

# Breaking Barriers to Reach Farther: A Call for Urgent Action on Tele-ICU Services

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## INTRODUCTION

The World Health Organization defines telemedicine<sup>1</sup> as “the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities”. While complex, this definition encompasses and delineates the complete scope of telemedicine. The origins of telemedicine can be traced back to mid-late 19th century when electrocardiographic data were first transmitted over telephone wires.<sup>2</sup>

The advent of tele-ICU can be tracked to a report by Grundy,<sup>3</sup> which demonstrated the potential and feasibility of tele-ICU consultation and scheduled rounds. However, the impetus for the explosion of tele-ICU was provided by the Leapfrog Group recommendations in the United States (US) from November 2000.<sup>4</sup> This was in response to the Institute of Medicine’s report “To Err is Human” calling for action to reduce medical errors and to improve quality of care.<sup>5</sup> The Leapfrog group advocated staffing all intensive care units (ICUs) with Board-certified Intensivists for the coordination of care and emphasized availability of an intensivist during the day and healthcare professionals with appropriate skills (whom they described as ‘certified effectors’) to implement their suggestions round the clock. Given how closely reimbursement and funding models in the US are tied to adherence to such recommendations and the considerable influence of the Leapfrog group, this inevitably meant that hospitals across the US needed to quickly comply.

To implement the Leapfrog recommendations, without having to stretch the existing limited qualified workforce, newer innovative solutions, such as, tele-ICU coverage was introduced. Between 2003 and 2010, the US witnessed a rapid expansion of tele-ICU coverage and the number of hospitals using ICU telemedicine increased from 16 (0.4% of total) to 213 (4.6% of total).<sup>6</sup> The number of ICU beds served by telemedicine during the same period increased from 598 (0.9% of total) to 5799 (7.9% of total)<sup>6</sup> with coverage broadening to include cardiac, neurological, surgical, and medical patients requiring intensive care.

## MODELS OF TELE-ICU CARE AND IMPACT ON PATIENT-IMPORTANT OUTCOMES

Several models and structures of tele-ICU care have been described including centralized vs decentralized, open vs closed architecture,

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and continuous vs episodic (which could be scheduled or reactive) amongst others.<sup>7,8</sup> These different models are not mutually exclusive and have significant overlap. In the centralized approach, physicians, nurses, and other allied staff are connected to one or multiple ICUs from a remote monitoring center (often referred as “command center”) and provide consultative care.<sup>7</sup> In the decentralized model, physicians and other healthcare staff can be located anywhere and provide consultation through internet access.<sup>6</sup> There is no defined command center or dedicated staffing in this model. While both models come with their own advantages and drawbacks, demonstration of improvements in patient outcomes may be more challenging with the decentralized approach.<sup>9</sup>

## Impact on Patient-centered Outcomes

Although intuitively it would appear that the availability of a trained intensivist would translate into improved outcomes, the evidence on the benefits of tele-ICU is inconsistent. Much of the reason for such variability in the literature relates to the types of study designs (predominantly nonrandomized pre- and postcomparisons or surveys), model of tele-ICU delivery, duration of coverage, unit-level acceptance of the tele-intensivist, and heterogeneity in the ground support.

Broadly, impact on patient outcomes can be examined under three important domains:<sup>9</sup>

- **Timeliness of the interventions:** there are limited data on the relative proportions of proactive and reactive interventions by tele-ICU teams or on the response time to intervention. One survey found that only 6% of the interventions were for episodes of physiological instability.<sup>10</sup> Lily et al. identified routine case review of all admissions by an intensivist and faster response times as components that impact outcomes.<sup>11</sup>
- **Compliance with best practices:** it is in this domain that the evidence appears to be most consistent with multiple studies

demonstrating that tele-ICUs improved adherence to best practices, such as, care bundles for ventilator associated pneumonia (VAP) prevention, for deep venous thrombosis (DVT) prophylaxis, for sepsis management (antibiotic delivery and measurement of lactate, etc.), glycemic control, and compliance with a strategy of lung-protective ventilation.<sup>12-15</sup> The benefits in this domain are perhaps expected, given that the tele-ICU models consistently provide immediate access to experts, who reinforce the importance of and ensure compliance with such quality improvement bundles.

- Patient-level outcomes: Most studies have examined the impact of tele-ICU on mortality, ICU, and hospital length of stay. There are limited data on aspects, such as, patient/family satisfaction and the impact on medical errors, which interestingly was the primary reason for evolution of tele-ICUs.

A recent systematic review<sup>16</sup> led by Fusaro et al. evaluated the impact of tele-ICU based on observed and predicted ICU mortality. They included 13 studies (all were pre-post comparisons) with a total of 161,109 patients. The pooled odds ratio (OR) in their meta-analysis was 0.75 (95% CI of 0.65–0.88) in favor of the intervention. Importantly, in studies with high baseline observed/predicted mortality, the pooled OR was 0.64 (95% CI of 0.52–0.77), and in studies with low baseline observed/predicted mortality, the pooled OR was 0.98 (95% CI of 0.81–1.18), thus suggesting a benefit based on baseline performance.

Another older systematic review by Wilcox and Adhikari from 2012<sup>17</sup> included 11 studies. In their pooled analysis, they observed a decrease in ICU mortality (risk ratio of 0.79 with 95% CI of 0.65–0.96) and a decrease in ICU length of stay (weight mean difference of –0.62 days with a 95% CI of –1.21 to –0.04 days). Of note, all studies included in this review were observational and of moderate quality.

Caution must be exercised in interpreting the evidence, however, due to nonrandomized design and possibility of residual confounding, variations in individual study quality, secular trends, and wide variations in the delivery and application of tele-ICU itself. One optimal design to definitively answer this question will be a cluster-RCT of tele-critical care vs standard care or alternately and robust attempts to adjust for the longitudinal time component in before–after studies, such as, an interrupted time-series design (quasiexperimental).

## URGENT NEED FOR TELE-ICU IN INDIA

India has only 0.55 government hospital beds per 1000 population<sup>18</sup> and approximately 70,000 ICU beds (inclusive of public and private healthcare facilities).<sup>19</sup> Most ICU beds are concentrated in tier 1 and tier 2 cities with limited to no critical care capacity in districts and smaller towns. In terms of human resources, India currently has 1 doctor for every 1445 Indians (still below the WHO target of 1:1000).<sup>20</sup> While the total number of doctors with intensive care training in India is unknown, the Indian Society of Critical Care Medicine (the largest critical care body for the country) has 12,046 members (including consultants and in-training members) across 87 branches.<sup>21</sup> Clearly, these numbers are woefully inadequate for a country as large and as populous as India. There are similar human resource constraints with nursing capacity in general<sup>22</sup> and major gaps in availability of trained critical care nurses.

These gross shortages in resources imply that large parts of the country do not have access to skilled personnel or ICU beds. These shortages will be further amplified in the middle of disasters, such

as, the current coronavirus disease-2019 (COVID-19) pandemic. Even if attempts are rapidly made to shore up surge capacity by increasing the number of “critical care capable” beds and additional equipment, such as, ventilators are procured, there is limited scope for rapidly increasing the capacity of trained personnel. It is here that tele-ICU can play a vital role.

In addition to the challenge of resources, there are wide variations in the quality of critical care delivered across the country.<sup>23</sup> The deployment of tele-ICU services in remote underserved areas will help flatten the landscape *vis-à-vis* access, quality of care, and affordability.

## TELE-ICU IN THE CONTEXT OF A PANDEMIC

The benefits of tele-ICU become readily apparent in the face of pandemics, such as, COVID-19<sup>24</sup> (Table 1). First, tele-ICUs can provide expert advice in the screening of patients and regulate triage into COVID units. Often during pandemics, panic among healthcare providers can lead to suboptimal triage and the healthcare system can be overwhelmed by unnecessary admissions. Guidance from a remote specialist can help mitigate this. Second, expert tele-ICU staff can provide clear instructions regarding the need for testing of admitted patients and serve as a resource hub for bedside caregivers with regard to infection-control practices. Third, the biggest advantage of tele-ICU is the ability to closely monitor patients suspected or diagnosed with COVID from remote sites and minimize the exposure time of the bedside staff. Consistent evidence has demonstrated that exposure time of caregivers correlates with the risk of incurring the illness and the viral load once infected. Tele-ICU serves as an effective alternative for the provision of high-quality care while attenuating caregiver exposure. Fourth, at times of a pandemic when bedside staff are burdened by high volume and high acuity of patients, there is little time to interact and counsel family members. Tele-ICU teams enable families to interact with a care provider without disrupting the flow of bedside care. Finally, several isolation wards and high-dependency units could be managed simultaneously centrally by a team of intensive care physicians with assistance from ground teams, thereby maximizing the efficiency of the available personnel. Simple and innovative solutions using existing applications (apps) on smart phones may also be used to provide a tele-health solution during the crisis.

## IMPEDIMENTS TO THE WIDESPREAD IMPLEMENTATION OF TELE-ICU IN INDIA

There are several barriers to the widespread establishment of tele-ICU in India.<sup>25</sup> These include, but are not limited to, acceptance and attitude amongst patients and caregivers, policy and regulatory

**Table 1:** Potential benefits of tele-ICU during pandemics

1	Remote screening and triage of patients to appropriate level of care
2	Reinforcement of infection control measures for caregivers by specialists
3	Remote monitoring of patients and minimizing exposure time for healthcare workers (HCWs)
4	Management of multiple pandemic-focused high-dependency wards and ICUs from a single command center (critical for surge capacity building)
5	Counseling and planning goals of care with family

challenges, buy-in from healthcare personnel on the ground, initial cost of setup, variable internet connectivity, training of healthcare professions, and medicolegal issues.

### Policy and Regulatory Challenges

India, until very recently, had no guidelines for the practice/delivery of telemedicine. This has fortunately changed with the release of “Telemedicine practice guidelines 2020”, issued by the Ministry of Health and Family Welfare, Govt. of India<sup>2</sup> on 25 March, 2020. With sections focused on the scope of telemedicine, patient consent, training, mechanisms for clinical evaluation, prescription, ethics, technology-related aspects, documentation, data privacy, confidentiality, and professional fees, this framework lays a solid foundation for the establishment and rapid expansion of telemedicine services in India.

While the effort is admirable, the focus of the current iteration is heavily based on the practice of outpatient telemedicine. As such, clarity is still lacking for several aspects of inpatient telemedicine, including tele-ICU. However, we are confident that these guidelines will be dynamic and continue to evolve with input from professional societies, such as, the Indian Society of Critical Care Medicine (ISCCM).

### Training of Healthcare Professionals

Professionals intending to practice tele-ICU need training in specific skills, such as, navigation of technology, familiarity with electronic health records, the ability to perform remote clinical assessment, the ability to collate information from multiple electronic sources and remote troubleshooting, in electronic prescription of drugs or interventions, clear medical documentation, communication, and relevant medico-legal aspects. Tele-ICU providers need to clearly understand the workflow at the bedside of the hospital they are caring for and need to provide input without being intrusive or disruptive to the care. Formal mechanisms of training do not exist currently for any of these domains. The “Telemedicine practice guidelines 2020”<sup>26</sup> envisions a mandatory online training program for professionals intending to practice telemedicine and further information is expected from the ministry of health and family welfare on this. The Telemedicine Society of India (TSI)<sup>27</sup> has created a free online course for Telehealth. Critical care societies should supplement such online training with specific skill sets that may be essential for the delivery of tele-critical care.

### Cost and Challenges with Technology

While tele-ICU is expected to be cost-effective in the long run with improvements in process measures, compliance with best practices and with reductions in length of stay, setup costs as related to technology, and training may be substantial. These include costs related to setting up and maintenance of a remote command center, hardware (audio and video), software, electronic medical records, high-speed internet connectivity, and training of healthcare professionals (at the command center as well as ground personnel). Operational costs of a centralized tele-ICU center can be cost-ineffective if the number of beds covered is limited. Decentralized provision of tele-ICU care may be an easier model but its impact on outcomes may be diluted. In an environment where quality improvement bundles are not enforced, demonstration of outcomes to substantiate the cost incurred will be challenging. Economic analysis by Yoo et al. suggested that tele-ICU could be cost-effective in most cases and cost-saving in some cases.<sup>28</sup>

Technological innovations and low-cost homegrown solutions may help mitigate some of the initial setup costs. Major improvements in the internet bandwidth will however be essential as the target audience for tele-ICU will likely be smaller towns and districts which typically lack reliable high-speed internet connectivity. Tele-ICU will need the real-time transmission of audio, visual, and text information for the safe management of critically ill patients. India is one of the countries with a rapidly expanding base of internet users. However, penetration of broadband internet connectivity remains limited.<sup>29</sup>

Additionally, most hospitals in the country (including large public and private hospitals in cities) lack robust electronic medical records (EMR) and do not have the capacity for seamless transmission of data from patient monitors, infusion pumps, and ventilators. In the interim, go-arounds can be designed for the remote access of such information; however, for seamless two-way patient-care interactions, integration of tele-ICU with either existing commercially available EMR systems or with low-cost locally developed EMR platforms will be essential for the expansion of this service.

### Other Challenges

Critical care in India is predominantly delivered as an “open” model,<sup>30</sup> which means that while qualified intensivists provide consultation, they are not fully empowered to direct care. Patients in this model are admitted under a primary physician (or surgeon) who directs care and the intensive care unit serves as a high-intensity monitoring location with the need for multiple interdisciplinary consultations. By design, this limits the influence of trained in-house intensivists and further complicates the task for the delivery of tele-critical care. For tele-ICU to be successful, buy-in would be essential from several stakeholders (hospital administrators, ‘primary’ physicians or surgeons, bedside nurses, in-hospital anesthesiologists, and other physicians who may be moonlighting). In a systematic review by Young et al.,<sup>31</sup> they found that while overall acceptance by on-site staff was high, there was a high degree of initial ambivalence and reluctance from nursing personnel.

### Our Experience (US and India)

As an independent critical care group, we established the first international tele-ICU service for hospitals in the United States from Chennai in 2010. We have provided over 32,000 hours of remote monitoring and consultative services covering over 50 hospitals across many states in the USA. The clear structure, process and protocols, and the acceptance and technology at the user end have made this seamless and a true value-added service. The time zone advantage has helped provide nighttime coverage for the US hospitals which served an unmet need. The ability to scale the services is limited by the fact the physicians providing this service from India should be American Board Certified and have the necessary licensure and privileges to provide coverage.

The success of our model reassured us that distance was not a real barrier and prompted us to establish centralized tele-ICU services within India in 2012. During the period from June 2013 to June 2014, we supported 4 hospitals across two states covering 23 ICU beds.<sup>32</sup> We enabled 8261 interventions on the 961 patients admitted during that period. Most of the interventions (70.3%) were for routine evaluation while 27.8% were active recommendations. Almost half of the interventions (48.3%) were performed at night. Ventilation management, sedation titration, and prescription

or modifications of medications contributed to 39.9% of the interventions. Average length of provision of tele-ICU care was 3.6 days with only 2.8% of patients being referred to higher facility for management. Overall mortality of patients under tele-ICU care was 2.8%. Our data thus support the feasibility and usefulness of tele-ICU in the Indian context. Unfortunately, these services could not be continued after two years due to multiple barriers, primarily relating to technology and end-user expectations. With the current pandemic situation and the need for specialized care, it would be prudent to implement tele-ICU services with easy to use technology and setting the tone right on the value and expectations.

## RESEARCH

While further research is essential on several aspects of tele-critical care, such as, patient and family satisfaction, timeliness of interventions, and impact in resource-limited settings, such as India, we also believe that systems supporting tele-ICU can potentially support the wider agenda of critical care research. Integration of tele-ICU platforms with hospital EMRs can facilitate seamless flow of data for describing the epidemiology of critical illness, in developing prognostic models, and in the conduct of clinical trials. This will empower smaller intensive care units from semiurban and rural areas to actively participate in answering context-relevant questions and thus close gaps in knowledge.

## CONCLUSION

Tele-ICU services have been structured and successfully implemented in the United States and have been shown to impact quality particularly in ensuring best practices. It has been of great value to improve access to specialists and avoiding multiple visits by healthcare professionals in isolation rooms during the COVID-19 pandemic. While such services are provided remotely to USA from India, earlier attempts for hospitals in India were unsuccessful due to technology issues and mismatch of end-user expectations. We call to action an effort reviving and reenergizing tele-ICU services in India using innovative, easy to use homegrown solutions.

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