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Editorial

Can we stop patients from “falling off the cliff”?



Patients with shock from any cause are at risk for rapid deterioration and cardiac arrest. The vast majority of studies of cardiac arrest have focused on sudden cardiac death, usually caused by an arrhythmia such as ventricular fibrillation. On the other hand, studies of shock have typically focused on appropriate resuscitation and short-term or long-term mortality, not sudden deterioration. Few studies have looked at patients who suffer acute decompensation from shock to cardiac arrest in the out-of-hospital or in-hospital arena.¹ These patients may do better than patients who are already in arrest when emergency medical services providers arrive, but they still have poor outcomes even though the decompensation occurs with healthcare providers in attendance.

Theoretically, many of these cardiac arrests would be preventable if the providers could recognize the warning signs and rapidly intervene. More often than not, the warning signs come too late for adequate intervention, either because the signs are too subtle or the providers don't react quickly enough. For example, Richard, et al., found that systolic blood pressure (SBP) patterns in patients who ultimately suffered a cardiac arrest during helicopter transport demonstrated an inflection point at 80 mm Hg.² The problem is that this level of hypotension is very common in patients who don't suffer a cardiac arrest. Even though there seemed to be at least several minutes between this inflection point and the cardiac arrest, the lack of specificity of this parameter means that providers are still left with the question of when and how to intervene.

In this issue of *Resuscitation*, Davis et al. have reviewed the records of 70 patients who suffered a cardiac arrest from shock during helicopter transport.³ By employing a novel approach to the vital sign pattern prior to cardiac arrest, going beyond just SBP as in their previous study,² these investigators hoped to find vital sign data that could better predict cardiac arrest. They found a slow decrease in blood pressure and increase in heart rate followed by a terminal drop, with worsening shock index and a rapid decompensation to cardiac arrest. Unfortunately, the inflection points for these parameters included values that were similar to the initial values. End-tidal CO₂ (ETCO₂), on the other hand, decreased to abnormally low values before the inflection point of rapid decompensation. These findings suggest that close monitoring of vital signs, particularly ETCO₂, might yield early enough warning signs for rapid intervention by providers to prevent cardiac arrest. The challenge is that patients in shock, particularly young and otherwise healthy patients, can compensate very well until they suddenly decompensate and “fall off the cliff”, often too late for effective intervention.

Though the findings by Davis et al.³ are intriguing, they are inconclusive. In addition to the fact that the sample size is small and involved a single helicopter system, this study has significant methodologic limitations, which the authors acknowledge, leaving a number of questions unanswered. First, there is no data on the cause of shock. Though shock from trauma can respond quickly to fluid resuscitation, improvement in shock from sepsis or cardiac dysfunction takes more time for improvement. Second, there is no data on interventions by the providers. Did they miss the cues in vital sign changes? Did they intervene too late? Were their interventions appropriate for the matter at hand? Third, there was no comparison to patients in shock who did not suffer a cardiac arrest. If the same vital sign patterns occurred in patients who did not suffer a cardiac arrest, did the patients' physiologic response allow them to avoid decompensation spontaneously or did the providers intervene? Fourth, vital signs were typically recorded every 5 min, which may be too late when every minute counts. If decompensation occurs between readings, precious time for intervention could have been lost. More continuous monitoring may have a better chance for picking up vital sign inflection points in time to prevent decompensation.

Davis, et al., propose several desirable qualities for the ideal physiologic parameter that could predict imminent decompensation from shock.³ These are useful for future research in this area, with some caveats. First, they suggest that the pre-arrest pattern should be consistent across multiple patients. If they are referring to different patient populations, this may not be necessary or appropriate. One could imagine that patients decompensating from cardiogenic shock would have a different vital sign pattern than patients decompensating from hemorrhage. Assuming the providers know the patient's underlying pathology, they could look for disease-specific patterns. Second, they suggest that the parameter gradually changes over 30–45 min prior to arrest. This would be nice, but may not be a realistic expectation. Patients can compensate for shock very well, until they can't anymore; they reach the “point of no return”. Third, they suggest identifying a “clear pre-arrest inflection point after which deterioration accelerates but still leaves adequate time for intervention”. Indeed, this is the holy grail.

Future studies of vital sign patterns in patients in shock should include more information about the cause of shock and interventions by providers. All patients in shock should be included so that the difference in vital signs between those patients who go on to suffer a cardiac arrest and those who don't can better be described. For timely intervention, vital sign monitoring needs to be continuous or at least much more frequent

than every 5 min. Combinations of parameters or more detailed data within parameters, such as heart rate variability in addition to just heart rate, could help. The analysis could be even more sophisticated by utilizing big data and machine learning methods.⁴

Davis et al. should be commended for their efforts to identify the inflection point, or “point of no return”, in patients with shock who decompensate to cardiac arrest. They have demonstrated that collecting and analyzing this data is feasible. The next steps will be to determine if these patterns are unique to patients who suffer a cardiac arrest and if recognizing these patterns can allow providers to intervene earlier to stop the patient from “falling off the cliff”.

Conflicts of interest

None.

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