Tele-Critical Care at 25 Years Old

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"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change."

- Charles Darwin

The tele-ICU concept, recently renamed Tele-Critical Care (Tele-CC), is approximately a quarter century old. We should take this time to review and reflect on how the approach to Tele-CC has changed and how its characteristics have evolved.

In the late 1990s/early 2000s, organizations such as the National Quality Forum, The Leapfrog Institute, and the Agency for Healthcare Research and Quality were calling for full-time onsite intensivist care 24 h a day, 7 days a week at the 7,500 ICUs across the United States.[1] However, in the year 2000, the intensivist shortage was estimated to be approximately 23,000–24,000 to meet these around-the-clock bedside needs. The shortage was expected to worsen by the year 2020 due to the aging of the U.S. population.[2,3] Several factors have potentially attenuated the predicted intensivist shortage. These include a slow but progressive expansion of Tele-CC programs (less than 8% of U.S. ICU beds in 2010 to 25% by 2018),[4] a steady increase in the number of accredited critical care training programs (369 in 2008 to 462 in 2018),[5] an increased number of critical care fellowship positions (2,003 in 2008 to 3,074 in 2018),[5] and estimated increases in critical care physician assistants and advanced practice nurses by 54% and 119%, respectively, by 2025.[6,7]

Although some debate exists about whether the shortage is less or more severe than these estimates, the Tele-CC model was one possible solution to the dilemma. Numerous published meta-analyses and single-site studies have reported significantly improved clinical outcomes via Tele-CC with reductions in mortality, length of stay, complications, and improved protocol adherence.[8] Most reports of improved mortality and clinical outcomes are found at sites with synchronized care delivery models and with the ability to provide full interventions as needed, as opposed to sites that limit Tele-CC interventions to emergencies only and/or best practice prophylaxis care (Figure 1).[9,10]

Mixed, or a lack of positive, outcomes with Tele-CC versus standard care have been reported with asynchronous care models, typically with non-real-time care delivery and e-consults, when remote clinicians are limited to providing emergency care or best-practice prophylaxis initiation (e.g. stress ulcer, or venous thromboembolism) (Figure 2).

Tele-CCs were initially set up as networks using a hub and spoke model, characterized by a central hub hospital with services virtually deployed to multiple spoke hospitals requiring ICU services. Over the past 25 years, the care model has changed to encompass centralized or decentralized care. Decentralized systems provide care to one patient at a time and typically consist of scheduled evaluations and/or interventions as a specialist on-call model as opposed to continuous monitoring. Centralized systems simultaneously care for a patient population, are typically equipped with more robust technology, and consist of scheduled and/or continuous evaluations and interventions.

Factors impacting Tele-CC uptake are varied. Hospital mergers into health systems since 2010 may use economies of scale of a hub and spoke model versus individual smaller hospitals. This type of hospital may also play a factor, as non-profit and public hospitals are four to eight times more likely to implement Tele-CC than for-profit hospitals.[11] Before the COVID-19 pandemic, a major consideration of telehealth provision was the Interstate Medical Licensure Compact (IMLC), designed to preserve state medical practice regulations. Since the pandemic, the use of the compact has grown by 47%, with 32 states and U.S.
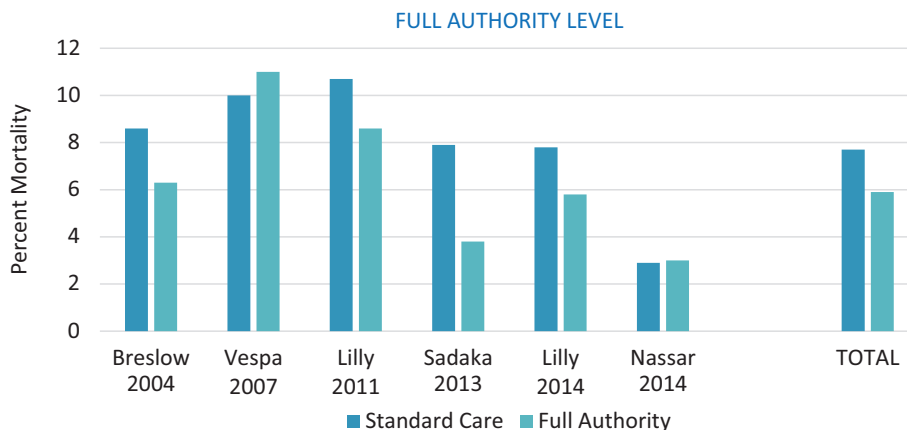
FULL AUTHORITY LEVEL

Fig. 1. Tele-critical care mortality rates based on authority level[10] (# Patients: Standard care: 17,399; Tele-CC: 117,417).

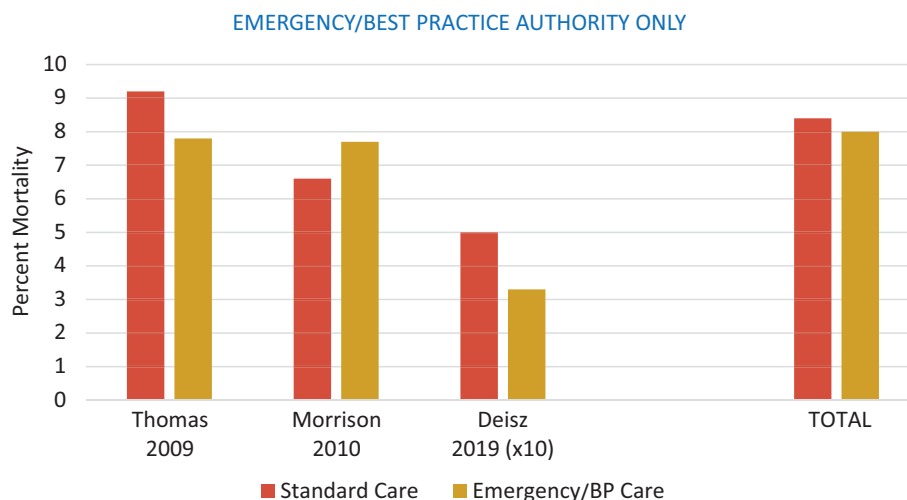**EMERGENCY/BEST PRACTICE AUTHORITY ONLY**

Fig. 2. Tele-critical care mortality rates based on emergency/best practice authority only[10] (# Patients: Standard care: 17,399; Tele-CC: 117,417). # Patients: Standard care: 3,425 Tele-CC: 3,416.

territory members (as of April 2021) due to the temporary waiver of the requirement limiting in-state-only practice. Whether the regulatory and financial waivers issued with the pandemic will remain permanent is yet to be determined.

Tele-CC was always intended as an extension of bedside care, not as a substitute for bedside clinicians. As such an extension, Tele-CC should aid the bedside by ensuring the treatment care plan for the patient continues, even when the managing provider is not onsite. Additionally, the remote team should take on duties that can be completed remotely, allowing the bedside team to focus on activities that can only be accomplished at the bedside. From its initial introduction, the Tele-CC has evolved into two broad categories: extending coverage to underserved areas (i.e. rural) or areas with intensivist staffing shortages and improving adherence to known ICU best practices in order to avoid the development of complications.

Changes in care processes primarily drive both approaches: the use of reminders and checklists, the use of electronic alerts and notifications (clinical decision support software), data reporting, and benchmarking. Artificial intelligence algorithms are not far behind.

Concerns regarding the use of Tele-CC remain. A recent survey of Tele-CC experienced users identifies their greatest concerns as lack of reimbursement (22.5%), degradation of autonomy (15.9%), and a tie between legal responsibility and costs (15.2%).[12] The lowest concern was privacy (3.5%).

The recent SARS-CoV-2 pandemic serves as an excellent example of Tele-CC expansion due to the burden placed on the healthcare system, as well as helping drive new and unique technological approaches. The COVID-19 pandemic has opened Pandora's Box to Tele-CC globally, which will only grow from here. The COVID-19 highlighted the limitations of our health system with a shortage of trained intensivists but also with a lack of ICU beds. It

also demonstrated the creative ways to meet patients' and clinicians' needs. The urgent and unique needs generated global Tele-CC solutions, including teleconsultations, telemonitoring, tele-rounding, and family conferencing.

Remote two-way video has aided family visits during quarantine times, minimized the use of personal protective equipment (PPE) during times of shortages, and limited unnecessary exposure by the bedside team, including physicians, nurses, hospital chaplains, social workers, etc.[13] The pandemic created opportunities such as remote ventilator management to mitigate in-person respiratory therapist room interventions while preserving PPE.[14] Unfortunately, the pandemic also highlighted the need for discussions we have previously ignored, such as rationing of scarce mechanical ventilator and ICU bed resources.[15]

Since its inception, Tele-CC programs have not been a low-cost investment. Initial total costs can range from $1,000,000 to $6,000,000, with annual per-bed costs of $50,000–$100,000. However, cost savings from decreased ICU length of stay can be 25% – 31% with a drop in variable costs of 24.6%.[16] Three methods have been used to report the financial impact of Tele-CC: (1) drive revenue growth by providing Tele-CC services to non-health-system hospitals; (2) decrease costs associated with patient care, specifically length of stay and bed turnover; (3) quality life years saved by decreasing mortality.[11,15,17]

Using a decentralized care model can limit a Tele-CC program's cost. However, the greatest cost of a program is not necessarily the technology itself but rather the personnel costs. Published studies present opposing views on whether the Tele-CC program is a positive or negative financial endeavor. The greatest financial impact will be based upon the ability to decrease the length of stay in the ICU and re-occupy the bed. Therefore, length of stay and number of patients (i.e. beds covered by the Tele-CC program) are key factors in determining the return on this innovation.[15]

The shift from inpatient to outpatient care has been evolving for decades and will continue.[18] With this shift, the severity and acuity of inpatients will rise, making what may appear a hospital solely consisting of critically ill patients. The critical care setting is already data-rich and does not need more data input. Instead, the existing data need to be more appropriately packaged with greater patient context into knowledge bundles to aid clinicians in caring for a population of 400+ critically ill patients simultaneously, effectively, and efficiently.

The evolution of the Tele-CC system over the past 2.5 decades has transcended barriers worldwide. The Tele-CC should not be considered a technology system but rather a new care delivery model leveraging the currently available and evolving technology. The main factors for success include leadership, the value provided and perceived by bedside providers, and the support of the organization.[19] Teamwork, communication, trust, and engagement level are more important for success with Tele-CC than the

technology platform. The "correct" Tele-CC model will vary from site to site and be the one to meet your health systems' unique needs, some of which are mentioned above. Once those needs are identified, the next decision is to buy or build a solution (there are pros and cons with each option). Growing areas addressed by the Tele-CC include pharmacy, case management, palliative care, pain, agitation, delirium, sepsis, glucose management, nutritional care, respiratory therapy, and length of stay.

The next 25 years should be as fast-paced as the previous 25 years, if not faster. The advances in artificial intelligence, digital twins, augmented intelligence, and smart wearables and sensors (e.g. sutures capable of detecting the onset of infection) will provide greater opportunities to move from reactive care to proactive care. However, tomorrow's clinicians will need an ever-increasing set of digital skills. This will involve much more than simply downloading an app. Numerous challenges exist to digital literacy, including adoption willingness, appropriate training, confidence in the technology, and privacy issues. Bedside care models will need new clinical workflows, population-based virtual rounding will require different skill sets and approaches than bedside rounding, and clinicians will need to be able to adapt to this new environment.

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Application of Ai-Generated Text or Related Technology

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