The Future Has Arrived*

Once you have eliminated the impossible, whatever remains, however improbable, must be the truth.–Spock, Star Trek (2009)

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RBC transfusion was frequently used in septic patients with the intention of optimizing arterial oxygen content and its utilization by the tissues (1), thereby maintaining an adequate oxygen supply and minimizing cellular dysfunction progression (2).

The plasma concentration of macromolecules increases during the acute phase response to infection, enhancing aggregation of red blood cells, increasing blood viscosity, and reducing oxygen transport to the tissues (3, 4). Therefore, it seems desirable to evaluate RBC aggregation as a relevant marker of inflammation and tissue perfusion.

In this issue of *Critical Care Medicine*, Tripette et al (5) propose to use the Structural Factor Size and Attenuation Estimator by means of a new cellular imaging modality to assess real-time variations of RBC aggregation as a surrogate marker of inflammation in a cardiopulmonary bypass swine model. They succeeded in demonstrating a new technique that in the near future turns out to anticipate shock occurrence in postoperative sepsis. A new promising tool should be able to monitor real-time inflammation and possibly allow early recognition and management of the pathophysiologic process and hence possibly improve sepsis outcome.

Increased blood viscosity can worsen tissue perfusion, impede microcirculation, and increase pulmonary vascular resistance (6). Furthermore, it has been reported that worsening of gastric oxygenation by capillary obstruction by transfused old red cells will subsequently decrease to local blood flow (7). Erythrocyte aggregation is the basis for the blood echogenicity (8). It correlates well with the erythrocyte sedimentation rate and may in the future play an important role in the surveillance of critically ill patients.

Furthermore, it seems highly desirable to rely on a monitor with real-time capabilities of identifying hypoperfusion in critical care. Further investigation in humans would be highly desirable to overcome any technical problems. Microcirculatory alterations are frequently observed in critically ill patients and especially in patients with severe sepsis. These alterations are characterized by a decrease in capillary density and an increase in heterogeneity of perfusion with nonperfused in close vicinity to well-perfused capillaries. As a heterogeneous decrease in perfusion is less tolerated than a homogenously decreased perfusion, the diagnostic tool used to assess the microcirculation should be able to detect heterogeneity of perfusion. This is best achieved with handheld microvideoscopic techniques, such as orthogonal polarization spectral imaging technique and sidestream dark-field (SDF) imaging technique. The use of vascular occlusion tests with laser Doppler or near-infrared spectroscopy investigates microvascular reactivity, another important, but different, aspect of microvascular function. Combining techniques may be of interest in the future. Guiding resuscitation with the use of these tools may allow more complete resuscitation and improve outcomes.

An important subject characterizing critically ill patients is that capillary circulation cannot be predicted by macrohemodynamic parameters (9). As depicted in situations like septic shock or heart failure, despite an optimal macroperfusion (blood pressure, cardiac output, etc), microcirculatory perfusion could be inadequate and capillary flow severely altered and responsible for a persistent tissue ischemia. Using SDF imaging, microcirculatory flow can be visualized at the bedside, noninvasively, in different tissue regions (sublingual, rectal mucosa, etc). Hence, microcirculatory assessment becomes a part of the global hemodynamic evaluation in critically ill patients, as patient standards of care could be influenced. However, it is important to highlight that microcirculatory monitoring with SDF could be difficult as it has its own limitations regarding measurement errors (10), for example, different recordings of 20 seconds should be performed in different locations and microcirculatory quantification should be based on the average of multiple recordings, each being performed by two independent investigators. Indeed, sometimes the result presented (microvascular flow index, capillary density, etc) must be taken with caution for the present semiquantitative technique. Optimistically, in the future, new technology and measurement method should be developed to allow rapid, accurate, and reproducible assessment of capillary perfusion at the bedside. The aforementioned ultrasound technique presented by this new approach represents hope.

***See also p. e171.**

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Focused Echocardiography Trainee Curriculum and Competency: Demand Outpacing Training?*

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Agreement is unanimous. Critical care experts repeatedly maintain that point-of-care ultrasound education should be incorporated into critical care training curriculums. However, interest is currently growing beyond the pace of implementation.

Basic critical care ultrasound training to develop level 1 competency has been previously outlined to include a comprehensive program incorporating workshops, diverse didactic approaches, hands-on training, case-log maintenance, trainee diagnostic assessment, and expert supervised interpretation (1). Recently, a widely endorsed, large multinational expert panel from the European Society of Intensive Care Medicine agreed on a similar framework of principles to use in the implementation of ICU ultrasound training programs (2). In the meantime, other consensus statements from the American College of Chest Physicians, the American Society of Echocardiography (ASE), and the American College of Emergency Physicians (ACEP) have suggested similar reasonable minimum standards for point-of-care ultrasound (3, 4).

To date, the validation of point-of-care ultrasound curriculums has only been tested in mostly small studies (5–7). Despite promising results, trials testing focused echocardiography curriculums, either small or large scale, have not been as impactful as expected. This may be a testament to the difficulties of translating educational theory to clinical practice.

In this issue of *Critical Care Medicine*, Beraud et al (8) build on earlier studies in the emerging field of point-of-care ultrasound education (5–7, 9, 10). Over an approximately 1-year period, an ASE/ACEP consensus statement-based curriculum in focused transthoracic echocardiography was implemented and tested. Eighteen noncardiology fellows underwent evaluation in curriculum proficiency, simulation, and internet-based testing. In this study, which involved more trainees than most other studies to date, the trainees improved their diagnostic accuracy, time to diagnosis, and cognitive examination scores after curriculum implementation (8).

We congratulate the authors for their success in the development and implementation of a meaningful training curriculum. Although this study of curriculum implementation was well planned and executed, there were a few weaknesses. First, only one expert was involved in rating the adequacy of image acquisition and the validity of the interpretations. Ideally, this assessment of competence should involve more than one rater to allow for assessment of interrater reliability.

Another improvement in the study would have been the inclusion of a more complete description of the curriculum details to facilitate reproducibility. As stated earlier, one of the biggest obstacles currently preventing the widespread

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Key Words: competency; credentialing; echocardiography; point-of-care ultrasound; training curriculum

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