Tele-ICU: Models, Outcomes, Optimization, and a Strategic Evaluation Framework

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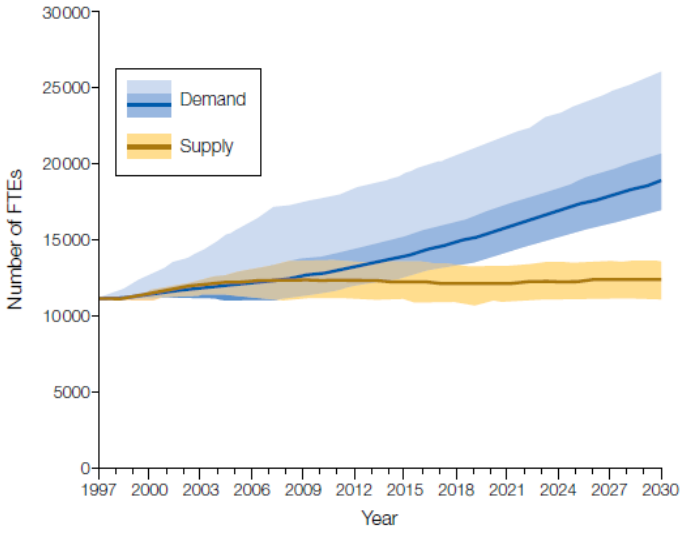
Background

Intensivist-directed care models play an important role in the deliverance of effective, expert-level care in the intensive care unit (ICU). Intensivist-directed critical care is associated with improved ICU mortality, reduced ICU length of stay, and lower cost of care amongst critically ill patients [1-4]. Currently, only 14% of patients admitted to ICUs throughout the United States receive intensivist-directed care despite widely recognized best practices that all ICU beds have such oversight [3, 5]. One important reason for this is a national shortage of intensivists. A Health Resources and Services Administration (HRSA) study projected a 1500 intensivist deficit by 2020 [6]. This deficit is even more pronounced in rural areas and is expected to worsen in the next decade (see Figure 1) [7-9].

Figure 1: Mismatch between critical care physician supply and demand based on sophisticated models factoring population growth, retirement rates of physicians, work hours, new physician estimates and others by Angus et al [9].



ICU telemedicine (Tele-ICU) was developed to bridge the gap between the need for expert-level critical care oversight to a larger proportion of the U.S. population than can be achieved through conventional care delivery models [3, 8]. Tele-ICU refers to the healthcare delivery for critically ill patients by an intensivist from a remote location using electronic transfer of information through interactive, two-way audiovisual tools [10, 11].

Tele-ICU Structure

Tele-ICU providers utilize local electronic health records, computer order entry, telemetry, imaging software, and risk-prediction algorithms to trend physiologic variables, identify early clinical deterioration, and respond to alarms and crises [1, 3, 7]. The intensity of the tele-ICU interaction care can be highly customized based on timing (continuous vs intermittent), reactivity (proactive vs reactive), and scope (full autonomy to minimal discretion) to meet needs of the receiving

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organization [4]. The overall goal is to utilize remote intensivists to provide uninterrupted critical care oversight at all times [3].

The most commonly used tele-ICU model is a hub-and-spoke organizational design (see figure 2a) [12]. In this model, the most advanced healthcare services are strategically centralized at a single hub and is home to tele-ICU providers. The spokes represent outlying facilities that may either be owned by or contracted by affiliates of the hub. The tele-ICU team at the hub provides remote coverage for ICU beds at each spoke from a central location based on each spoke's individual specific arrangement. The physician service model (figure 2b) is an alternative tele-ICU model that employs individual intensivists from multiple institutions and is not affiliated with one hospital entity. This decentralized practice serves more as a private virtual practice, and typically functions as a specialist on-call consultative service, rather than providing continuous oversight [4, 12].

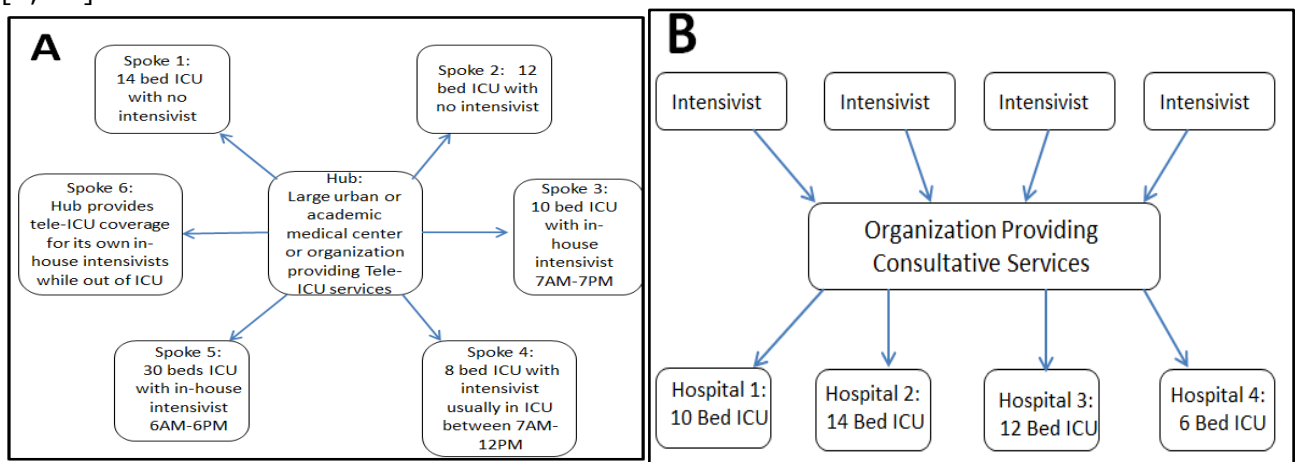

Figure 2: A) Hub-and spoke model of tele-ICU coverage, where tele-ICU providers are centralized at a single, large institution. B). Physician service model utilizes de-centralized tele-ICU providers who come together to form a virtual practice.

Tele-ICU Outcomes

Early clinical data on tele-ICU outcomes reported significant reductions in mortality and ICU length of stay, mostly from single-center before/after study designs [4, 13]. Despite comparatively weak study designs, these initial reports sparked a surge in technology development and implementation of tele-ICU programs. Last evaluated by the New England Health Care Institute (NEHI) and the Massachusetts Technology Collaborative in 2010, there were 50 programs at 250 hospitals with ongoing growth subsequently.

More recently, a tele-ICU systematic review conducted by the Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers, analyzed 22 studies evaluating mortality, costs and adverse effects with grading of evidence. [14] The study concluded there was moderate quality evidence to support the improvement in ICU and hospital mortality with tele-ICU, however, insufficient evidence to make a case for the economic benefits of tele-ICU.

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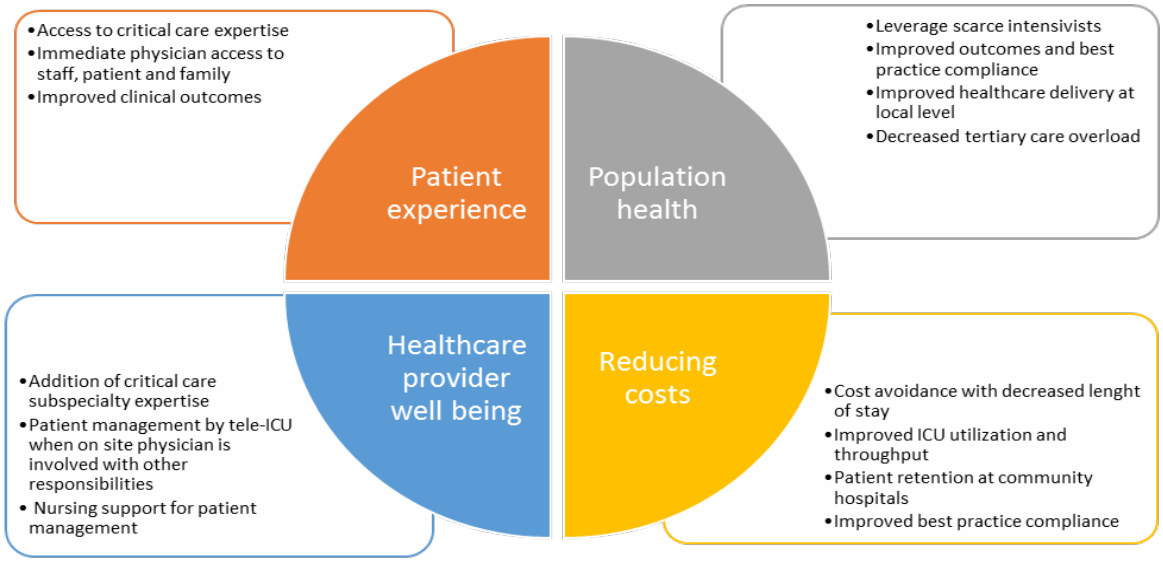
The costs associated with a tele-ICU program are a major concern for health systems as these are not currently reimbursement by CMS or third-party payers. This makes justifying the establishment of a tele-ICU program challenging, especially for resource-limited hospitals. While some studies have shown favorable financial gains through increased case volume, revenue, and lower cost of care [15], more robust studies are needed to further elucidate the cost-to-benefit financial performance of tele-ICU programs.

Tele-ICU Optimization

The need for a high performing, cost-effective critical care services is frequently the strategic driver for adopting tele-ICU by a hospital. A strong tele-ICU program positively impacts a hospital's ability to achieve the Institute of Healthcare Improvement's "Triple Aim" of improving patient care experience, improving population health and reducing the cost of care; along with improving the work life of health care providers that is now proposed as a fourth aim (see Figure 3).

Figure 3: The Quadruple Aim of Drivers for Tele-ICU Adoption



Tele-ICU represents an innovation that has the potential to improve access to and quality of critical care, however, its impact varies on how it is applied. The effectiveness of tele-ICU begins with the onboarding process and implementation. Some key characteristics to consider include developing tele-ICU protocols for day to day clinical work in the ICU, triage systems to ensure the sickest patients are provided immediate assistance in an active manner (rather than passive monitoring), striving to improve communication for co-management of patients between the tele-ICU and bedside teams (e.g. sign-out, collaborative rounding models, agreement on standard best practice approaches).

Thus, for optimization of tele-ICU, it is imperative to understand the wide range of hospital environments, local culture, available resources and promote active integration between tele-ICU team and local hospitals. One recent study utilized a robust qualitative design and evaluated 10 sites that had adopted tele-ICU and identified 3 main themes for success of tele-ICU- *leadership*, *perceived value of front-line providers* and *organizational structure* that can support tele-ICU.

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[16] This study highlighted that the above factors cannot exist in silos and had to interact with each other positively to optimize the success of tele-ICU. Although a decade of research has showcased the potential benefits of tele-ICU, future research studies should focus on understanding how and when tele-ICU should be adopted for maximal benefit.

Strategic Evaluation Framework

During the early phase of expanding the tele-ICU program at MUSC, we began experiencing certain factors that were positively associated with uptake, adoption, implementation, success and sustainability of the program. Additionally, we observed that hospitals lacked a strategic framework through which they can effectively analyze and improve their performance after adopting a tele-ICU program. Recognizing this important need and the dearth of available tools in the area, we identified the "Balanced Scorecard" (used in business analyses) conceptual framework that acknowledges that no single measure can provide an assessment of the value obtained from a program.[17] Adapting this framework, we identified 4 value domains (organizational, clinical, financial and strategic domains) as important factors for success of a tele-ICU program. [18]

Organizational Domain: The organizational domain characteristics include: site specific structural, cultural and human factors impacting the benefit perceived from tele-ICU. First and foremost, assessing the exacted need for a tele-ICU program for the hospital is the initial step. Subsequently, the tele-ICU program will need to obtain buy-in from all stakeholders (eg: bedside physician, nurses, tele-ICU providers, IT staff, paging operator) involved in the adoption and implementations of the program. Finally, the program will need to account for and adapt to the specific rural hospital operational and clinical workflows that are vital to day to day activities and patient care.

Clinical Domain: The clinical domain is defined as tele-ICU's ability to drive improvement in clinical quality metrics. Operational data made available for public view through efforts such as Leapfrog and CMS quality initiatives, and an increasing number of best practices and practice guidelines have prompted hospitals to recognize the need to standardize care. This standardization requires high quality ICU specific data and a consistent approach to compliance at all times. Identifying the specific need of each hospital by obtaining baseline data prior to implementing the program would be vital for clinical outcomes tracking and metrics.

Financial Domain: The financial domain includes tele-ICU's ability to drive revenue growth and decrease costs associated with patient care for the hospital. This is particularly important as tele-ICU is a sizable investment for hospitals. This may include direct revenue growth by adding critical care expertise as well as cost savings due to reduction is ICU/hospital length of stay. Another aspect is the indirect revenue growth and the halo effect generated by tele-ICU by providing a layer of support for bedside providers to care for more complex patients and possibly retain patients in their ICU.

Strategic Domain: Strategic domain is defined as tele-ICU's impact on staff satisfaction, organizational reputation, and future resource deployment. As mentioned above there is a rural shortage of physicians/intensivists in the United States. Rural areas account for 25% of the United States' population but have only 10% of the physicians serving the area. Thus, rural hospitals perceive tele-ICU as a viable solution to address not only access to high quality critical care but

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also from a standpoint of hiring physicians, reducing workload and improving their reputation in the community.

Table 1: Examples of key components to assess in each domain during adoption, implementation and operation of tele-ICU.	
Organizational	*Level of need of the Tele-ICU program, leadership and staff engagement, level of collaboration, structure of critical care committee, tech compatibility*
Clinical	*Obtain crude and adjusted mortality data, best practice adherence metrics, readmission data, case mix index breakdown*
Financial	*ICU volume data, ICU bed utilization data, crude and adjusted length of stay data, ventilator free days data, inter-ICU transfer data*
Strategic	*Tracking physician recruitment and retention, measuring physician and patient satisfaction*

For more information on tele-ICU or a consultation with our Center of Excellence, please contact us at telehealthcoe@musc.edu.

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