

# But It Makes Sense Physiologically...

Sara E. Crager, MD\*; Jerome R. Hoffman, MD, MA

\*Corresponding Author. E-mail: [scrager@mednet.ucla.edu](mailto:scrager@mednet.ucla.edu).



0196-0644/\$-see front matter

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<https://doi.org/10.1016/j.annemergmed.2018.06.007>

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[Ann Emerg Med. 2018;72:490-492.]

Point-of-care ultrasonography is increasingly being used as a tool to support medical decisionmaking in patients with undifferentiated shock. This is based on a series of assumptions about the physiology of shock, and the ability of point-of-care ultrasonography to differentiate assorted pathophysiologic states for which the optimal treatment is believed to vary. A number of small studies have suggested that point-of-care ultrasonography can improve disease-oriented endpoints, including diagnostic accuracy at the bedside; if this is true, the thinking goes, it should lead to improvements in what really matters—patient-oriented endpoints, including morbidity and mortality.

Many readers will therefore be disappointed that the first randomized controlled trial of emergency physician use of point-of-care ultrasonography in undifferentiated shock, which examined patient-oriented endpoints, had completely negative results. What does this mean, and where does it leave us?

There are many reasons a trial can have negative results, the most obvious being simply that the hypothesis is wrong and the intervention being studied is not beneficial. But there are other possibilities, and just as a single positive-result trial is rarely definitive, the same is true for a single negative-result study, even if the study is carefully conceived and performed. No study is perfect, and even minor methodological issues and biases can produce results that lead to an incorrect conclusion. In addition, any single study can, by chance alone, get the “wrong” results. Alternatively, benefit in a subset of patients can be obscured by absence of benefit—or even harm—in a different subset, making the results seem uniformly negative even though the intervention is useful in an important subgroup. Furthermore, if the intervention distracts us from other more important tasks, the net effect of even a “useful” intervention may be neutral. Finally, even if an intervention such as point-of-care ultrasonography provides

information that could be useful, it will not be so unless and until we know how to use that information; if our pathophysiologic reasoning is mistaken, or if the clinicians involved in the study misunderstand or misapply this reasoning, even the “best” data may lead to actions that harm as many patients as they help.

As is true of virtually any study, the randomized controlled trial of point-of-care ultrasonography by Atkinson et al<sup>1</sup> has substantial limitations. We believe two of the most important are as follows: the protocol used a single ultrasonographic result, which makes it impossible to benefit from the purported utility of point-of-care ultrasonography in guiding ongoing therapy through serial assessments. Perhaps even more critical, the study was substantially underpowered, with a sample size intended to detect an extremely ambitious 10% reduction in mortality. It is hard to identify any single intervention that has this much influence on mortality in acutely ill patients; to put this in perspective, the absolute risk reduction in mortality conferred by aspirin in acute myocardial infarction is something on the order of approximately 3%. If application of point-of-care ultrasonography in undifferentiated shock could decrease mortality by even 3%, it would be a resounding success, but a study of this size would be extremely unlikely to find such a benefit.

Despite these concerns, this carefully conducted trial did not show even a trend toward benefit. Although it is true that this negative-result trial is far from definitive, it also continues to be true that there is no evidence that point-of-care ultrasonography actually improves the patient-oriented endpoints that truly matter.

## BUT HOW CAN IT HURT?

Absent anything close to definitive evidence, we still have to decide what to do at the bedside. Despite the results of this trial, then, advocates may claim that we should keep using point-of-care ultrasonography because it might ultimately prove useful...and how can it hurt?

Unfortunately, such reasoning has proven to be terribly wrong in many cases, at great harm to patients. Examples

include the use of antiarrhythmics in acute myocardial infarction, decompressive craniotomy for elevated intracranial pressure that is refractory to all standard therapies, and tight glucose control in ICU patients, among many others.

Still, one might ask what possible downside there is of using a diagnostic imaging modality that is relatively inexpensive and does not expose the patient to ionizing radiation. One obvious potential harm is that point-of-care ultrasonography could divert time and energy from more important interventions. Time and resource allocation in the emergency department (ED) is a zero-sum game both on an individual provider and departmental level, so focusing on an unproven intervention at the expense of proven interventions is an obvious concern. Adding point-of-care ultrasonography to an ever-expanding list of things that need to be done can also lead to harmful neglect of other patients in the ED. In addition, as is true of any imaging modality, major downstream harm could result from unnecessary evaluation and treatment of incidentalomas and overdiagnosis. Finally, in the acutely unstable patient, major false-positive and false-negative results could cause significant harm, and increasing clinician certainty about potentially incorrect conclusions would obviously be very worrisome.

## THE PITFALLS OF CLINICAL DECISIONMAKING BASED ON PHYSIOLOGIC DATA

Most of what we do in medicine is not backed by solid evidence and relies instead on physiologic reasoning to help us make our best guess under suboptimal conditions. This has led to important advances; if a failing heart has trouble pumping against increased resistance, for example, it makes good sense that afterload reduction would be helpful...and indeed so it is. On the other hand, our knowledge of physiology has changed greatly and will surely continue to change. "Treatments" such as leeches and bloodletting surely made physiologic sense at one time, which is to say that such physiologic reasoning is only as good as our current understanding of pathophysiology. There are many examples of "scientific" approaches that unfortunately proved to be wrong, and that ended up harming patients.

In regard to the use of point-of-care ultrasonography in undifferentiated shock, the most obvious comparator is the use of pulmonary artery (Swan-Ganz) catheters for the hemodynamic monitoring of critically ill patients. The theory behind this seemed impeccable. Using real-time physiologic data to guide management made complete sense—until it was shown that its actual application in fact likely worsens patient outcomes.

Even assuming our understanding of the physiology is accurate, for management based on physiologic data to be helpful, a number of discrete criteria must be met. First, the data must mean what we think they do; central venous pressure, for example, is not in fact an accurate predictor of fluid responsiveness. Second, the data must be obtained accurately and reliably. This is often a major problem with skill-dependent procedures such as ultrasonography. Third, the data must be interpreted correctly; multiple studies suggest that even trained intensivists frequently misinterpret Swan-Ganz data.<sup>2-6</sup> Fourth, the appropriate management in response to the data must be readily apparent. Board-certified intensivists choose to initiate extremely different management strategies when provided with identical Swan-Ganz data.<sup>7</sup> Even were this not the case, there is evidence that chasing numbers may lead to overtreatment that is more harmful than helpful.<sup>8,9</sup>

Clinicians often lack insight into their own limitations. A particularly relevant example involves the response of intensivists asked about how well the data derived from pulmonary artery catheterization are understood; most respondents agreed that the understanding of "other practitioners" was poor, but were confident in their own ability to use such information for the benefit of patients.<sup>7,10,11</sup>

## SO WHERE DOES THIS STUDY LEAVE US?

It is impossible to know to what extent, if at all, clinicians in the current trial were able to meet the above prerequisites for successful use of physiologic data, or even to what extent the information provided by point-of-care ultrasonography can accurately define physiology in a way that means what most clinicians think it does. Indeed, current education about point-of-care ultrasonography tends to focus on how to do the procedure. We believe it needs to place at least as much emphasis on how ultrasonography can help construct a valid model of physiology.

The study by Atkinson et al thus cannot definitively answer whether some ideal version of point-of-care ultrasonography could be efficacious in improving patient-oriented endpoint outcomes in undifferentiated shock. What it does show is that the version of point-of-care ultrasonography used in this trial was not effective. Although answering questions about (real-life) effectiveness is ultimately more important, future studies that wish to answer the former question about efficacy (under ideal conditions) need to address how well point-of-care ultrasonography measurements can approximate the relevant physiologic parameters being sought, how accurate

and reliable is the data collection and interpretation, and how appropriate and predictable is the response to the data that are gathered. If such an ideal version of point-of-care ultrasonography could be developed, it could then be possible to test whether its application improves patient-oriented endpoints. And even if that could be shown, it would still be necessary to study whether such an ideal approach could be implemented by large numbers of practicing clinicians. To this end, clinical research will be most useful after point-of-care ultrasonography protocols have been specifically designed to allow a broad range of clinicians reliably and accurately to obtain, interpret, and act on the ultrasonographic data.

In summary, point-of-care ultrasonography, as performed in this first randomized controlled trial to assess patient-oriented endpoints, failed to find benefit. Although that doesn't preclude the possibility that a different application of point-of-care ultrasonography could be useful, as a general rule the standard for deciding about whether to adopt a new management strategy should not be "is it proven to be useless?" but rather "is there is adequate evidence of benefit?"

Still, the practice of clinical medicine routinely obliges us to make decisions about what to do in the absence of definitive evidence. Even thus hamstrung, we must decide what to do, using our best judgment (along with whatever limited evidence that we do have). We therefore don't believe it reasonable to insist that no one incorporate point-of-care ultrasonography into the evaluation of undifferentiated shock, even though this first trial result was negative. Anyone who chooses to do so, however, should at the very least have a well-thought-out plan in regard to exactly what information to gather, and how to respond to whatever results are obtained. Even that—a firm belief that one's reasoning makes sense—is no guarantee that the plan is actually a good one, or that patients will actually benefit. Furthermore, we should all understand, and take very seriously, two very important, and very disconcerting, truths: that ideas that seem logically unassailable frequently prove to be wrong, and that interventions that seem completely benign can in fact lead to substantial harm. Finally, as a community we need to be concerned that widespread adoption of an unproven approach makes it that much harder to conduct the studies that could ultimately answer the question about whether the approach is actually valuable, and, even more important, that much harder to abandon it if and when there is evidence that it is harmful.

*Supervising editor:* William R. Mower, MD, PhD

*Author affiliations:* From the Department of Emergency Medicine (Crager, Hoffman) and the Division of Critical Care, Department of Anesthesia (Crager), David Geffen School of Medicine at UCLA, Los Angeles, CA.

*Authorship:* All authors attest to meeting the four [ICMJE.org](http://www.icmje.org) authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

*Funding and support:* By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see [www.icmje.org](http://www.icmje.org)). The authors have stated that no such relationships exist.

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