Innovations in critical care: Tele-ICU augmented ICUs in the Indian setting

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Abstract

Intensive care has advanced over the past few decades to find its space as a separate specialty in medicine[1]. In addition to prompt diagnosis and timely intervention, measures such as unit staffing, observance of hand hygiene and adherence to standard protocols for common disorders result in improvements in outcome in Intensive Care Units (ICU)[2]. Presence of a specially trained intensivist in an ICU has been shown to improve mortality and length of stay in Western studies [3]. However, due to the shortage in supply of such specialists world over, their presence at smaller ICU in low and middle-income countries (LMIC) can be prohibitively expensive for the hospitals [4]. Tele-ICU based technologies that help increase the efficiency and reach of the specialists can be an effective way to bridge such supply-demand disparities [5]. Here we report a case where a fourteen-year-old boy admitted with Severe Acute Respiratory Distress Syndrome (ARDS) to an ICU in Bihar which was managed successfully, with lung protective and prone ventilation utilizing a tele-ICU service.

Keywords: Tele-ICU, Critical Care, ARDS, Prone Ventilation, Global Health

Introduction

The advent of technology presents great opportunity in increasing the outreach of expert medical services to the most inaccessible parts of the world. Rapid development of critical care as a field in medicine over the past few decades has left little time for the low and middle income countries (LMICs) to expand its army of trained intensivists. With several countries facing such dire shortage of specialists, tele-medicine technology can aid in bridging the demand supply disparity with little compromise in the outcomes. Here we report a case where a fourteen-year-old boy admitted with severe Acute Respiratory Distress Syndrome (ARDS) to an ICU in Bihar which was managed successfully, with lung protective and prone ventilation utilizing a tele-ICU service.

Case Report

A fourteen-year-old male with no significant past medical history was admitted to an ICU under a tele-ICU network. The patient was previously diagnosed with right-sided pneumonia and was started on oral levofloxacin, azithromycin, and theophylline in the outpatient setting. He developed severe exfoliative dermatitis after the medications were started. On admission to the hospital, he was tachypneic, oxygen dependent and the rash covered most of his trunk, face, and limbs. He was admitted to the ICU in view of his critical condition and further investigation revealed he had ARDS. The patient was intubated and was put on high positive end-expiratory pressure (PEEP) and low tidal volume settings. He was also placed on vancomycin, piperacillin-tazobactam, and oseltamivir.

Despite these measures, his condition worsened, and he was then paralyzed and placed on deeper levels of sedation. He continued to have an oxygen saturation of less than 90% despite these measures. At this point, following joint discussions between the bedside team and the tele-intensivists, it was decided to prone the patient and ventilate per previously published literature[6]. The hospital had not previously used prone ventilation on a patient and hence the nursing team was unfamiliar with the manoeuvre. There were no hospitals within a 75-kilometre radius to manage a patient of this severity. The patient's severe hypoxemia precluded safe transport of this patient to any distant higher facility. In the following hours, the bedside nurses were trained by the tele-ICU team on how to safely prone the patient. In a systematic fashion with the aid of tele-video conference they were guided by the tele-ICU team to safely prone the patient. The patient was placed on prone ventilation for at least 16 hours per day and then placed supine for the next 8 hours as per the PROSEVA investigators protocol [6]. The patient was placed in prone ventilation as per protocol for 2 days and after sufficient improvement in his oxygenation prone ventilation was discontinued. Implementation of the ventilation and weaning protocol with real-time ventilator waveform analysis and troubleshooting were monitored by the critical care team at the

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command center.

He was successfully extubated on the seventh day after his admission. The patient was followed up in the clinic a few weeks after discharge and was asymptomatic and free from any respiratory problems. Over the subsequent months, the team at the bedside has continued to gain experience in prone ventilation by utilizing it in other cases of severe ARDS under the guidance of the tele-ICU team.

Discussion

The total number of qualified intensivists in India is around 3500, which translates to a large shortage in the delivery of high-quality critical care[6,7]. While quality improvement in healthcare is a ubiquitously accepted requirement, scarcity of trained intensivists is a factor which limits the delivery of critical care services in LMICs. The dearth of qualified intensivists is more pronounced in smaller cities and towns or small and mid-sized hospitals. The use of a tele-ICU model to improve outcomes has been shown to be successful and cost-effective in high-income settings, however, it has not been investigated much in an Indian setting[5]

The tele-ICU workflow functions as a hub and spoke model. The spoke ICU doctors and nurses are connected to the hub command center where intensivists and highly experienced critical care nurses (tele-ICU team) are present round the clock. The live video feed streaming through high definition cameras installed at the spoke ICUs ensure that nurses and the intensivist at the hub command center can perform detailed visual assessments of the patients, view their monitors, ventilators, syringe pumps, infusion pumps, drains and tubes as needed and on a scheduled basis. The laboratory, radiology and additional patient information from the hospital is sent to the command center through communication platforms that conform to privacy requirements. All patient data, including hub intensivist assessments, are systematically recorded in a secure online repository which meets the Health Insurance Portability and Accountability Act (HIPAA) standards.

The system is designed to ensure appropriate utilization of expertise and ensure 24/7 availability of trained intensivists. The command center critical care nurses monitor patients, assimilate data and follow predefined triage criteria enabling them to continually escalate issues to the Intensivists at the command center.

The command center team closely coordinates with the team of bedside doctors and nurses to ensure that appropriate recommendations, investigations, medication changes and procedures are performed. The system under the guidance of the hub-based Intensivist potentiates the ability of the bedside nurses' and doctor's and augments their skills to appropriately manage critically ill patients. The spectrum of intensivist input varies from routine advice on diagnosis and management, implementation of appropriate clinical protocols, antibiotic stewardship, venous thromboembolism prophylaxis, ventilator management, implementation of weaning and extubation protocols, appropriate fluid management strategies, interpretation of electrocardiograms and chest radiographs, etc. The far end of the spectrum consists of more complex situations like management of refractory hypoxemia and ARDS, interpretation of bedside ultrasound scans and bedside echocardiograms through high definition camera monitoring systems, augmentation of cardiopulmonary resuscitation (CPR) via tele-ICU guidance and interpretation of advanced hemodynamic data.

An appropriately structured telemedicine workflow has been shown to translate to better patient outcomes and increased patient and patient family satisfaction[7]. In addition, by compiling the stream of patient data coming from the spoke ICUs, we can provide routine audits on the standard quality metrics in these ICUs creating a 'feedback-improve' cycle. Furthermore, since multiple ICUs share the cost of ICU expertise this allows the system to be cost effective. Western countries have found tele-ICU systems to be a cost-effective model, however, the average cost of healthcare is also significantly higher in high-income countries, hence a dollar to dollar conversion would not be tenable in LMICs. Technology solutions prevalent in high-income countries are not feasible given Indian constraints. The cost of setting up tele-ICUs in the United States has been reported to be above $70,000 per bed for the first year of operation, which translates to $191 per day [8]. This is vastly out of reach for most LMIC ICUs, especially ones in India.

Implementation of homegrown solutions and modifications to workflow has enabled us to deliver quality critical care at costs as low as $30 per bed/day. The cost of tele-ICU setup and maintenance has been shown to offset the cost to the patient and hospital favorably by thedecreased length of stay, improved outcomes and better utilization of resources [9].

Tele-medicine is presently at a very nascent stage in India and there remain many barriers to wider adoption of this technology. There is a great deal of misunderstanding among doctors regarding the role of tele-medicine and the technology is perceived as a replacement to traditional bedside medicine rather than an adjunct. On the contrary, tele-ICU systems are complementary to the bedside team acting as an additional set of eyes and ears. For example, we have recently reported the feasibility of tele-CPR based augmentation of bedside CPR in an Indian setting [10].

Tele-ICUs improve patient care and outcomes and streamline workflow for the bedside physician and nurses [11]. There are several Western studies elaborating the cost-effectiveness of the use of teleservices in ICUs [12]; Pragmatic studies conducted in relevant settings will help in better adoption of technology in India and other LMIC's.

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