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**The Impact of Remote ICU Monitoring on Patient Outcomes and Processes of Care**

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**BACKGROUND/RATIONALE:**

There is growing appreciation that the staffing of intensive care units (ICUs) by physicians trained in critical care medicine (intensivists) can result in improved patient outcomes. Intensivist staffing of ICUs has been endorsed by a number of high-profile public and private partnerships. However adoption of intensivist staffing by hospitals has been hampered by a shortage of intensivist physicians. Recruiting and retaining intensivists may be particularly challenging for smaller rural hospitals including many smaller facilities within the Veterans Health Administration (VA). In an effort to overcome a lack of available intensivists a growing number of hospitals have installed remote ICU monitoring systems. These systems typically combine high-speed videoconferencing with features of an electronic medical record to connect the clinical care team and patients at the remote (physical) ICUs to intensivist physicians and nurses at a central monitoring center; using this technology it is possible for a single intensivist and two or three nurses to monitor upwards of one hundred patients distributed across multiple physical ICUs. Staff at the monitoring center can check vital signs and laboratory tests, write orders, and communicate via videoconference with the on-site clinical care teams at the physical ICUs about changes in the condition of individual patients. Despite rapid adoption of remote ICU monitoring by hospitals, rigorous empirical data about the impact of these systems are extremely limited.

**OBJECTIVE(S):**

This study will take advantage of a unique natural experiment that will occur with the implementation of a remote ICU monitoring system in the eight ICUs (seven hospitals) within VISN 23 during calendar year 2010. Our primary objective will be to examine the impact of remote ICU monitoring on patient outcomes including mortality, ventilator acquired pneumonia, and ICU length of stay. Our secondary objectives are to develop taxonomy for describing the nature of the recommendations made by the central monitoring center and to evaluate the cost of implementing the ICU monitoring system.

**METHODS:**

First, we will use validated VA administrative and clinical data to assess the impact of remote monitoring on patient mortality, length of stay, and selected intermediate patient outcomes including ventilator acquired pneumonia (VAP) and catheter-related bloodstream infections (CR-BSI). For these analyses the intervention group will consist of consecutive patients admitted to the eight ICUs

within VISN-23 where the remote ICU monitoring system will be implemented. The control group will consist of a cohort of patients admitted to eight control ICUs outside of VISN-23 that will not receive remote monitoring and are selected by propensity score matching. Second, we will develop taxonomy for describing the nature of the recommendations made by the monitoring center staff and then use the taxonomy to characterize the types and relative frequency of therapeutic and diagnostic recommendations. Third, we will examine the start-up and maintenance costs associated with the implementation of the remote ICU monitoring program.

### **FINDINGS/RESULTS:**

During the past 12-months, we have made progress on several fronts. First, we have published two systematic reviews related to tele-ICU care. Second, we have completed an evaluation of the costs of tele-ICU program implementation. We found that tele-ICU programs cost between \$60,000-\$120,000 per-bed per-year to implement and operate; these results are in press at Chest currently. Third, our team has conducted interviews and focus groups with more than 50 providers and staff in VISN-23 who are involved with the tele-ICU. We are in the process of analyzing these data currently. We will be presenting some of our findings at the upcoming HSR&D meeting. We also disseminated a Research Brief through Dr. Peter Kaboli's Rural Health Resource Center describing the potential impact of tele-ICU on rural VA hospitals.

### **IMPACT:**

To date we have published three manuscripts stemming directly from this research. We have disseminated our findings to the larger VA Community through a Rural Health Brief. We believe that we are providing important information to both VA and the private sector regarding tele-ICU programs.

### **PUBLICATIONS:**

#### Journal Articles

- Kumar G, Falk DM, Bonello RS, Kahn JM, Perencevich E, Cram P. The costs of critical care telemedicine programs: a systematic review and analysis. *Chest*. 2013 Jan 1; 143:(1):19-29.
- Wilson SR, Cram P. Another sobering result for home telehealth—and where we might go next. *Archives of internal medicine*. 2012 May 28; 172(10):779-80.
- Conference Presentations
- Moeckli J, Cram PM, Cunningham CL, Reisinger HS. Staff Acceptance of Tele-ICU Monitoring. Paper presented at: VA HSR&D / QUERI National Meeting; 2012 Jul 19; National Harbor, MD.
- Young LB, Chen P, Lu X, Nallamothu B, Sasson C, Cram PM. Impact of Tele-ICU Coverage on Patient Outcomes: A Systematic Review and

Meta-Analysis. Paper presented at: VA HSR&D National Meeting; 2011  
Feb 17; National Harbor, MD.

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