ICU Telemedicine Solutions

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KEYWORDS

• Telemedicine • Intensive care unit • eICU • Virtual medicine • Tele-ICU

KEY POINTS

- Intensive care unit (ICU) telemedicine programs have improved patient safety practices by standardizing best-practice processes and achieving high rates of adherence through real-time collaboration.
- ICU telemedicine programs provide an effective solution to the problem of alarm fatigue and provide immediate management by off-site Critical Care experts.
- ICU telemedicine programs are one remedy for physician and nursing staffing shortages.
- ICU telemedicine programs can improve the financial performance of health care systems that standardize processes and engage in population management.
- ICU telemedicine–associated reporting solutions and real-time intervention are increasingly being used to improve ICU quality metrics, including those that are publicly reported.

INTENSIVE CARE UNIT TELEMEDICINE SOLUTIONS

In April, 1924, *Radio News*[1] teased that a "radio doctor" may someday bring virtual medical care directly to patients. In that decade, house calls were common and twice-daily hospital rounds a mainstay of patient evaluation and treatment so the construct probably seemed nonsensical. However, the increasing need for high-quality subspecialty care and advances in telecommunication technology have now transformed that prescient fantasy of 1924 into an achievable and increasingly common[2] approach to getting the right expertise to the right patient at the right time.

This article focuses on critical care services that are provided via telemedicine. It describes the evolution of the technology and the ways that telemedicine tools are supporting the practices of critical care professionals.

The potential for telecommunications technology to make information available where and when it is needed was explored nearly 40 years ago by a group that provided real-time intensive care unit (ICU) consultation using television.[3,4] The failure of this attempt to use telecommunication tools without informatics support stifled the development of ICU telemedicine. Clinicians learned that television consultation that relied on verbal descriptions of clinical information is

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inefficient and prone to errors of omission and interpretation. Since then, advances and integration of health information technology have led to the wide adoption of ICU telemedicine. Reports from a 1997 intervention provided proof of concept for a critical care delivery construct in which off-site intensivists could deliver care that was superior to usual care.[5] The maturation of the tools and refinement of the interactions among bedside clinicians and off-site intensivists led to reports from Norfolk, Virginia, of an ICU telemedicine program implementation in the year 2000 that was associated with less mortality and shorter length of stay (LOS).[6]

These studies led to the commercialization of enabling health information and telecommunications technologies.[7,8] The adoption of ICU telemedicine was increasingly driven by the evolving shortage of critical care–trained physicians that was accurately predicted by Angus and Kelley.[9] During the first decade of the growth of ICU telemedicine, services were most commonly delivered by a team of professionals located at an off-site telemedicine center. Initial reports were promising because program implementation was associated with lower ICU mortality and ICU LOS.[2,8,10] One key element of these reports was that access to high-quality critical care services was increased through workforce leveraging that allowed each telemedicine intensive care specialist to support many more patients than was possible with geographically restricted staffing models.

These early reports were followed by studies of ICU telemedicine program implementations with mixed results, including studies that were not associated with significantly reduced mortality or LOS.[11–13] One conclusion was that simply making telemedicine tools available is not sufficient to guarantee improved outcomes. Several investigators prominently cited poor integration and acceptance of the telemedicine program in the conventional work flow of the ICU as one explanation for limited impact. The recognition that both implementation and outcomes were heterogeneous led to analyses of combined studies.[10,13] These reports also generated mixed results because some could not distinguish a lack of effect because of inadequate sample size.[10,14] Moreover, lack of information about specific processes that were changed by this complex intervention made it difficult to identify characteristics and process changes that predict association with better outcomes. A subsequent large multicenter study showed that workstation-assisted remote intensivist case review, improved adherence to ICU best practices, reduced response times to alarms, interprofessional rounding, and real-time use of performance measures were characteristics of ICU telemedicine programs that were significantly associated with larger reductions in mortality and LOS.[15]

Three common factors have emerged that prompt transitions from traditional ICU staffing models to those that integrate ICU telemedicine: (1) enhanced patient safety; (2) a workforce solution; and (3) improved outcomes through population management, standardization of the process of care, and reporting solutions that improve ICU management.

PATIENT SAFETY

The most common primary driver for the earliest wave of adoption of an ICU telemedicine program was patient safety. An influx of patients presenting to hospital emergency departments with critical illness and injuries[16] increased the number of at-risk patients at a time when workforce growth was limited by a lack of physicians who were trained in critical care,[9] the restriction of duty hours for physicians in training,[17] and nursing workforce shortages.[18]

Further, the advent of sparsely tested and expensive bedside monitors resulted in new risks for patients. One widely adopted strategy to limit labor costs was to replace telemetry staff with monitoring systems that alerted bedside staff at central monitoring stations. The unintended consequence of relying on monitoring systems with high false-positive alarm rates was that some alerts were missed because most were not actionable.[19–24] Increased rates of failure to rescue have defined the alarm-fatigue crisis that is a target of current national patient safety efforts.[25]

ICU telemedicine professionals who provide real-time evaluation of physiologic alerts, filter false-positive signals, and triage true-positive alarms are one effective remedy for alarm fatigue.[26] A community hospital 10-bed ICU with an average APACHE IV (Acute Physiology and Chronic Health Evaluation) score of 50 to 60 generates as many as 100,000 alerts for physiologic instability per year. Most alerts are attended to by bedside nurses, but several true-positive events per patient per day are not recognized by the bedside team in a time that is considered safe. On average, video evaluation by an off-site critical care professional resulted in more than 1 intervention per ICU per day that was recorded in the medical record as involving a major change to the care plan. Telemedicine interventions for higher-acuity populations are more frequent despite the availability of more bedside resources; however, delays in bedside attendance to true-positive alerts are