Telemedicine Using Stationary Hard-Wire Audiovisual Equipment or Robotic Systems in Critical Care: A Brief Review

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A shortage of critical care physicians in the United States has been widely recognized and reported (1). Most intensive care units (ICUs) do not have a formally-trained intensivist in their staff despite compelling evidence that high-intensity intensivist staffing leads to better patient outcomes (1,2). Critical care telemedicine is one potential solution that has expanded rapidly since its inception in 2000 (3). In its simplest form, telemedicine leverages audiovisual technology and the electronic medical record to provide remote two-way communication between a physician and a patient. Current telemedicine models differ by the type of hardware facilitating remote audiovisual interaction, the location of the provider, and the type of patient-care service provided. We collectively have experience with several of these models and feel that future telemedicine programs will likely integrate the most advantageous aspects of each with an increasing role for telemedicine robotics.

The dominant current model for providing critical care telemedicine in large healthcare systems utilizes stationary hard-wired audiovisual equipment linking each ICU room to a centralized control location (4). Typically, this control center provides surveillance of a large number of patients using computerized decision support software linked to the EMR – a single physician can cover approximately 100 patients with the appropriate support infrastructure. This model also provides the ability to remotely “round” on ICU patients and to quickly respond to questions posed by nursing or medical emergencies across a broad geographic range. This approach requires a high up-front capital cost approximated at 50-100K per hospital bed covered (5).

Data supporting the benefit of this model of ICU telemedicine has been mixed, but several considerations are important in appraising the literature. A double-blinded RCT for ICU telemedicine intervention is not feasible. Heterogeneity in clinical workflows and staffing models across the country should be considered when assessing the internal validity and generalizability of published studies. For instance, Thomas and colleagues concluded that a telemedicine ICU service resulted in no overall improvement in mortality or length of stay (LOS) (6), but the tele-intensivists in the study were limited by only being allowed to intervene in the care of less than a third of the study patients. Nassar and colleagues published a negative study in a healthcare system in which

resident and attending physicians were already available in-house for overnight patient care (7). Likely, the potential benefit of a telemedicine program can be optimized in a clinical setting in which other physicians are not physically available at the locality 24/7 and telemedicine intensivists are allowed to appropriately intervene when indicated.

Despite these difficulties, there is a growing body of evidence that suggests a centralized telemedicine ICU model is effective in a number of areas including: improvements in compliance with evidence based practices (8, 9), increased job satisfaction of ICU nurses (10) and reduction in the cost of care of the sickest patients in the institutional setting (11). Other studies suggest that a telemedicine platform can reduce mortality and LOS by allowing for earlier intensivist involvement, promoting adherence to best practices, shortening alarm response times and improving access to ICU performance data that can be used to drive continuous quality improvement (12,13).

Commercially available telemedicine robots are mobile units equipped with a digital camera, microphone and monitor screen that provides two-way audiovisual communications with the control center via a wireless internet connection (14). Telemedicine robots can be operated with much lower initial capital costs - for instance, an ICU group at a large acute care hospital might provide coverage at a rural healthcare setting using a single robot (15). Such a system can be used for daily rounding or for reactive consultation. Like hard-wired systems, telemedicine robots have been shown to be well accepted by providers (16) and patients (17), and their use has been associated with reduced ICU length-of-stay and decreased delay in response to clinical events by the physician (18).

Telemedicine robotic systems have several disadvantages – they do not provide large-scale EMR surveillance leveraging computerized decision support logic and they are significantly less efficient than hard-wired systems for high-volume patient care since they have to physically relocate from patient room to patient room. However, unique capabilities of telemedicine robots are being developed that cannot be duplicated by hard-wired systems. Telemedicine robots can be equipped with a digital stethoscope (19). They can perform physical examination elements that require tactile communication – such as the determination of the Glasgow coma scale (20). A robotic arm can be used to remotely perform point-of-care ultrasonography. This has been successfully operationalized for cardiac, abdomino-pelvic, and vascular indications (21,22). Telemedicine robots have been developed that can place peripheral or central venous catheters (23). The development of surgical robots that incorporate tomographic capability and that can perform battlefield stabilization procedures in either autonomous or teleoperative modes (24) provide a glimpse of the potential for telemedicine robots in the ICU.

Although healthcare systems currently implementing telemedicine services will likely choose either a hard-wired or a robotic model – largely based on cost and the volume of required services - we believe the optimal telemedicine system of the future will and should incorporate both technologies. Real-time data acquisition coupled with ready access to timely interventions constitute the basis for faster deployment of precision health care strategies in the ICU setting.

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