ICU Telemedicine and the Value of Qualitative Research for Organizational Innovation

The story of ICU telemedicine started in the 1970s, when an intensivist at a university hospital connected to a single small ICU using audiovisual technology to remotely conduct daily patient rounds and weekly teaching rounds with the local staff (1). Telemedicine, a technology-based strategy to improve patient care and outcomes, can extend the reach of nursing and physician specialists to greater numbers of critically ill patients, can serve as a platform for quality improvement and benchmarking efforts, and can facilitate the development of hospital networks that may add efficiencies to our healthcare system. On this promise, ICU telemedicine presently covers more than 10% of ICUs in U.S. hospitals, and seems to be growing still (2, 3). It seems safe to say that it is here to stay.

However, the literature on the effectiveness of ICU telemedicine has not been convincing. The story has evolved over the past 40 years much like those of other organizational innovations—a series of variable-quality studies of heterogeneous interventions with mixed results (4). The most recent systematic review was somewhat encouraging. A meta-analysis of the nine existing studies of patient outcomes demonstrated that telemedicine was associated with lower ICU and hospital mortality rates (risk ratio, 0.79 and 0.83, respectively) (5). However, all of these studies used prepost designs, the interventions were heterogeneous, and the overall study quality was only moderate. The costs of establishing and maintaining ICU telemedicine programs are substantial: first-year costs are estimated to be up to $100,000 per monitored ICU bed without clear resultant cost reductions (6). Thus, understanding how to optimally implement ICU telemedicine is crucial.

In this issue of the *Journal*, Kahn and colleagues (pp. 970–979) use qualitative research methods to develop a conceptual model for ICU telemedicine effectiveness (7). Based on prior quantitative work (8), the authors used a positive/negative deviance approach (9) to select six telemedicine programs and 10 ICUs monitored by those programs for site visits, interviews, and focus groups. Analysis of 460 hours of direct observation, 222 interviews, and 18 focus groups resulted in the identification of three primary domains of ICU telemedicine effectiveness: leadership, perceived value, and organizational characteristics. Perceived value, for example, was generally absent for programs without improved patient mortality after adoption. It also moderated the impact of both leadership and organizational characteristics. Organizational characteristics common to programs with improved mortality included having shared staff (nurses and physicians worked in both the telemedicine facility and the ICU) and orientation of new hires. The study authors also described how components of the telemedicine program might interact with contextual factors in the target ICU environment, providing an explanation for why a program may be effective in a dyad with one ICU but not another.

The greatest strength of this study is the choice to apply qualitative methods to understand a complex process in its context (10). "Every ICU has certain situations or has certain circumstances that are different than others, and so you can't just put in the IT," said one telemedicine medical director. So it should be no surprise that the evidence for the effectiveness of ICU telemedicine has been limited and mixed. Organizational interventions are not as straightforward as therapeutic interventions; they are complex, multicomponent programs that affect multiple stakeholder groups and are in turn influenced by contextual factors. This is especially so in the complicated, high-stakes, interprofessional environment of the ICU. Because new organizational models must be tailored to local needs, they are messy and challenging to assess quantitatively and with generalizability. Clinical trials are nearly impossible to conduct due to costs and logistical challenges, as exemplified by the organizational innovations of ICU physician staffing models (no trial [11]) and nighttime intensivist staffing (one trial [12]). ICU telemedicine is another example of the challenge—perhaps the impossibility—of using traditional quantitative methods to completely elucidate the effectiveness of an organizational intervention.

Using a rigorous qualitative approach, this study provides empirical evidence to guide institutions seeking to establish ICU telemedicine programs. It also lays a pragmatic foundation for the implementation—or perhaps the deimplementation—of components of ICU telemedicine programs where they already exist. Many ICUs already have substantial financial and resource investments in telemedicine programs, making it impractical for them to adopt a single model that has proven effective in a trial. It may be possible, however, to modify programs to increase the likelihood of improving patient care and outcomes.

The limitations of this study arise primarily from its generalizability. Although the authors approached more telemedicine programs for participation, in the end they surveyed only 10 dyads. Given the great diversity of ICUs in this country, the included units likely do not represent all the variability that exists. For example, all of the studied programs used a centralized telemedicine model. Less common, decentralized ICU telemedicine programs may have different determinants of effectiveness. And although one of the great potential benefits of ICU telemedicine is increased access to critical care specialists, all of the study ICUs except one had at least some availability of bedside intensivists (13). The needs of ICUs without any intensivists are likely to be very different and may not have been captured.

There will never be a landmark clinical trial of ICU telemedicine. No large experimental study could capture all the nuances of a complex organizational intervention and the contextual

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factors that influence its effectiveness. Although unanswered questions about ICU telemedicine remain, this qualitative study provides us with a practical guide for local implementation, as well as for future qualitative and quantitative research. Furthermore, it a useful reminder of the value of qualitative research for organizational innovations. ■

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The Search for Efficacious New Therapies in Sepsis Needs to Embrace Heterogeneity

Most new drug treatments fail because they lack efficacy (1). In sepsis research, new therapies must contend with an additional barrier: the intractable heterogeneity of the sepsis syndrome (2). Together, these challenges have so far proved insurmountable. Hundreds of clinical trials have been conducted, at a cost of hundreds of millions of dollars, to test new agents to modulate the host response to injury in sepsis. None have succeeded (2).

The sepsis syndrome itself is simultaneously too broad and too narrow. Sepsis encompasses numerous different etiologies and pathophysiological processes, but—by definition (3)—excludes sterile injuries that lead to the same pathophysiology and organ failures, such as trauma, burns, hemorrhage, and pancreatitis.

Some components of heterogeneity in sepsis are clinically apparent, such as variability in causal pathogens, comorbidities, environmental factors, and host genetics. But there is also evidence from recent studies (4–6) that important pathophysiological processes that are active in sepsis patients may vary in ways that are not directly observable at the bedside. If so, there is a chance that these processes may be amenable to different treatments (Figure 1).

Large observational studies of blood transcriptomics applied to sepsis populations have provided several models based on molecular classification of patients with sepsis. In particular, the Genomic Advances in Sepsis (GAinS) consortium in the United Kingdom (4, 6) and the Molecular Diagnosis and Risk Stratification of Sepsis (MARS) consortium in the Netherlands detected distinct molecular endotypes in leukocyte genome-wide expression profiles from samples collected on ICU admission. The MARS consortium identified four molecular endotypes in all-cause sepsis (designated MARS 1–4) (6), whereas the GAinS consortium identified two molecular endotypes in

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