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EDITORIAL

Telemedicine in critical care

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Current practices of telemedicine in the ICU

Telemedicine in intensive care medicine describes the use of communication technology to provide intensive care unit (ICU) services over variable geographic distances [1]. Audiovisual technology for the provision of tele-ICU services has first been successfully implemented in pilot programs in the 1970s [2]. In the last 2 decades, however, we have seen a surge of tele-ICU in research and routine settings [3, 4]. As of 2018, 18% of ICU beds in the US were covered by telemedicine [5], which likely increased following the COVID-19 pandemic. The implementation of tele-ICU services is driven by the increased demand, represented by the rising numbers of patients admitted to an ICU, an increasing age and severity of illness among patients, a shortage of trained intensivists, and the need to transfer rapidly evolving medical knowledge to the bedside [6].

Different models of tele-ICU care exist, such as telemedicine programs in US vs. Europe or Latin America. These are driven by diverse geographical medical and health-systems' cultures, availability of intensivists, regulatory and ethical allowances, academic and commercial interests, and stakeholder's perception of telemedicine implementation. Commonly, it entails a tele-ICU or hub in a large medical center, which is connected to a network of ICUs, called spoke ICUs, using audiovisual technology [6, 7]. The network may be established within a hospital network or span across different stand-alone hospitals and providers. Different staffing models exist, from 24/7 staffing and around-the-clock telemedicine services to scheduled telemedicine rounds during weekdays (Fig. 1). The tele-ICU is usually staffed with experienced intensivists, ICU nurses, and administrative staff [6]. The remote ICU can have board-certified and not certified critical care physicians, or even not have a physician at bedside, as some models in the US. The level of data integration within the telemedicine network varies. For some programs, there is only an audiovisual connection, whereas other programs have established note sharing, direct access to the patient's electronic medical record, real-time telemetry and visual clinical examination, and automated alert and decision support systems [6].

Telemedicine as a tool to convey evidence-based practice to the bedside

Studies on the effects of telemedicine implementation in the ICU have mainly focused on length of stay and mortality [4]. Despite the great heterogeneity across telemedicine programs, meta-analyses of before-after studies have concluded that telemedicine may reduce mortality and length of stay [4, 8]. Recently, the first cluster-randomized controlled trials on tele-ICU were published, namely the ERIC and TELESCOPE trials [9, 10]. As primary endpoints, TELESCOPE did not find a length of stay benefit, whereas ERIC found significant improvements in quality of care. Neither study was powered for detecting a mortality benefit [9, 10]. This highlights the controversy surrounding the evidence-based results supporting tele-ICU in the delivered models (e.g., daily rounds) and at the tested scenarios. A great discussion about the methodological challenges of testing tele-ICU programs in trials followed their publications [11].

It has been stipulated that improvements in patient outcomes may be driven by telemedicine as a tool to implement evidence-based practices and increase the quality of ICU care [6]. This is supported by the ERIC trial, which demonstrated that telemedicine enhances adherence to quality indicators pertaining to various evidence-based ICU practices [9] and a before-after study from the US, where telemedicine increased adherence to multiple best-practice measures [12]. Interestingly, the TELESCOPE trial did not find

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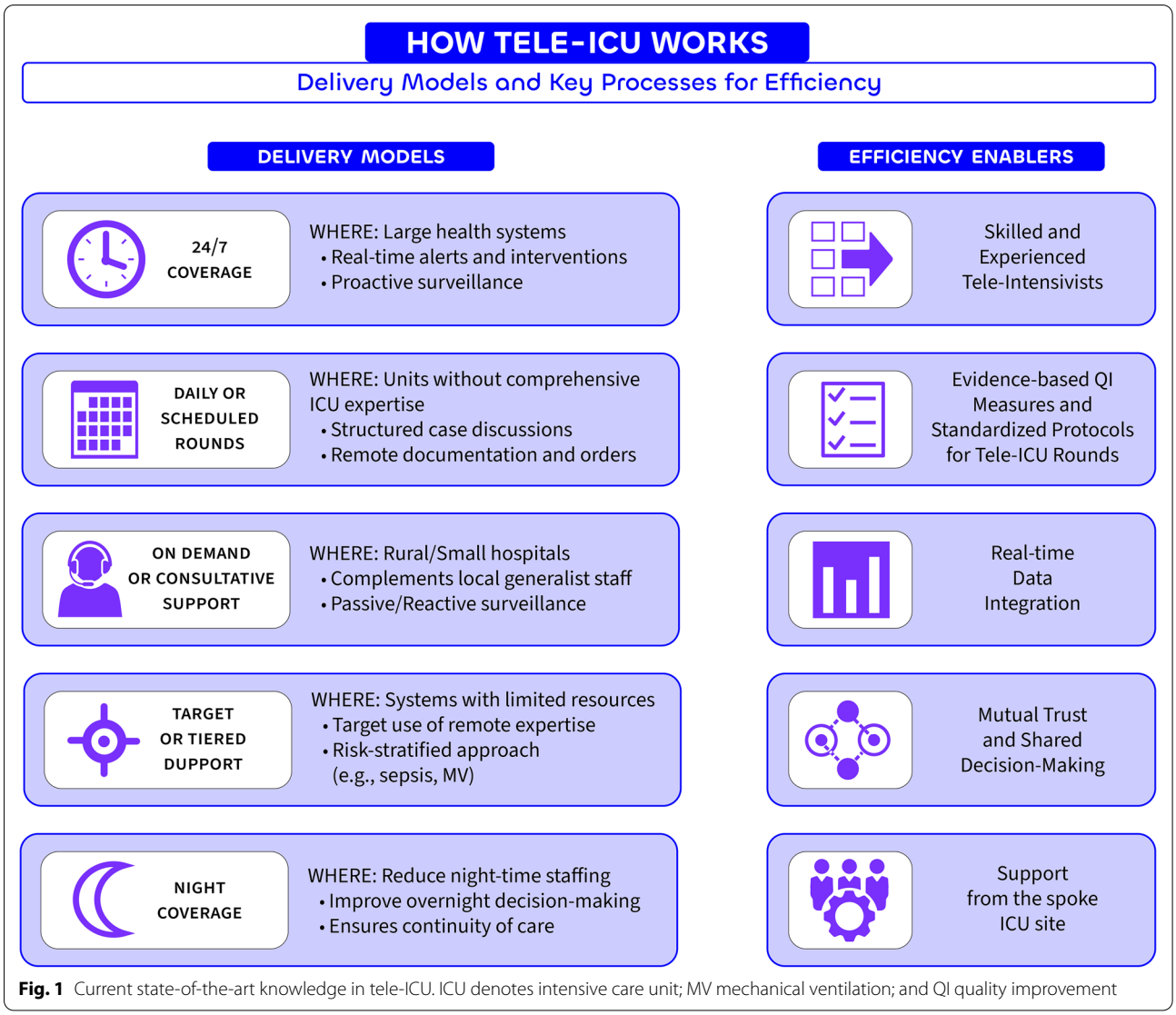

Fig. 1 Current state-of-the-art knowledge in tele-ICU. ICU denotes intensive care unit; MV mechanical ventilation; and QI quality improvement

improvements in the implementation of best practices such as light sedation [10].

Several key areas remain understudied. The cost-effectiveness of tele-ICU programs, including their long-term sustainability and potential added workload for local staff, has not been well characterized. Additionally, rapid advancements in this field suggest that novel modes of remote interaction and bedside assessment will soon emerge for testing within tele-ICU frameworks. Finally, to our knowledge, no standardized educational platforms or formal training requirements currently exist for intensivists practicing in tele-ICU settings. Based on our experience, the direct application of bedside clinical practices to tele-ICU is not straightforward and demands specialized training protocols.

Characteristics of successful ICU telemedicine programs

The discrepancies in the effectiveness of different telemedicine programs underscore the variability and the complex nature of telemedicine interventions in the ICU. It is undisputed that telemedicine programs need to rely on evidence-based standards such as clinical guidelines. At the same time, it is a way to share knowledge and experience from high-qualified intensivists that usually are constrained to a single hospital. As such, telemedicine may be conceived as a tool to transfer knowledge over large distances. Its effectiveness is dependent on five crucial issues, which we believe should be applicable to diverse scenarios of tele-ICU implementation programs:

1. The intensivist in the tele-ICU conducting the telemedicine rounding needs to have a high level of technical competence and experience in the areas that clinical advice is provided for. For the tele-ICU center, this may necessitate the involvement of other specialties such as neurology or infectious diseases physicians, if required.
2. The telemedicine rounding needs to be structured around quality measures which are not already implemented at the remote-ICU, ensuring that there is room for improvement. Providers need to choose quality measures that have a high impact on mortality, morbidity and quality of life of ICU patients. To have an impact on these outcomes, telemedicine needs to enhance the adherence to these defined quality measures beyond a critical threshold. Additional tele-ICU access to EMR, automatic alarms, trend alerts or quality reports may increase the ability of the tele-ICU physician to increase adherence to the quality measures. The effective implementation is also dependent on having enough structural and staff capacity at the remote-ICU. Otherwise, a telemedicine program will be incapable of impacting patient outcomes.
3. Remote-ICU physicians need to be open to counseling and involvement of the tele-ICU physicians. This warrants a seamless integration of the tele-ICU in the remote-ICU workflow, an empathic and clear communication, a high level of openness, understanding, and mutual trust between both parties.
4. A systematic review of observational studies indicated that the level of decision-making autonomy granted to the tele-ICU has an impact on outcomes. Programs where the tele-ICU intensivist could only consult on-site staff did not improve outcomes, whereas programs with full decision responsibility with the tele-ICU intensivist were associated with mortality and length of stay benefits [13].
5. A qualitative study has defined a framework of determinants for effective telemedicine programs [14]. The authors stress the value of leadership support at all levels at the tele-ICU center and the remote-ICU hospital to design and implement telemedicine programs [14]. This study emphasizes that remote-ICU physicians will only accept the tele-ICU support if it is available when needed and if they experience the tele-ICU as an added value to patient care [14].

Directions of future research

Patients may benefit from telemedicine in the ICU, but there is a clear need for additional research. Considering the heterogeneity of existing programs, we need to identify delivery models that improve patient outcomes. As a next step, after the identification of effective program elements, best-practice guidelines need to be established, as recently published by the Society of Critical Care Medicine [15]. These guidelines should also define sets of meaningful outcomes to comparability across telemedicine studies. We must also consider equity and access to tele-ICU, particularly for vulnerable populations and low-resource settings—groups that may benefit the most from telemedicine programs.

In summary, tele-ICU is a tool that alone cannot change patient outcomes. It would be a powerful tool if implementation of evidence-based medicine is improved. However, more research is needed to determine the optimal delivery model and the ICUs where it works best.

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Conflicts of interest
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