Published in final edited form as:

Crit Care Med. 2014 April ; 42(4): 996–997. doi:10.1097/CCM.0000000000000084.

The Evolving Application of Implementation Science in Critical Care*

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Keywords

hospital-acquired infections; implementation science; intensive care units; mechanical ventilation; telemedicine

We are fortunate to be able to practice medicine at a time when we have many evidence-based therapies and practices to improve critical care outcomes (1). But like all areas of medicine, these scientific advances are not always adopted in clinical practice (2). Now, implementation science is increasingly being used to help us. Implementation science asks why therapies are not fully adopted, how to accelerate adoption, and how to achieve high-fidelity practice. Modern implementation science has supplanted traditional (and less effective) methods of implementation, which rely on hospital administrators, guideline-writing committees, or conference speakers to lead implementation efforts (3), in favor of a multifaceted, multidisciplinary approach that focuses on direct provider contact at or near the point of care and that frequently employs new technology.

ICU telemedicine is one such new technology that has been shown to improve patient outcomes (4, 5). This system-level intervention has commonly been thought of as a means of addressing the growing deficit of trained intensivists to care for a rising population of critically ill patients. ICU telemedicine provides high-intensity intensivist coverage, improving patient outcomes (albeit from afar) in hospitals whose ICUs use a low-intensity coverage model or who do not have 24-hour intensivist coverage.

In addition to remote monitoring of patients, ICU telemedicine can provide remote screening to alert providers to improve the use of evidence-based therapies or best practices (4). This exemplifies another important trend in critical care implementation: transitioning from impersonal, top-down interventions to interventions much closer to the point at which a decision is made. Checklists, reminders or prompting, audit and feedback, and local opinion

*See also p. 896.

leaders are examples of this approach, which incrementally improve processes of care and patient outcomes (6–8). However, these interventions are resource-intensive, especially for hospitals that may not have the resources or priorities to establish a high-intensity critical care practice model. As a result, the scalability of some of these implementation interventions, for example, bedside prompting, may not be feasible.

In this issue of *Critical Care Medicine*, Kahn et al (9) intriguingly merge these two recent lines of critical care implementation research by extending the paradigm of ICU telemedicine to focus solely on screening for omissions of evidence-based care and by building on the idea of an external prompting mechanism that relies on dedicated prompting personnel. At a single academic medical center, they employed a pre/postimplementation design to determine whether remote screening for selected practices—including ventilator bundle compliance, concordance between sedation orders and level of sedation, and the appropriateness of indwelling catheters—and prompting providers if gaps were observed improved adherence to these practices. Remote monitoring was unnecessary at this medical center as it has 24-hour in-house intensivist coverage. Instead, the ICU telemedicine infrastructure focused on remote screening: dedicated ICU nurses, whose sole responsibility was to perform this function, audited the electronic health record at least daily and contacted bedside nurses if providers omitted evidence-based care.

Including 13,277 patients, they found that patients admitted in the postintervention period 1) were more likely to receive sedation interruption and a spontaneous breathing trial, 2) were not more or less likely to have hospital-acquired infections, and 3) had shorter adjusted mechanical ventilation duration and ICU and hospital lengths of stay. They demonstrated no difference in mortality with the intervention.

There are several limitations to this study. As with many implementation studies, the authors used a pre/post study design without concurrent controls. This is often necessary when conducting initial studies of a system-level intervention at a single site. However, this design is prone to erroneous conclusions if there are preexisting trends at the time an intervention is implemented. The authors made a solid attempt to address this by examining temporal trends during the period preceding the intervention and by performing sensitivity analyses. However, their ability to assess trends is limited by the availability of only 6 months of preintervention data. Time-series analysis with one full year of data prior to implementation would have been optimal and should be a goal for future similar studies (10). Yet, this is often difficult because the understandable imperative clinicians feel to implement innovations rapidly. Alternatively, recent studies have used quasi-experimental and randomized trial designs, enhancing confidence in a study's causal inferences and allowing for rapid intervention roll-out (7, 8).

In addition, the degree to which bedside providers accepted prompting from the remote screeners is unclear. The authors do not present data on the frequency with which prompting led to changes in patient management or how often the prompted bedside nurse communicated with the rest of the multidisciplinary team. Prompting that is removed in time and space from the point at which a patient is first eligible for an intervention may be less effective. This may explain the lack of improvement in some processes of care, hospital-

acquired infections, and mortality. Ultimately, the mechanism of improvement remains unclear, and it is possible that some of the improvement observed resulted from a Hawthorne effect of providers knowing their care was being examined. Implementation studies should attempt to understand not only whether an intervention works but also the mechanisms driving change.

It is unreasonable and dangerous to expect critical care providers to remember to use all evidence-based practices in a system as complex and evolving as the ICU. Indeed, even strongly evidence-based care, such as lung protective ventilation in acute respiratory distress syndrome, remains underimplemented (2). When this occurs, we fail to most effectively achieve the promise that clinical trials of these therapies demonstrate.

Implementation science aspires to fill this void. The work by Kahn et al (9) is an important step in the maturation of implementation science interventions from the impersonal and distant to the more direct. They take advantage of telemedicine technology and couple this technology with newer implementation strategies focused on near real-time, point-of-care interventions, such as prompting. This merger of technology and strategy may help achieve an efficient balance between the advantages of bedside prompting (real-time direct intervention) and the advantages of telemedicine (centralization and scalability). Studies such as this one by Kahn et al (9) will help us learn more about which implementation methods most effectively translate evidence-based therapy into clinical practice.

Acknowledgments

Dr. Weiss received grant support from the National Heart, Lung, and Blood Institute (K23118139-01) and Parker B. Francis Fellowship Program and received support for article research from the National Institutes of Health.

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