective, accurate, easy to perform pulse assessment techniques and technology are needed in cardiac arrest. It appears we are at the brink of a change from manual to POCUS pulse checks in cardiac arrest, but many questions remain. Which POCUS pulse check technique is the easiest to learn and perform without sacrificing accuracy? Can a combination of arterial compression and Doppler ultrasound improve diagnostic accuracy? Can new ultrasound technology eliminate or ease the technical skills required for POCUS pulse checks? Can ultrasound predict intrinsic pulsatility during active chest compressions and eliminate the need for a pulse check at all? I am excited to see how researchers and technology transform the POCUS pulse check in cardiac arrest over the next decade, and to finally stop questioning my own and other's fingertips.

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