The Future of Critical Care Medicine: Integration and Personalization

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SIMPLE PROTOCOLS DO NOT WORK FOR COMPLEX PATIENTS

We have to admit it: “simple” protocols do not work in the “complex” world of critical care medicine! Although protocols can be useful in managing single, well-defined events, such as a thrombus in a coronary or cerebral artery or an appendicitis, they are considerably less effective, if at all, in conditions with multiple potential variants in complex patient groups, for example, managing intracranial hypertension in brain trauma, fine-tuning ventilator settings in patients with acute respiratory distress syndrome (ARDS), managing septic shock, or even providing adequate nutrition to ICU patients. Indeed, the complexity of critical illness means that simple, effective treatment protocols are difficult to develop and apply. For example, in septic shock, it is not possible to recommend a specific, fixed level of arterial pressure, cardiac filling pressures, cardiac output, or central venous oxygen saturation (ScvO₂) that is optimal for “all” patients. Likewise, it is naive and, indeed, somewhat foolish to recommend a single hemoglobin threshold that could be used to determine the need for blood transfusion in all patients (1). Clearly, for each variable, there will be a range of “globally acceptable” values, but within that range the optimal value for a specific patient will depend on multiple individual factors. Simple, effective protocols are not able to take all these considerations into account.

Nevertheless, despite the complexities of critical illness, multiple attempts have been made over the years to try and simplify management choices by conducting randomized controlled trials (RCTs) to compare various treatment options. The recent study comparing a buffered crystalloid solution with normal saline is a good example (2), as one should individualize the types of IV fluid given, as is done for drugs. Most groups of critically ill patients enrolled in clinical trials are heterogeneous, and almost all our interventions have beneficial “and” detrimental effects, which will be influenced in part by individual patient factors. How is it even possible that we thought that a trial comparing intermittent dialysis with continuous hemofiltration would give us a clear answer as to which was “best” in all patients, when we know the advantages and the problems associated with both techniques? Large prospective RCTs in critically ill patients are most useful when they demonstrate strategies that can limit iatrogenicity, the best examples being the avoidance of large tidal volumes (3) and use of prone positioning (4) or early neuromuscular blocking agents (5) in severe ARDS. A protocolized, “one-size-fits-all” approach is not the way forward for the majority of circumstances. Rather, the future lies in personalized medicine, with therapeutic decisions made on an individual patient basis, for example, steroids will be given in septic shock only when a particular phenotype is present, new interventions will be tested only in patients with specific organ dysfunction criteria, and supplementation will be started only when concentrations of the molecule in question are decreased.

Protocolized care may be useful in situations in which the quality of intensive care medicine is relatively low, especially when well-trained ICU physicians are not available. However, if used, there is a risk of a vicious circle developing because doctors who are told to follow protocols may no longer take any notice of, or even try to understand, basic pathophysiological alterations. Yet, the complex mechanisms of acute illness and the diversity of critically ill patients and their responses to therapy are what make critical care medicine so fascinating and rewarding. Watching and understanding how different patients respond to a change in ventilator settings, to a fluid challenge, to a small dose of vasopressor is an attractive aspect of our specialty and removing this feature by forced protocol adherence may encourage potential intensivists and other intensive care staff to look toward other, more stimulating—and perhaps more lucrative—specialties. The lack of trained ICU staff will increase the need for protocolized care, which in turn will further reduce interest in ICU work, and so the circle continues (Fig. 1). We need to ensure that critical
care medicine remains an interesting field and to encourage younger staff to join and experienced staff to remain. The development of telemedicine can help provide qualified consults and advice even for units without adequately trained staff on site, thus helping to break the protocol circle. We currently have too many applicants for critical care medicine in Brussels, and see no obvious reason why this is likely to decrease in the future.

**CHECKLISTS ARE USEFUL**

Although standardizing care with protocols does not work, the risk of human error will never be eliminated, so simple reminders or checklists are of use. Importantly, though, some thought needs to go into designing appropriate checklists. Complicated lists, which are too long or take too much time to complete, are unlikely to be effective (6) because they result in poor compliance (7) or, worse, people tick boxes without actually reading the statements. But short, focused checklists should be developed and used (8). Incorporation of such checklists into computer systems can be used to provide caregivers with important reminders about key aspects of patient management and best practice (9), for example, to think about prevention of thromboembolism or gastric ulcers, to increase caloric intake or to decrease the doses of sedative or analgesic agents.

**SUBSPECIALIZED ICUS ARE UNNECESSARY... AND MAY EVEN BE DETRIMENTAL**

Although critically ill patients are diverse in terms of individual patient factors, such as age and comorbidities and types and numbers of organ failures, the conditions associated with critical illness are actually similar. All ICU patients can develop the same problems of infection, electrolyte disorders, arrhythmias, or renal dysfunction; all ICU patients need to be fed and have their tissue perfusion optimized. As such, continuing to separate medical and surgical ICU patients makes little sense, the differences between these two groups of patients are actually really minor. In my opinion, subunits should also be avoided, as neurologic patients, patients after cardiac surgery, etc., have many similar problems to all other critically ill patients. Furthermore, lack of available beds in one subunit may result in a patient being admitted to the “wrong” section, where management may be of poorer quality because staff are not sufficiently trained in other aspects of critical illness (10). Excessive specialization can actually sometimes create more harm than good. Rather, all ICU patients should be managed together in large multidisciplinary departments of critical care medicine, with adequate numbers of specially trained intensivists, nurses, and other healthcare staff available to deal with all acute problems. Of course, having multidisciplinary units does not mean that individual intensivists cannot choose to have specific areas of clinical and research interest. But, regardless of any chosen subspecialty, every trained intensivist should be able to manage all the basic problems a critically ill patient may develop.

**THE PATIENT’S TRAJECTORY BEFORE THE ICU IS ALSO IMPORTANT**

Over recent years, we have increasingly come to realize that an ICU admission is just one part of a patient’s trajectory through his/her illness. In many hospitals...
around the world, ICU admissions are limited by the lack of ICU beds, so that patients are admitted only when they have already deteriorated to reach a state of crisis requiring emergency tracheal intubation or even cardiopulmonary resuscitation. These patients have a high risk of death and, if they survive, are likely to require prolonged ICU stays. Hospital and unit administrators and managers must appreciate that earlier ICU admission can result in shorter stays and, therefore, reduced ICU bed occupation and lower costs. Admission earlier in the disease trajectory will also improve the rehabilitation process, with fewer patients needing sedation and more patients being able to be ambulant at an early stage, associated with improved function and reduced long-term neuromuscular complications (11).

So, how can patients be admitted to the ICU sooner in their critical illness? First, we need to improve integration and collaboration with emergency departments and even with prehospital systems. Acutely ill patients arriving at the hospital should be managed jointly by emergency physicians and intensivists, in a spirit of mutual respect and positive collaboration. Ambulance teams need to be more aware of the key features of potential critical illness and patient management in ambulances needs to improve. Emergency department staff need to be forewarned about a patient's imminent arrival and better prepared to start appropriate treatment immediately. Improved collaboration between hospitals and better emergency systems will facilitate regionalization of care, as already occurs for trauma; regional centers are also needed for patients with stroke (with interventional neurologists available) or maybe after cardiac arrest (12). Ambulances can be equipped not only with electrocardiogram monitoring, but also with small echocardiography machines and even CT scanners so that early diagnosis can be made and some treatments, such as thrombolysis, already applied before arrival at the hospital (13), thus saving precious minutes. Once at the hospital, acutely ill patients will enter the emergency department through a passage equipped with modern imaging facilities, avoiding the need for later transfers to radiology departments and again aiding rapid diagnosis so that treatments can be appropriately directed. Less time will be spent being evaluated in emergency departments; rather an initial evaluation will rapidly determine the likely critical illness and, much as trauma teams have been developed for the multi-trauma patient, so sepsis teams or shock teams will be available to rapidly start evaluation, investigation, monitoring, and treatment. As in trauma teams, the “event” must be overseen and directed by a “team captain” with other team members including doctors, nurses, phlebotomists, perfusionists, etc. Secondary transfers will be rapidly arranged for specialized procedures, such as extracorporeal membrane oxygenation, until technology and training have evolved so that these interventions are much more widely available.

INTEGRATED INTENSIVE CARE: PATIENTS AND EQUIPMENT

As we move toward a more integrated form of intensive care, we must not forget our ICU equipment. We still have far too many monitors around the patient's bed (Fig. 2) and not enough interaction between them. The huge advances in information technology could revolutionize patient management. Closer interaction between ventilator readings and hemodynamic monitors could help better identify signs of fluid responsiveness; even the relatively complex leg raising procedure (14) could be automated to some degree. Closed-loop systems will better evaluate the response to therapy and automatically adjust dosages accordingly. Computerized systems can help staff identify problems, without substituting for their clinical evaluation and experience. By providing an intelligent trend evaluation, these systems can help in the early identification of a new problem, allowing more proactive interventions.

Technological advances will also make organ support less invasive and easier to apply. Endotracheal intubation will be less commonly required, as simple gas exchange systems will be inserted IV. These systems will be coupled with continuous extracorporeal renal support to support failing kidneys and personalized metabolic support, choosing the correct dose of the right constituent for each patient. New cardiac support systems will be developed, including artificial hearts (15).

CONCLUSIONS

Importantly, mortality rates in our ICUs should not decrease: the present 15% average (16) is probably optimal. Our patient population will be older and sicker, but patients will spend less time in the ICU because we will stabilize them quicker. And in those patients who are clearly not benefitting from ICU treatment, we will perhaps decide earlier to allow them to die peacefully.

We must push critical care medicine to its limits by incorporating new technology, collaborating with other hospital departments, limiting protocolized care to units where well-trained intensivists are not available, and adopting more personalized medicine—in so doing, we will continue to make great progress.

REFERENCES


