Tele-ICUs: Remote Management in Intensive Care Units

New England Healthcare Institute

MASSACHUSETTS TECHNOLOGY COLLABORATIVE

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New England Healthcare Institute (NEHI)

The New England Healthcare Institute (www.nehi.net) is a not-for-profit collaborative dedicated to transforming health care for the benefit of patients and their families. Through research, education and policy change, NEHI finds and promotes innovative ways to improve health care quality and lower health care costs. Working in partnership with its members from all sectors of the health care system, NEHI forges bold and lasting solutions to the health care crisis.

Massachusetts Technology Collaborative (MTC)

The Massachusetts Technology Collaborative's (www.masstech.org) mission is to support the state's innovation economy by acting as a catalyst between the private sector, government, and academia. Its major programs include renewable energy, nanotechnology, support for university-based R&D with close industry involvement, and advanced technologies in health care which improve quality and lower costs. Its "2002 Index of the Massachusetts Innovation Economy" identified the Massachusetts life sciences "Super Cluster" as an integrated system of biomedical research, medical education, biotechnology, information technology, medical devices, and related industries.

Health Technology Center (HTC)

The Health Technology Center (www.healthtech.org) is a non-profit research organization and expert network that offers its partner hospitals and health systems proprietary reports, decision support tools, and educational events for adopting care delivery innovations and deploying emerging technologies. Partners develop a competitive advantage by using HealthTech's resources to redesign care, plan future facilities, prioritize technology investments and avoid costly errors.

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Executive Summary

What are Tele-Intensive Care Units (Tele-ICUs)? Tele-ICUs are networks of audio-visual communication and computer systems that link critical care doctors and nurses (intensivists) to intensive care units (ICUs) in other, remote hospitals. The intensivists in the "command center" can communicate by voice with the remote ICU personnel and can receive televised pictures and clinical data about the patients. Direct patient care is provided by the doctors and nurses in the remote ICU who do not have to be intensivists themselves. In recent years there has been an increase in the number of patients needing ICU care without a corresponding increase in the supply of intensivists. Tele-ICUs offer a solution to this problem by enabling a relatively small number of intensivists to oversee the care of a large number of ICU patients.

Background: increased use of ICUs. ICUs became common in hospitals across the U.S. in response to the polio epidemic of the late 1940s, which flooded the hospitals with patients who required complex new technologies, such as the iron lung, for respiratory support.

Sixty years later, ICUs have become a key element in hospital care—they are the units where the most fragile and complex patients are treated. While many inpatient units are being downsized with the shift to outpatient care, ICUs are expanding. The approximately 6,000 pediatric and adult ICUs in the U.S. account for more than 10 percent of all hospital beds[1] and more than 7 percent of National Health Expenditures. The use of ICUs is expected to grow with the increased numbers of critically ill patients requiring treatment with ever more complex technologies.

An aging population means more and sicker ICU patients. The current surge in the ICU patient population is driven largely by demographics: between 2000 and 2020 the U.S. population age 65 and over is projected to grow by 50 percent.[2] The volume and severity of cases treated by the approximately 4,000 adult ICUs[3] will dramatically increase. To meet this demand, ICU capacity and capabilities must be expanded.

Intensivist shortage limits ICU expansion and quality of care. There is substantial evidence that today's highly complex ICUs are best managed by specialists in intensive care. For example, the Leapfrog Group has found that mortality rates are up to 30 percent lower and lengths of stay (LOS) up to three days shorter in ICUs managed by intensivists. The Leapfrog Group has made adequate intensivist staffing a criterion against which its payer members measure the performance of hospitals. At present, less than 10 percent of reporting hospitals meet these standards. There are simply not enough intensivists in practice to permit all hospitals that maintain ICUs to staff them with even one full-time physician intensivist. Only about 4,000 intensivist physicians are now practicing in ICUs in the U.S. and many of them work in other areas of critical care, such as emergency departments and burn units. The supply of intensivists is unlikely to be able to keep up with the surge of older patients. Many medical schools have decreased their critical care fellowship programs, largely for funding reasons.

How can Tele-ICUs help? Telemedicine offers a means of leveraging intensivist coverage over more ICU beds. One physician and four nurses in one command center can oversee the care of up to 75 patients in distant ICUs. These clinicians are aided by "smart" databases that track patients' clinical values and give an alert when signs indicate a negative trend or when a change in treatment is scheduled according to protocol programs. The remote ICUs are staffed with physicians and nurses providing direct care to patients, but they do not have to be intensivists and they are also assisted by the computer alert systems.

How widely are Tele-ICUs used? Tele-ICUs as complete, commercially packaged systems were introduced by VISICU in 2000. The first installation was in Hampton, Virginia, where a command center covered two Sentara Hospital ICUs. Since then approximately 40 command centers have been installed in the U.S. About 3,850 adult ICU beds, perhaps 4 percent of the total, are covered by Tele-ICUs. Although the licensing capacity of a command center currently permits coverage of up to 300 beds, most (about 60 percent) cover fewer than 100 beds.

Barriers to broader use. The increase in use of Tele-ICUs (as measured by either the number of new command centers or the number of new beds covered) peaked in 2004 and 2005[4]. Barriers to the adoption of Tele-ICUs by hospitals include the following:

- Tele-ICUs are expensive;
  - Capital costs of construction, installation, and training for a new command center range from $2 million to $5 million;
  - Capital costs of adding another ICU to the system are approximately $250,000;
- Annual operating costs of a command center are about $2 million;
- Admitting physicians often resist sharing or delegating patient management to the command center intensivists;
- Physician fees for command center intensivists are not currently reimbursed by insurers and must be paid for by the command center hospital as part of the operating expense;
- Extending the coverage of a command center to ICUs outside its health care system requires organizational cooperation on issues of technology, finance, management of patient care, and referrals.

What has been the experience of early-adopting hospitals? There are few evaluations by early adopter hospitals and they offer only limited support for the value of Tele-ICUs. There are some reports of decreased mortality and length of stay (LOS), the two key outcome measures for ICUs. Some hospitals report clinical improvements such as higher rates of survival from emergency resuscitations and lower rates of hospital-acquired infections. Only one hospital system, Sentara, has published its findings in a study that compares patient outcomes before and after the installation of the Tele-ICU.[5] Sentara found that mortality, LOS, and financial measures all improved. Although other early adopters have not been able to replicate Sentara's strong findings, all reports suggest improvements in either key outcomes or in process and quality of care measures. (See Figure 1-1 below.)

Figure 1-1

Summary of Findings from Early Adopters – January 2006

Hospital and Year	Meet Leapfrog Standards?	Published?	ICU Mortality Change	Average ICU Los Change/ Other Costs
Sentara (VA) 2000	Yes	Yes (2004)	25 percent reduction	5.6 to 4.8 days LOS (-14 percent) / -25 percent operating costs +20 percent ICU cases
Sutter (CA) 2003 & 2005	Yes	No	No significant change	No significant change in LOS / Reduced septic infections
Lehigh Valley (PA) 2004	Yes	No	Reduction from 15 percent to 10 percent all-cause mortality	ICU LOS reduced "more than projected"
Areva (SD) 2004	Not rated by Leapfrog	Conference abstract (2006)	Reductions in actual over projected mortality in 3 of 5 hospitals to which coverage extended	ICU LOS reduced against projected for severity of caseload/Hospital LOS reduced
Memorial Hermann (TX) 2004	Not rated by Leapfrog	No	1.5-2 percent average reduction	Reduced LOS in 3 of 5 reporting ICUs

What are the highest-value applications of Tele-ICUs? Tele-ICUs can be a valuable resource for hospitals faced with the need to expand capacity and improve care for a growing elderly population. Evidence from some early-adopter hospitals indicates that Tele-ICUs can leverage management of patient care by intensivists, reduce mortality rates, and reduce LOS.

However, positive outcomes appear to depend on the organizational environment into which the Tele-ICU is introduced. The dramatic improvements in mortality and LOS reported by some early-adopter hospitals have not been matched in most hospitals. These differences may be due to more complicated organizational structures or less enthusiastic adoption of Tele-ICUs by physicians. For example, intensivists may only monitor and not manage patient care, or personnel may not be adequately trained in responding to Tele-ICU alerts.

As with most medical technologies, some applications of Tele-ICUs are more likely than others to yield improved outcomes. The limited research available suggests that the best outcomes may occur in ICUs that:

- Can make organizational arrangements to support the management of patient care by intensivists using Tele-ICUs;
- Have little or no intensivist staff available to them in the absence of Tele-ICUs;
- Have relatively high severity-adjusted mortality and LOS rates;
- Are located in remote or rural areas where safe and efficient transfer of patients to regional centers for advanced critical care presents difficulties.

The financial, organizational, and reimbursement barriers to Tele-ICUs have both slowed its rate of adoption and skewed adoption toward the more financially stable hospitals. Thus, early adopters are most likely to be hospitals that are already using intensivists for patient care. These hospitals may well improve care and reduce LOS by the use of Tele-ICUs, but they are not necessarily the users that will benefit the most from them. Conversely, the hospitals meeting the profiles outlined above are unlikely to be able to afford Tele-ICUs.

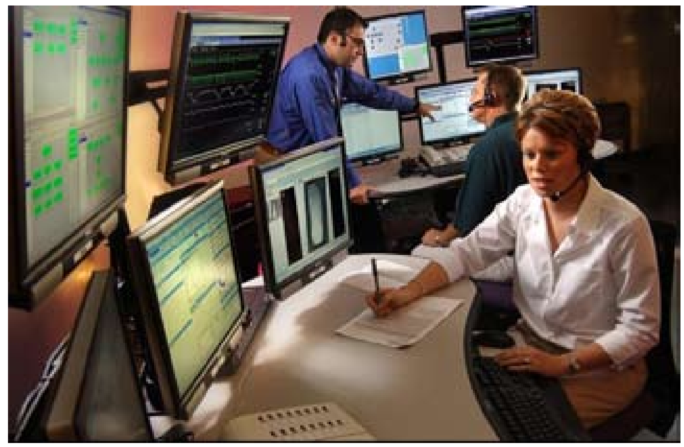
In order to direct the use of expensive technology to its highest-valued applications and to prepare to care for an aging population, payers and providers should consider steps to lower barriers to broader Tele-ICU coverage for those hospitals that have the most need to improve their adult ICU care. The most efficient means of doing this is to expand coverage from existing command centers across hospital systems to ICUs most in need of tele-intensivist management of patient care.

The Fast Adoption of Significant Technology (*FAST*) Initiative

Tele-ICUs are one of four technologies under review by the FAST Initiative, a joint partnership of New England Healthcare Institute, Massachusetts Technology Collaborative, and Health Technology Center. The objective of this program is to identify and evaluate medical technologies that are not well adopted despite their potential for improving patient outcomes and reducing total treatment costs. If our reviews confirm a candidate technology's value, we work with our Steering Group of national payers and providers to lower barriers to broader use and track results over time.

What Are Tele-ICUs?

Tele-ICUs are an enabling technology that monitors ICU patients and permits doctors and nurses who are specialists in critical care medicine ("intensivists") to manage the care of patients in multiple distant units. Also referred to as telemedicine, Tele-ICUs hold great promise to improve the care of ICU patients, save lives, and increase both the productivity and the reach of specialists in critical care medicine. These specialists are in very short supply, and without telemedicine there are few options for expanding their coverage of ICUs. The U.S. Census Bureau estimates that between 2000 and 2020 the U.S. population aged 65 and over will grow by 50 percent, providing further need for adult ICUs.



Tele-ICUs connect a central command center staffed by intensivists with patients in distant ICUs. Continuous, real-time audio, video, and electronic reports of vital signs connect the command center to the patients' bedsides. Computer-managed decision support systems track each patient's status and give alerts when negative trends are detected and when changes in treatment patterns are scheduled.

The success of Tele-ICUs in improving patient outcomes, decreasing ICU costs, and leveraging the use of intensivists for management of patient care depends on organizational arrangements and physicians' acceptance of Tele-ICUs. Moreover, Tele-ICUs are expensive to build and operate. NEHI's *FAST* Initiative selected Tele-ICUs as a promising new technology that faces barriers to wider use. If they can be shown to both improve patient outcomes and decrease costs, Tele-ICUs will deserve the efforts of payers and providers to foster their wider use. This evaluation involved reviews of the published literature and interviews with more than 30 users of Tele-ICUs, three manufacturers of Tele-ICU systems, and researchers in ICU care.

Figure 2-1

Hardware Components

- Computer systems to collect, assemble, and transmit information
- Communication lines
- Physiological monitors
- Therapeutic devices
- Medical records
- Video feed (with angle and zoom adjustments)
- Audio communications
- Video display panels

Overview of technology. A Tele-ICU system contains hardware that collects and assembles patient data and transmits it (including video and voice) from the remote ICU to the command center. The patient data include physiological status (e.g., EKG and blood oxygenation), treatment (e.g., the infusion rate for a specific medicine or the settings on a respirator), and medical records. Ideally the hardware provides the clinicians in the command center and the ICU with the same patient data.

Figure 2-2

Software Components

- Software to operate hardware and enable data transmission
- Algorithms for alerting clinicians to potentially actionable situations
- Adjustable triggers for alerts and alarms
- Data capture and analysis capabilities to enable retrospective quality review and improvement

The software for a Tele-ICU includes the programs that make all the monitoring and information transmission hardware function properly (see Figure 2-2). One challenge in developing Tele-ICU software is to enable it to interface with and electronically accept data from other electronic information systems that serve the ICU (e.g., laboratory results, medications, nursing flow sheets, physicians' notes, etc). As with many sophisticated software products, building connectivity with initially incompatible systems is possible but can take time and money. Furthermore, when systems are purchased from competing companies, additional software may be required to make them interoperable.[6]

The U.S. market has one dominant vendor, VISICU, which entered the market in 2000. Two other vendors, iMDSoft and Cerner, entered the U.S. market in the past two years. The latter two companies offer multiple health information products. Details of the three main Tele-ICU manufacturers are given below (Appendix 2):

✦ **VISICU:** The leading U.S. vendor is VISICU, founded in Baltimore in 1998 by two intensivists. All but two Tele-ICU systems in the U.S. are VISICU products. The firm claims installation of 28 ICUs with 2,300 beds and contracts for another 7 eICUs® serving about 150 hospitals and over 300 ICUs.

✦ **Cerner**: This diversified health care system and data company offers a product, Critical Care/Critical Connections, which has been installed in a hospital system in Kalamazoo, MI. Their approach to Tele-ICU monitoring is built around their existing electronic medical records (EMR) system and electronic charting of ICU nursing and physicians' information.

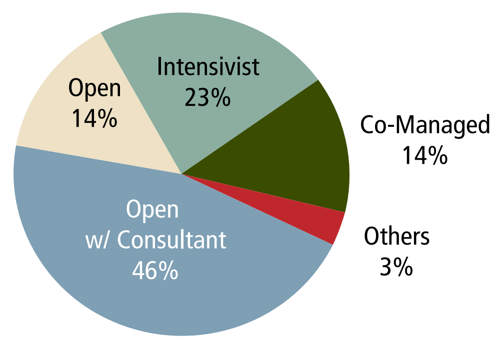
✦ **iMDSoft**: iMDSoft's core product is a clinical information system called the MetaVision Suite, which includes a clinical information system for ICUs called MVICU and a similar system for the operating room called MVOR. Many of these systems have been installed in Europe and a few have been installed in the U.S. The MVICU clinical information system includes smart alarms that can be based on multiple physiological parameters and customized for each patient. These alarms are "open-sourced" and thus can be modified and added to by the health system customer. MCIVU users can add or retrieve such customized alarms from a central library maintained by the company.

The Case for Tele-ICUs

Findings for intensivist management of ICUs. A presumptive case for Tele-ICUs has been made by a body of research measuring the outcomes associated with staffing of ICUs with intensivists as compared with traditional staffing. There are several models for the staffing of ICUs by intensivists (see Figure 3-1). In the intensivist model, the intensivist manages patient care directly; with this system, patients' problems are identified sooner, leading to more rapid and complete interventions, and lower mortality rates. In the open ICU, the patient's physician of record is a community physician with hospital admitting privileges. An intermediate model is the co-managed or transitional ICU, where ICU patient care is managed jointly by community physicians and intensivists.[7]

Figure 3-1

Tele-ICU Models of Care



Studies examining the different models of care found that the open model with consultants was the most widely implemented in Tele-ICUs. One study from 1997 indicated that 23.1 percent of patients were treated by full-time intensivists, whereas 13.7 percent had a "consultant intensivist" (i.e., co-managed) model, 45.6 percent had a number of consultants working with the patient's primary care physician (with none designated as a specific consulting intensivist), 14.2 percent had a single non-intensivist physician, and 3.4 percent used some other model.[8]

Mortality. An assessment of peer-reviewed articles on the effects of intensivist staffing of ICUs found that most (11 of 16) of the studies comparing similar ICUs found a statistically significant decrease in hospital mortality and most (11 of 15) also found a statistically significant decrease in ICU mortality.[9] One study estimated that mortality was reduced by 15 to 60 percent with the use of intensivist staffing in comparison with conventional or open models in which management of patient care is directed by, or largely shared with, physicians who are not dedicated critical care specialists.[10] A systemic review of the literature found a similar reduction of 23 to 50 percent in hospital mortality rates with intensivist staffing.[11]

The Leapfrog Group estimated that if the standards for ICU physician staffing were met in the 84 percent of adult admissions that occur in urban hospitals (i.e., if intensivist coverage for adult admissions increased from 21 percent to 100 percent), the in-hospital mortality rates at these hospitals could be reduced by 30 percent from baseline and about 53,000 adult deaths could be avoided.

Another researcher estimated that reducing the mortality rate from 12 to 8 percent would prevent 134,000 deaths annually.[12]

ICU length of stay (LOS). Similar to the findings for mortality rates, there is substantial evidence that the intensivist model can lead to reduced LOS in both the ICU and the hospital. In all, 6 of 13 studies found a statistically significant decrease in hospital LOS and 11 of 17 found a significant decrease in ICU LOS (see Figure 3-2).[13]

Figure 3-2

Patient Outcomes after ICU Installation[14]

Outcome	Low-Intensity Staffed ICU	High-Intensity Staffed ICU
ICU LOS	2–13 days	2–10 days
Hospital LOS	8–33 days	7–24 days
Mortality	12 percent	8 percent

Studies examining the impact of a shift to the intensivist model from conventional models also report a shortening of both ICU and hospital LOS.[14] The intensivist model has also been associated with a decreased LOS in specific patient groups, such as patients with aortic aneurysms.[15]

Policy support for intensivist-managed care in ICUs. The research findings on the intensivist model of staffing for ICUs have led to strong policy support from the Leapfrog Group, the Society of Critical Care Medicine, and the American College of Critical Care Medicine.[16] Although these groups have slightly different criteria for full intensivist staffing and management of an ICU, their definitions include having an intensivist physician managing patient care during two of the three staff shifts in an ICU and available on call and able to respond in person during night shifts (see Appendix 6 for a summary of Leapfrog Group criteria for ICU physician staffing).

Shortage of intensivists. There are about 6,000 critical care specialists in the U.S., fewer than 4,000 of whom practice in adult ICUs—less than one for each ICU. One study estimated that over 30,000 full-time intensivists would be needed to staff the ICUs in the United States around the clock, and the shortage of intensivists is expected to persist for many years.[17]

It is estimated that less than 15 percent of U.S. hospitals with ICUs have dedicated intensivists; however, larger ICUs are more likely to have intensivist coverage, so the percentage of patients without intensivist coverage would be smaller than the percentage of ICUs without such coverage.[18]

The supply of intensivists is unlikely to increase. Teaching hospitals have decreased the numbers of fellowship programs in critical care for financial reasons; intensivists report an early retirement age due to workplace stress; and some trained intensivists appear to be choosing not to work in ICUs because of reimbursement limitations.[19]

Therefore, one way of providing full intensivist staffing to more ICUs is to use Tele-ICU technology to enable a single intensivist and a few critical care nurses to monitor and assist in the care of dozens of ICU patients.

Potential benefits of Tele-ICU monitoring and alert systems. The importance of such monitoring and alerting systems has grown with the complexity and size of ICUs. A recent assessment of ICU care found that:

> "Adverse events and serious errors were common and often potentially life-threatening. ...a daily rate of 0.8 adverse events and 1.5 serious errors for a 10-bed ICU. ...a significant relationship between ICU volume and risk-adjusted mortality."[20]

As the number of elderly and severely ill ICU patients grows, the value of these ICU systems will be underlined.

Figure 3-3

Internal Benefits of Tele-ICUs

- Reduced ICU complication rates
- Efficient delivery of care
- Improved productivity of clinical staff
- Improved staff morale and decreased turnover
- Enhanced training opportunities

Figure 3-4

External Benefits of Tele-ICUs

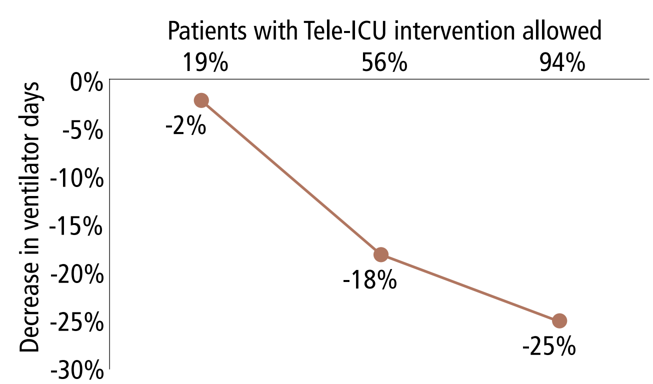
- Increased perception of quality of care
- Ability to meet Leapfrog standards
- Increased revenue
- Reimbursement for services
- Grants to acquire Tele-ICU systems or services

The use of Tele-ICUs offers several internal and external benefits (see Figures 3-3 and 3-4). Research indicates that Tele-ICU systems can directly reduce ICU LOS and indirectly reduce hospital LOS. Reduction in ICU LOS can lead to fewer patient complications in the ICU. Furthermore, by implementing standard protocols for the treatment and prevention of common clinical situations and complications, more time and resources can be directed to treating patients' primary conditions. These conditions provide more efficient delivery of care to patients in the ICU (see Figure 3-5)[21].

Another internal benefit is improved productivity of clinical staff. The electronic information systems that are often installed or adopted along with a Tele-ICU system can reduce staff time spent in both charting and delivering care.

Figure 3-5

Impact of Tele-ICU Management on Days Spent by Patients on Ventilation



For example, Lehigh Valley Health Network has noted that the electronic patient flow sheet for the nurse charting part of their Tele-ICU system has had a significant impact on the productivity of the ICU nurses. After implementation of these systems, ICU nurses increased their direct patient care by 75 minutes per 12-hour shift. Over a 30-day period, this equals 1,000 hours of increased patient care in a 28-bed ICU with 15 nurses per 12-hour shift. Similarly, the computerized physician order entry (CPOE) system installed as part of the Tele-ICU system decreased by almost 100 minutes the time from placing an order for an antibiotic to entering it on the chart.

Tele-ICUs also offer opportunities to conduct education and training. Tele-ICUs make experienced intensivists and critical care nurses who are dedicated to the management of ICU patient care available to junior clinical staff and students at times when these resources are not present in the physical ICU, such as at night. Furthermore, the Tele-ICU computer and alert systems not only monitor patients' vital signs but also contain and enforce ICU protocols for care. When successful, Tele-ICUs help improve outcomes and quality of care and avert errors in patient care.

Technology benefits. Tele-ICU systems contain software that analyzes the patient's physiological condition as well as trends in the patient's condition and alerts clinicians if the patient's condition is worsening or trending toward a significant adverse event.[22] For example, a patient's heart rate might be slowly increasing; whereas a normal pulse alarm might be set to trigger at a heart rate of 100 per minute, a software program monitoring the patient's trend toward an increasing heart rate (as well as other measures such as blood pressure, respiration rate, and blood oxygenation) could alert the clinicians before an alarm was triggered for any one of these parameters alone.

This software capability enables clinicians to focus on patient care without trying to constantly monitor all of their patients' physiological parameters. This type of assistance is increasingly valuable as the complexity of medical care grows faster than the ability of the human brain to integrate and analyze the expanding amount of available raw data. An additional benefit of the Tele-ICU system is that, because of the electronic nature of the data being transferred, it allows for data archiving and analysis for quality improvement and documentation of the Tele-ICU system's performance.

Figure 4-1

Staff Organizational Setting

- Tele-ICU staff, including physicians, nurses, clerical support staff and IT support staff
- Physical ICU staff (same as above, but in the ICUs where the patients are located)
- Hospital (or health system) IT management and staff
- Tele-ICU system (or components) management and technical staff

Reservations and Caveats: What Are the Practical Limitations?

Organizational setting and acceptance. The gains from Tele-ICU coverage appear to be highly dependent upon the organizational environments of the hospitals into which coverage is introduced, cultural acceptance by other staff, and the technology status of the hospital.

The ability of Tele-ICU clinicians to influence care is crucial to the success of a Tele-ICU system (see Figure 4-1). Tele-ICUs have been characterized as an extra set of eyes watching over critically ill ICU patients, but the eyes need to be effectively connected to care at the bedside. If the Tele-ICU clinicians are not empowered by the ICU patient's physician of record (either directly or through hospital protocols) to manage the patient's care, they might know what needs to be done but be unable to help the patient either directly or via a surrogate.

Several Tele-ICU system medical directors referred to the need to have physicians and nurses acting as champions in each ICU, both to promote teamwork and to encourage physicians to empower the Tele-ICU physicians to be actively engaged in management decisions. The degree to which physicians in an open ICU allow the Tele-ICU physicians to manage their patients' care typically evolves as the comfort level with the Tele-ICU system increases. One Tele-ICU medical director reported that the percentage of patients under full management authority in their open ICU increased from an initial 20 percent to 70 percent. However, another Tele-ICU medical director who faces significant resistance from community physicians remarked that a better title for the job would be "Change Management Director." According to one published report, a project team met weekly to plan implementation of a Tele-ICU system for almost a year after the specific Tele-ICU product was selected.[23]

Another Tele-ICU medical director discussed the need for education of ICU nurses so that they will think to call the Tele-ICU first rather than the attending physician who may be at home. One way that a Tele-ICU system covering multiple geographically distant ICUs can address this "out of sight, out of mind" problem is to have the Tele-ICU physicians visit each of the ICUs to which they are remotely connected. Putting a face with the Tele-ICU voice helps facilitate the working relationship between the Tele-ICU center and the ICU staff. An estimated two to five years is required to change the hospital culture to acceptance of the Tele-ICU—the same amount of time, the Tele-ICU medical director noted, that is typically cited for business operations to undergo a culture and operations change.

The critical care clinicians need to be distributed appropriately among the physical ICUs and the Tele-ICUs to help establish a team approach. This may involve rotating clinicians between the physical and the Tele-ICUs and requiring clinicians to have a certain level of expertise and experience to work in the Tele-ICU, where they may be directing care being provided by their peers in the physical ICU.

The hospital information technology (IT) executives and staff need to embrace the Tele-ICU system because they will be crucial for its proper installation, interfacing with existing hospital systems, maintenance, and ongoing support for both the physical and the Tele-ICU staffs. There also needs to be a good collaborative working relationship between the hospital IT departments and the staff of the Tele-ICU system or its components.

Costs of installation and operation. The capital, training, and operational costs of Tele-ICUs are high. Most hospital systems, and (disproportionately) those hospital systems that would most benefit from this technology, cannot raise the needed funds.

Acquisition and training. Acquisition and training costs include the purchase and installation of hardware and software and the costs incurred by training the critical care staff to operate the new systems. A health system's actual acquisition costs will depend upon the starting capabilities of the devices in the ICUs and how easily these can be integrated into the Tele-ICU system. If retrofitting is required, the up-front acquisition costs will be increased; if manual data entry is required, the ongoing operating costs for additional staff will be increased.

The Health Technology Center estimated the average cost of the hardware and software needed to create a Tele-ICU as $48,500 per ICU bed connected to the command center.[24] Hospitals that have installed full systems report costs of over $2 million to install a Tele-ICU center and its components beyond what they have spent on ICU electronic medical record systems.[25]

The estimated $2 to $5 million dollar cost of setting up a command center, acquiring and installing the Tele-ICU systems, and paying the initial salaries for the Tele-ICU staff may be a challenge for hospitals and health systems that lack significant financial reserves or borrowing capacity. This may be of particular concern if the Tele-ICU system is not fully compatible with the hardware or software systems of the physical ICU, thus requiring additional expenditures to upgrade the physical ICU components or purchase and install an EMR system for the physical ICUs.

Hospitals without such resources may be in locations where the shortage of intensivists is most severe and Tele-ICU coverage could have the highest value. An alternative to installing and running a Tele-ICU command center is outreach coverage from an established Tele-ICU center. Monitoring and management services are then provided under a yearly operations contract. Given the fact that most command centers have substantial unused coverage capacities, such outreach services may be the most efficient and high-valued applications of Tele-ICU technologies. An independent Tele-ICU has been established specifically to fill this market niche. Several health care delivery systems have begun providing Tele-ICU services to ICUs in local and regional independent hospitals.[26]

Operating costs. Operating and maintenance costs include expenses for staffing the Tele-ICU command center, licensing fees for the software, and periodic upgrades to the hardware or software. Additional costs could be associated with implementing new standardized care processes with the health care professionals in the ICU and the Tele-ICU.

One published study of a Tele-ICU managing two ICUs calculated 6-month operating costs of $248,000 for hardware and software leasing, technical support, and operating expenses, with physician staffing costs adding an additional $624,000.[27] Interviews with managers of other hospitals and health systems have reported higher operating costs of upwards of $1.5 million per year.

The operating costs of a Tele-ICU can be significant, generally ranging from $1 to $2 million annually for a single command center. These costs include hardware maintenance, software licenses, and upgrades, as well as the salaries of the intensivist nurses and physicians. As noted above, there may be additional operating costs if the Tele-ICU system is not completely interoperable with the electronic information from the hospital's information systems.

How Widely Is Tele-ICU Technology Being Used?

The first complete Tele-ICU system was installed by VISICU in 2000 at Sentara Healthcare in Norfolk, Virginia. Since then, an additional 39 command centers have been installed, bringing the total number of beds covered to 3,850, or about 4 percent of adult ICU beds.

Figure 5-1

Tele-ICU Command Center Installations[28]

Year	Regional Health System	Location of Command Center	# Covered Beds / # Hospitals
2000	Sentara Healthcare	Norfolk, VA	105 at 5
2000	U.S. Military	Bethesda, MD	Unknown at 6
2003	Sutter Health	Sacramento, CA	150 at 10
2003	Advocate Health Care	Oak Brook, IL	244 at 8
2003	New York-Presbyterian Healthcare System	New York, NY	98 at 2
2004	Avera Health	Sioux Falls, SD	63 at 12 (SD, IA, MN, NE)
2004	HCA Richmond Hospitals	Richmond, VA	65 at 6
2004	Inova Health System	Fairfax, VA	200 at 5
2004	Swedish Medical Center	Seattle, WA	75 at 3
2004	Health First	Rockledge, FL	62 at 3
2004	Parkview Health	Fort Wayne, IN	44 at 5
2004	Memorial Hermann	Houston, TX	132 at 4
2004	Aurora Health Care	Milwaukee, WI	252 at 13
2004	Kaleida Health	Buffalo, NY	92 at 5
2004	University of Pennsylvania Health System	Philadelphia, PA	67 at 3
2004	Lehigh Valley Hospital & Health Network	Allentown, PA	72 at 3
2004	Borgess Health Alliance	Kalamazoo, MI	35 at 1
2005	Clarian Health Partners	Indianapolis, IN	176 at 5
2005	Saint Luke's Health System	Lee's Summit, MO	86 at 5 (MO & KA)
2005	Baptist Health	Little Rock, AR	118 at 2
2005	OhioHealth	Columbus, OH	127 at 4
2005	Provena Health	Joliet, IL	120 at 6
2005	Sutter Health — Sutter System	San Francisco, CA	150 at 12
2005	Theda Care, BellHealth, & Froedtert & Community Health	Menomonee, Falls, WI	129 at 5
2005	Maine Health	Portland, ME	60 at 3
2005	Christiana Care Health System	Wilmington, DE	81 at 2
2005	Jewish Hospital & St. Mary's HealthCare	Louisville, KY	61 at 1
2005	Baptist Health South Florida	Doral, FL	120 at 5
2006	Banner Health	Mesa, AZ	76 at 5 (AZ & CO)
2006	St. Mary's Health Center & Saint Clare's Hospital	St. Louis, MO	22 at 2 (MO & WI)
2006	Moses Cone Health System	Greensboro, NC	101 at 4
2006	St. Joseph Health System	Sonoma County Santa Rosa, CA	35 at 2
2006	Via Christi Health System	Wichita, KS	120 at 5
2006	Sisters of Mercy Health System	St. Louis, MO	77 at 3
2006	Henry Ford Health System	Detroit, MI	> 60 at 3
2006	UMASS Memorial Medical Center Hahnemann Campus	Worcester, MA	53 at 2

The rate of new installations slowed in 2004 and 2005. In 2004, the number of new command center installations peaked at 12 (see Figure 5-2).

By 2006 the number had dropped to 8. The drop has been equally marked in new ICU beds covered: over 1,000 new beds in 2005 but only slightly over 400 in 2006. The drop in numbers of new beds covered is particularly interesting given that most command centers (over 69 percent) cover fewer than 100 ICU beds, which is substantially less than the maximum of 300 beds that manufacturers are able to license (see Figure 5-3).

Figure 5-2

Number of Tele-ICU Command Center Installations

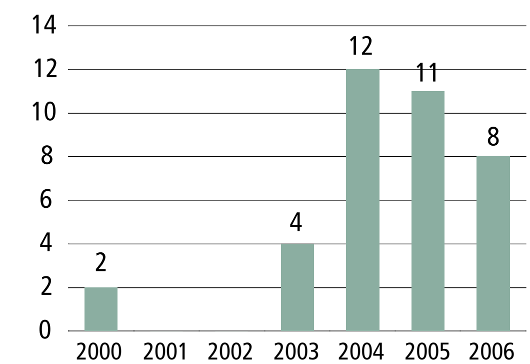
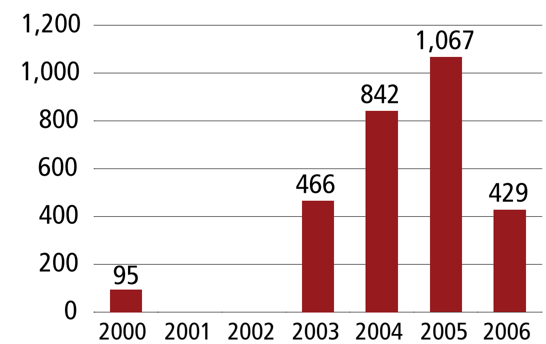


Figure 5-3

New Beds Covered Per Year



Barriers to Broader and Effective Use

Costs. The chief barriers to broader adoption of Tele-ICUs are the installation and operating costs that were discussed above. Few hospitals have access to the millions of dollars needed to install and operate the command center and its coverage of distant ICUs. Some early-adopter hospitals—such as Sentara and Lehigh—have realized returns on these investments in terms of reduced LOS and operating costs. Many hospitals, however, are not in a financial position to make such investments. Although we have case studies of selected hospitals' economic and financial experience after the introduction of Tele-ICUs, we do not have any economic models that can project the likely returns for a given hospital.

Organizational resistance. A second barrier to both the adoption of Tele-ICU technology and its effective use in hospitals is the opposition of admitting physicians to sharing management of patient care with the tele-intensivists. Even where Tele-ICUs have been successfully installed and extensive staff training has been completed, there may be limitations—both formal and informal—to the ability of the command center intensivists to work effectively. Several observers have suggested that variation among ICUs in the ability of the command center intensivists to intervene ("intervention ability") may explain the differing levels of success of a given command center in improving patient outcomes among the ICUs that it covers.

Different levels of intervention ability may, for example, be responsible for the different outcomes observed in the Sentara study between their medical and surgical ICUs. Nearly 80 percent of the private admitting physicians in the medical ICU allowed the tele-intensivists to be involved with patient care, as compared to only 35 percent of admitting physicians in the surgical ICU.[29]

Another hospital reported that mortality and LOS in the ICU were reduced more in a hospital in which most physicians allowed their patients' care to be managed by the Tele-ICU than in another hospital connected to the same Tele-ICU system in which most physicians did not allow this type of management.[30]

Intellectual property. Health system leaders may be reluctant to invest millions of dollars in a Tele-ICU system if they think that intellectual property protection (such as patents on Tele-ICU formation or alert algorithms) may limit their choices of Tele-ICU systems or the ability of manufacturers to upgrade or modify their Tele-ICU systems in the future. Although the three companies with Tele-ICUs currently installed in U.S. hospitals are involved in patent disputes, it appears that these disputes have not inhibited the development or use of Tele-ICU systems.[31]

Effects of reimbursement coverage and payment systems. The effect of a Tele-ICU system on reimbursements for ICU care will depend upon the payer mix of the health system. For payers using a Diagnostic Related Group (DRG) system, there will be little or no immediate change in revenue unless the complexity of their cases is changed by reductions in medical complications. For HMOs that own the hospitals in their system, changes in variable costs would benefit them directly. For the remaining patients whose payers reimburse hospitals on a cost-based fee schedule (or for uninsured patients who may be presented with a hospital bill), the financial benefits to the hospital resulting from a Tele-ICU system will translate to reduced costs for these payers to the extent that the hospital's charge system reflects actual costs.

However, a health care delivery system may also see an increase in revenue with a Tele-ICU system if it enables more accurate billing. One Tele-ICU system noted a 30 percent increase in their collections for ICU services as a result of this effect.

Figure 6-1

Physician Reimbursement Rates

CPT Code	Description	Medicare National Average Allowable Charge
99291	Critical care, evaluation and management of the critically ill or critically injured patient, first 30 - 74 minutes	$198.00
99292	Critical care, evaluation and management of the critically ill or critically injured patient, each additional 30 minutes (list separately in addition to code for primary service)	$99.00

Because third-party payers have not generally paid for physicians to provide clinical oversight of patients via Tele-ICU systems, hospitals must budget for the costs of the physicians working in the command center without the expectation of reimbursement. Paying four full-time equivalent (FTE) physician intensivists to cover a total of 14 shifts per week in the command center would require a hospital to budget thousands of dollars per day for physician salaries.

If health plans were to pay for Tele-ICU care, third-party reimbursement to physicians for critical care services can range up to $300 per hour, with Medicare fees being somewhat less.

Although there has been considerable discussion about payers providing reimbursement for these telemedicine services, none currently do, and an application for the creation of a CPT code for Tele-ICU monitoring was recently tabled by the American Medical Association's CPT Editorial Committee.[32] However, there has been some experimentation in finding ways to provide financial incentives for Tele-ICU services. Two payers have recently made financial contributions for the initial purchase of Tele-ICU systems and a community organization recently gave an existing health care system a grant to expand their Tele-ICU system.[33] In addition, a physician-hospital organization reportedly is paying its physicians a yearly bonus for permitting the Tele-ICU physicians to participate at a high level in managing care for their patients in an open ICU (see Figure 6-1). In addition, the data and quality reporting capabilities of Tele-ICU systems may help health care delivery systems meet payers' expanding expectations of pay-for-performance in the future.

As has been seen in other Tele-ICU systems, without adequate organizational preparation and buy-in, the clinical value both for direct patient care and for improvements in protocol adoption and adherence can be significantly decreased or delayed. Therefore, from the payers' perspective, any reimbursement for Tele-ICU services could be expected to be tied to clinical outcomes or process measures consistent with the increasing emphasis on pay-for-performance within the U.S. health care system.

Reports from Early-Adopter Hospitals

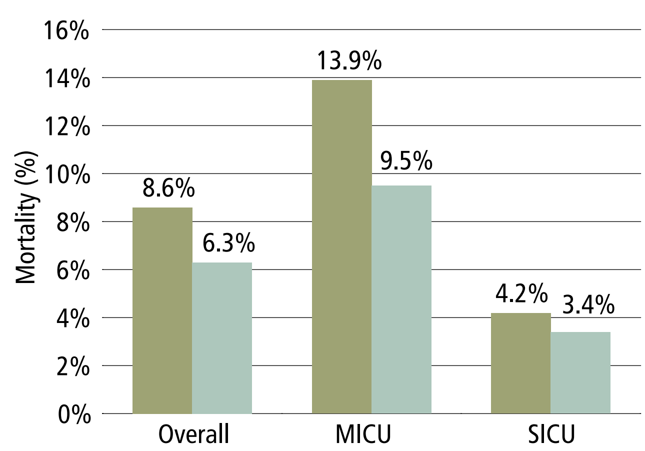
Reports from hospitals that have installed and are using Tele-ICU technologies are limited and are largely informal, internal assessments. Summarized below is some of the information reported by those hospitals that have participated in studies or that were willing to summarize their findings in interviews.

Tele-ICU impact on mortality. By extending the ability of the limited supply of intensivists to cover more patients, Tele-ICU systems may achieve reductions in mortality similar to those ascribed to the use of the intensivist model. Although there is not enough published evidence to support a claim of reduced mortality from the use of Tele-ICUs, there has been one published study and some preliminary unpublished findings:

Sentara study. This single study is a comparison of outcomes in two ICUs of Sentara Hospital, a regional hospital in southern Virginia, before and after installation of the first Tele-ICU system in the nation. The newly installed Tele-ICU was observed for a 6-month period. Mortality and other outcomes were compared with those seen in open, conventional ICUs for the previous 12 months. This study of a small number of patients found a 25 percent reduction in overall mortality (averaged for ICU and hospital mortality) as well as improvements in other outcomes, as discussed below (see Figure 7-1).

Figure 7-1

Mortality Rates in the Sentara Hospital Study[36]



It should be noted that mortality rates in these ICUs before installation were at the low end of the range reported in the literature, and with the Tele-ICU system, reductions in mortality were significant only for the 10-bed medical ICU and not for the 8-bed surgical ICU. However, this difference may have been partially due to the fact that the Tele-ICU intensivists were allowed to participate in the care of 80 percent of the medical ICU private patients but only 35 percent of the surgical ICU private patients.[34] It should also be noted that VISICU supported most of the costs of the study and several of its officers were coauthors.[35]

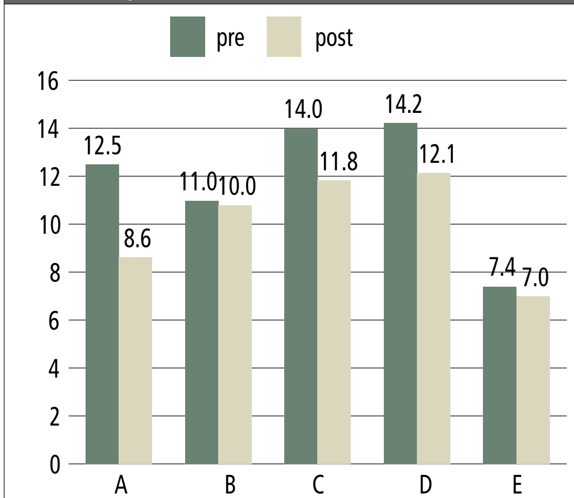
Lehigh Valley Health System. This hospital system in Pennsylvania installed a Tele-ICU system in 2004. The command center is connected to six ICUs at a community hospital and a university hospital. A pre-post assessment of outcomes in the community hospital ICUs indicates reductions in mortality that were summarized in a telephone interview as follows:

- ✦ Mortality from all causes among ICU patients declined from 15 to 10 percent;
- ✦ Mortality among ICU patients with moderately severe conditions (APACHE II scores of 10–20) declined from 15 to 5 percent;
- ✦ Mortality among ICU patients with conditions of low severity (Apache II score less than 10) was unchanged.[37]

Memorial Hermann Health System. Preliminary data from this multi-hospital health system at the University of Texas in Houston, which has a Tele-ICU system monitoring 4 open ICUs with about 140 beds, indicate reductions in mortality in 5 of their ICUs that have been operating since October 2004 (see Figure 7-2).

Figure 7-2

Mortality Rates in Memorial Hermann Health System[38]



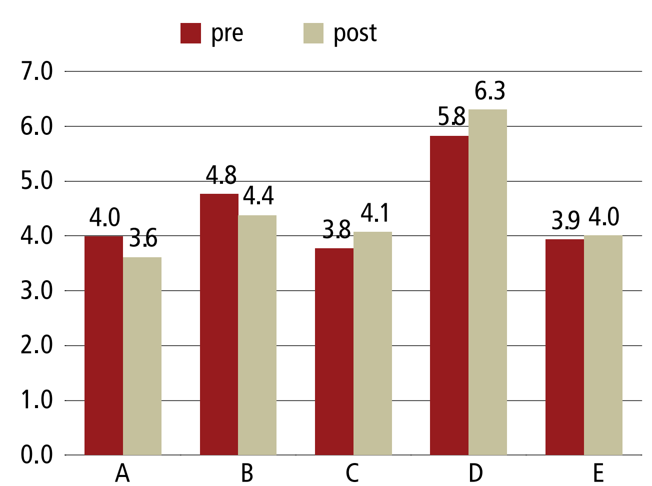
Other outcome assessments in progress. Other hospital systems have not yet been able to replicate Sentara's published findings of a 25 percent drop in mortality with the use of a Tele-ICU system.

Sutter Health System has Tele-ICU command centers connected to 30 ICUs with 200 beds.[39] Sutter has not observed any sustained trends toward either decreases or increases in ICU or hospital mortality, but they believe that this may be because before installing its Tele-ICU system, Sutter had relatively good intensivist coverage, a relatively low rate of ICU mortality, and mostly open ICUs.

Sutter speculates that the combination of these factors may be preventing a significant drop in mortality from occurring with its Tele-ICU system. Sutter continues to assess mortality and other outcomes, such as incidence of sepsis, and has observed clinical process improvements from standardizing their use of a number of accepted care protocols in the ICUs connected to the Tele-ICU system. For Sutter, this standardization was also facilitated by the fact that most of the intensivists in the community had been organized in a single practice group before the Tele-ICU system was installed and were therefore accustomed to joint decision-making.

Figure 7-3

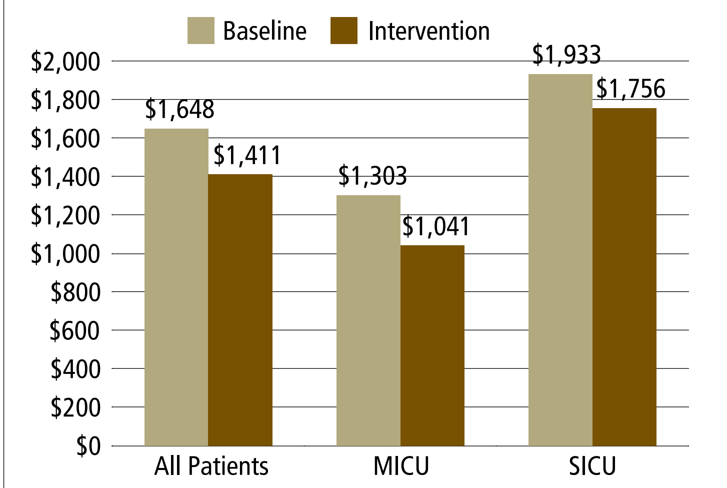
ICU LOS Rates in Memorial Hermann Health System[43]



At Cornell Medical Center in New York City, the adjusted mortality rate in the medical ICU dropped by 15 percent from the 12 months before to the 18 months after installation of a Tele-ICU system.[40] Other assessments of Tele-ICU outcomes are in progress at individual health care systems, including an assessment of the Memorial Hermann Health System Tele-ICU, funded by the Agency for HealthCare Research and Quality.

Figure 7-4

Change in Costs per Case[45]



Evidence of the potential of Tele-ICUs to change the costs of care. Calculating the actual financial effects of Tele-ICU systems is a complicated task, because most hospital accounting systems are designed for billing and reimbursement rather than for tracking actual costs per patient. Therefore, LOS in the ICU and in the hospital after discharge from an ICU are standard units of measure for the cost of critical care. Given the high costs of patient days in ICUs, interventions that reduce LOS can significantly reduce overall costs. Although many studies have used a 3:1 cost ratio for ICU to non-ICU hospital days, one study in two hospitals found that the cost of the first ICU day was about 400 to 500 percent more than an average post-ICU hospital day and that the costs of subsequent ICU days were about 250 to 280 percent more than an average post-ICU day.[41]

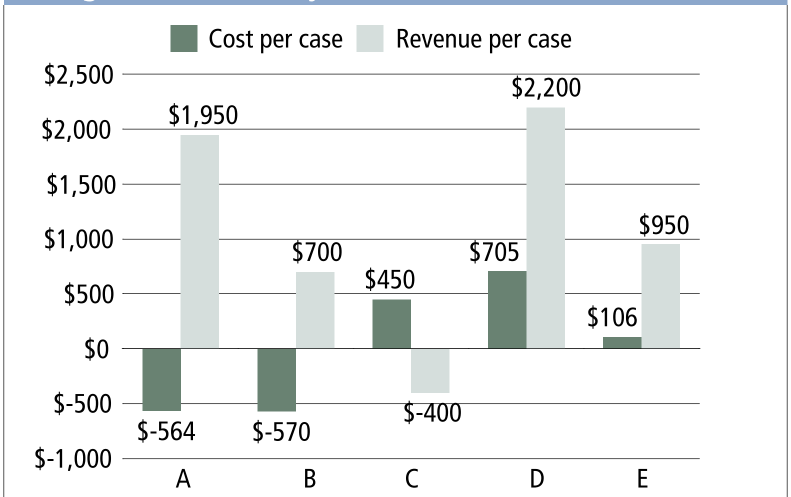
Impact of Tele-ICUs on length of stay. The only peer-reviewed, published assessment of the effect of Tele-ICUs on LOS is from Sentara. For hospital LOS, the reduction was statistically significant only in patients transferred from the surgical ICU. For ICU LOS, significant reductions occurred in patients in both the medical (from 5.62 to 4.84 days) and the surgical (from 3.30 to 2.59 days) ICUs. However, the medical and surgical ICUs differed greatly in the percentage of patients in whose care the Tele-ICU intensivists were able to intervene.

ICU LOS - Memorial Hermann Health System. Some preliminary data (with risk adjustment based on hospital billing information rather than specific clinical criteria) from this multi-hospital health system have shown mixed results for ICU LOS among four of their ICU (see Figure 7-3).

Financial effects of Tele-ICU - Memorial Hermann Health System. Similar to their LOS findings, this multi-hospital health system has reported mixed financial effects of their Tele-ICU system for five of their ICUs (see Figure 7-4 and 7-5).

Figure 7-5

Change in ICU Monthly Financial Performance at MHHS[46]



Conclusions

The use of telemedicine to permit the remote monitoring of ICU patients and management of their care by specialty-trained clinicians is a growing trend in the U.S. health care system. The use of Tele-ICU's was prompted by the finding that the care of ICU patients by dedicated intensivists improves both patient and cost outcomes. The hope for tele-intensivist systems is that they will result in the same improved outcomes that are attributed to actual intensivist care.

The limited body of findings from early adopters of Tele-ICU systems indicates that goal is feasible. Some early-adopter hospitals have demonstrated reductions in mortality and LOS of adult ICU patients approaching those seen in actual intensivist care. Mortality rates have decreased by 10 to 25 percent in ICU patients in some early-adopter hospitals, and one hospital has reported a drop in LOS of ICU patients from 5.6 to 4.8 days. However, not all early adopters have reported such achievements, which appear to be highly dependent upon favorable organizational arrangements.

As with most advanced medical technologies, the value of Tele-ICUs depends upon where and how they are used. Given the substantial barriers to broader use of Tele-ICUs, policies to encourage their use should target hospitals where their use is likely to reduce mortality and LOS. Some policy options include the following:

- Extension of coverage from established Tele-ICU command centers to adult ICUs where staffing by intensivists is low or unavailable and where organizational arrangements can be introduced for tele-intensivist management of patients.
- Financial support from regional payers for the initial purchase of Tele-ICU hardware and staff training under pay-for-performance arrangements.
- Focused demonstration projects and analyses comparing mortality and LOS in hospitals before and after acquisition of Tele-ICU coverage. The published literature and expert opinion conservatively support the conclusion that Tele-ICU improves these outcomes.

Appendix 1.

Organizations Represented in the *FAST* Initiative Working Group

- INOVA
- American Association of Critical Care Nurses
- Center for Medical Technology Policy
- Cerner Corporation
- iMDsoft
- Lehigh Valley Health System
- Massachusetts Technology Collaborative
- McDermott Will & Emery
- Mercer Human Resources
- Memorial Hermann Health System
- New England Healthcare Institute
- OhioHealth
- Pacific Business Group on Health
- Sutter Health Institute for Research and Education
- The Permanente Federation
- VISICU

Appendix 2.
Manufacturers of Commercial Tele-ICU systems

The U.S. market has one dominant vendor, VISICU who entered the market in 2000. Two other vendors, iMDSoft and Cerner, entered the U.S. market in the past two years. These latter two companies offer multiple health information products.

VISICU: The leading U.S. vendor is VISICU, which was founded in Baltimore in 1998 by two physicians. All but two Tele-ICU systems in the U.S. are VISICU products. The firm claims installation of 28 ICUs with 2,300 beds and contracts for another 7 eICUs serving about 150 hospitals and over 300 ICUs. VISICU became a publicly traded company on April 11, 2006

Cerner: This diversified health care systems and data company offers a Tele-ICU product, Critical Care/ Critical Connections, that has been installed in a hospital system in Kalamazoo, MI. Their approach to Tele-ICU monitoring is similar to iMDSoft's in that it is built off their existing EMR and electronic charting of ICU nursing and physicians information. Their smart alarms and data analysis focuses on severity adjustment analysis based upon their APACHE system.

iMDSoft: iMDSoft's core products are clinical information systems called the MetaVision Suite, which includes a clinical information system for ICUs called MVICU and a similar system for the operating room environment called MVOR. Many of these systems are installed in Europe, and a few in the U.S. The MVICU clinical information system includes smart alarms that can be based upon multiple physiological parameters, and customized for each patient. These alarms are "open-sourced" and thus can be modified and added to by the health system customer. iMDSoft was founded in Israel and its U.S. headquarters are in Needham, MA. Its Tele-ICU product (called MVCentral) is based upon its MVICU clinical information system. This system was first installed at the Lehigh Valley Health System in Allentown, PA. This new MVCentral product enables the Tele-ICU staff to have access to the same clinical information system (including embedded and customizable smart alarms) as the physical ICU staff, while also having two way video conferencing capabilities to the patients' ICU rooms and the ICU family room.

iMDSoft's Tele-ICU product (called MVCentral) is based upon its MVICU clinical information system. This system was first installed at the Lehigh Valley Health System in Allentown, PA. This installation in essence created the MVCentral system through a customized joining and modification of the MVICU clinical information system with data transmission and two-way video conferencing capabilities created by a local company. This new MVCentral product enables the Tele-ICU staff to have access to the same clinical information system (including embedded and customizable smart alarms) as the physical ICU staff, while also having two way video conferencing capabilities to the patients' ICU rooms and the ICU family room.

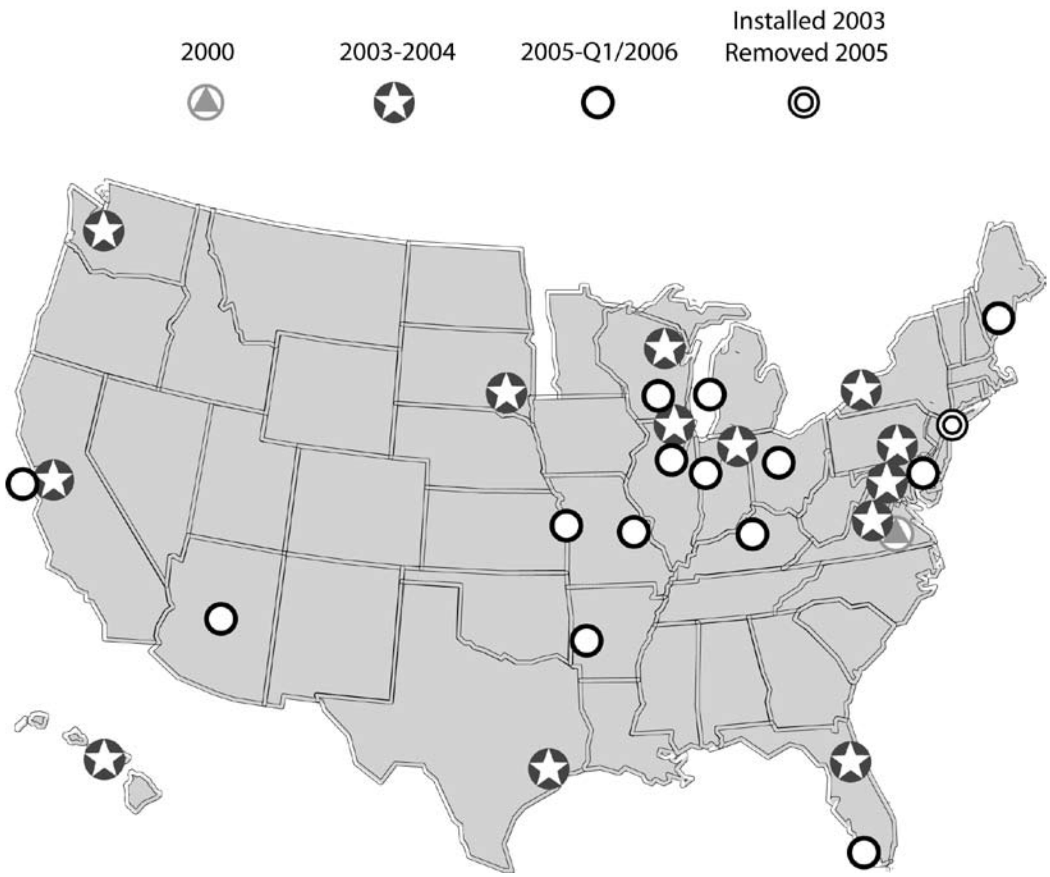
"Home-Grown" Tele-ICUs: In theory, hospitals and health systems could assemble their own Tele-ICU systems, since many components of commercial systems can be purchased separately or developed internally. While "smart" data bases that track patient care, queue changes in care, and sound alarms may be patent or copyright protected, such systems could theoretically be built internally. However, the costs and risks of doing so would seem to be prohibitive compared to buying commercially available systems; despite rumors of the existence of such "home grown" Tele-ICU systems, none have been found.

Others: Although VISICU, the market leader in remote ICU monitoring, entered this space from the remote monitoring and algorithms technology, other companies—including Cerner and iMDSoft—are entering this business area from their expertise and platforms in EMR and related technologies for critical care. Some other companies that are reported to be exploring Tele-ICU products are EPIC and Eclipsys.

Appendix 3. Estimated Dissemination of Tele-ICU Systems in the U.S.

Commercial systems. As of December 2006, there were approximately 30 Tele-ICU centers coordinating care for 300 adult ICUs. Given the estimate of 4,000 U.S. adult ICUs, this indicates a market penetration of roughly 7.5 percent of U.S. adult ICUs. Most of this growth has come since 2002 and all but two Tele-ICUs have been installed by VISICU, the dominant U.S. company.

Figure 1. Map of Tele-ICU Systems Installed in the United States 2000-Q1/2006



Dissemination Issues. The pattern of where Tele-ICUs exist is not easily defined. A majority of installations since 2003 appear to be at private, relatively well-funded hospital systems in suburban and urban areas. Academic medical centers (many of which use the intensivist model) are not rapid adopters of Tele-ICUs. With some exceptions, neither are inner city hospitals or smaller rural hospitals. Thus, some areas where intensivist shortages are reported to be most severe and Tele-ICUs may have the greatest value, may not have access to the technology. Hospitals facing financial strains—such as poorer, inner city hospitals—are not the target customers for commercial vendors because they are unable to make the necessary capital investments or fund the ongoing operating costs. Thus, the penetration of Tele-ICUs into smaller, less well-funded and remote hospitals at this time appears to be much lower than the national dissemination rates.

It is possible that extensions to inner city and rural ICUs could be in a second wave of dissemination. Hospitals that have established successful use patterns for their Tele-ICUs could extend their command center coverage to hospitals where the intensivist shortage is most severe and the hospital doesn't have the number of ICU beds to support an independent Tele-ICU system, so they may form a consortium of hospitals in a similar situation. This was the case for Froedert in Wisconsin. Although their Quality Consortium was not formed specifically around a Tele-ICU, it was the first initiative undertaken by this multi-hospital consortium.

Appendix 4. Summary of Leapfrog Group's 2006 ICU Physician Staffing Criteria

A hospital fulfilling the Leapfrog Group's ICU Staffing criterion assures that all patients in its adult or pediatric general medical and/or surgical ICUs are managed or co-managed by physicians certified in critical care medicine who:

1. Are ordinarily present in the ICU (on-site, or via telemedicine that meets Leapfrog specifications) during daytime hours a minimum of 8 hours per day, 7 days per week, and during this time provide clinical care exclusively in the ICU;

2. At other times return more than 95 percent of ICU pages within 5 minutes, based on a quantified analysis of pager response time; and can rely on a physician or a certified non-physician provider who is in the hospital and able to reach ICU patients within 5 minutes in more than 95 percent of cases, based on a quantified hospital analysis of pager response time.

3. This may exclude low-urgency pages, if the paging system can designate low-urgency pages or if the hospital has an alternative scientific method for documenting high-urgency pages that are not returned within 5 minutes.

4. Intensivist "presence" may be accomplished via telemedicine per Leapfrog's specifications: To meet the Leapfrog ICU requirement for intensivist presence in the ICU via telemonitoring, a hospital must affirm that its telemonitoring intensivist presence fulfills the following ten key features:

   a. An intensivist who is physically present in the ICU ("on-site intensivist) performs a comprehensive review of each ICU patient each day and establishes and/or revises the care plan. The tele-intensivist has immediate access to information regarding the on-site intensivist's care plan at the time monitoring responsibility is transferred to him or her by the onsite intensivist. When care is transferred back to the on-site intensivist, the tele-intensivist communicates with the on-site intensivist to review the patient's progress and set direction.

   b. When an intensivist is not on-site in the ICU managing or co-managing all ICU patients, a tele-intensivist is monitoring and able to manage all ICU patients for the remaining 24 hours per day, 7 days per week. "Monitoring" means the tele-intensivist has no other concurrent responsibilities, is immediately available to communicate with the ICU staff, and is in the physical presence of the Tele-ICU's patient monitoring and communications equipment. "Manage" means authorized to diagnose, treat, and write orders for a patient in the CU on his/her own authority.

   c. A tele-intensivist has immediate access to key patient data, including:

      1. Physiologic bedside monitor data (in real time);

      2. Laboratory orders and results;

      3. Medications ordered and administered; and,

      4. Notes, radiographs, ECGs, etc. on demand.

d. Data links between the ICU and the tele-intensivist are reliable (more than 98 percent of the time) and secure (HIPAA compliant).

e. Via A-V support, tele-intensivists are able to visualize patients with sufficient clarity to assess breathing patterns, and communicate with on-site personnel at the bedside in real time.

f. Written standards for remote care are established and include, at a minimum:

   1. Tele-intensivists are certified by a national medical specialty board in critical care medicine;

   2. Tele-intensivists are licensed to practice in the legal jurisdiction in which the ICU is located;

   3. Tele-intensivists are credentialed in each hospital to which he/she provides remote care (can be special telemedicine credentialing);

   4. Activities of the tele-intensivist are reviewed within the hospital's quality assurance committee structure;

   5. There are explicit policies regarding roles and responsibilities of both the on-site intensivist and the Tele-intensivist; and,

   6. There is a process for educating staff regarding the function, roles, and responsibilities of the tele-intensivist.

g. Tele-ICU care is proactive, with routine review of all patients at the frequency appropriate to their severity of illness.

h. A Tele-intensivist's patient workload ordinarily permits him or her to complete a comprehensive assessment of any patient within 5 minutes of the request for assistance being initiated by hospital staff.

i. There is an established written process to ensure effective communication between the on-site care team and the tele-intensivist.

j. The tele-intensivist documents patient care activities and this documentation is incorporated into the patient record.

Endnotes

1. Joint Commission Resources. Improving Care in the ICU, 1st Edition. Oakbrook Terrace; Society of Critical Medicine. Critical Care Statistics in the US, 2006 and 2004.

2. US Department of Health and Human Services: Report to Congress: A Study of the Supply and Demand for Critical Care Physicians. 2004

3. Of the 6,000 ICUs in the US, about 2,000 tend neonate and pediatric patients. This report focuses on adult ICU care in the remaining 4,000.

4. In 2004, 12 new command centers were built, but only 11 were built in 2005 and 8 in 2006. In 2005, 1,000 new beds were given Tele-ICU coverage, while 2006 saw only 400 beds newly linked to Tele-ICU coverage.

5. Breslow, et. al. "Effect of a Multiple-Site Intensive Care Unit Telemedicine Program on Clinical and Economic Outcomes: An alternative paradigm for intensivist staffing," Critical Care Medicine, 2004.

6. There are currently three companies offering Tele-ICU systems in the US. These firms provide the software components of the Tele-ICU systems, while working with the health care system to make certain that the health system's hardware (both new and existing) is compatible with the software to the greatest extent possible. At this time, none of these companies provides their own video systems or data transmission lines, but they work with the health systems to obtain these components from other vendors.

7. Brilli (2000) [Note: The Leapfrog Group uses the term "co-managed" rather than "transitional," and this report has adopted that terminology.]

8. Brilli (2000)

9. Pronovost (2002) One article of the 16 reported mortality rates only from the ICU and not from the hospital.

10. Young (2000)

11. Rothschild (2001), Pronovost (2004)

12. Leapfrog (2004)

13. Pronovost (2002)

14. Carson (1996), Pronovost (2002)

15. Pronovost (1999)

16. Milstein (2000), Brilli (2001), Haupt (2003), Pronovost, (1999), Pronovost (2002), Leapfrog (2004), Appendix F

17. HealthTech, "The Future of Workforce Productivity: Technology Impacts in the Med/Surg and ICU Units," February, 2005.

18. Leong (2005), Brilli (2001)

19. The average expected age of retirement for critical care physicians is about 60. HRSA (2006)

20. Milbrandt et.al., "Update in Critical Care," Am J of Respiratory and Critical Care Medicine, 2006

21. 21. Cowboy, et. al., "Impact of Remote ICU Management on Ventilator Days," Critical Care Medicine, 2005.

22. Schoenberg (1999)

23. Rabert (2006)

24. Personal communication with Ravi Nemana, Senior Analyst, Health Technology Center,

telephone interview, February 2006.

25. FAST interviews with hospital systems. A list of organizations with which interviews were conducted is in Appendix B.

26. Creating a free-standing Tele-ICU command center that would provide monitoring and management services to ICUs was the original business model for VISICU, but organizational and cultural barriers prompted them to shift to selling and servicing Tele-ICU systems owned and operated by health care delivery systems.

27. Breslow (2004)

28. Information was gathered from the official websites of hospitals with Tele-ICUs, phone calls to those hospitals, and VISICU, imDSOFT and Cerner press releases.

29. Breslow (2004)

30. Zawada (2006) (APACHE III mortality was reduced 76.5 percent versus 16 percent, and ICU LOS was reduced 33 percent versus -2 percent)

31. iMDsoft has filed an interference proceeding with the US Patent Office claiming that its prior patent claims make many of VISICU's claims invalid. Cerner has sued VISICU on the grounds that VISICU's patents are invalid.

32. "Current Controversies," National Assoc. of Medical Directors of Respiratory Care, Mar/April 2006.

33. Blue Cross Blue Shield plans in Illinois and Maine (personal communications) and "LVH gets $500,000 grant," The Morning Call, July 11, 2006.

34. Leong (2005)

35. Breslow (2004)

36. Source: Breslow, et. al. Critical Care Medicine, 2004.

37. Telephone interview with S. Matchett, MD, Director of Telemedicine at Lehigh Valley Health System, March 20, 2006. Mortality analysis for patients with high-severity conditions was not significant because of the small number of these patients. This analysis compared mortality rates for 3 months prior to initiation of their Tele-ICU system with the same calendar months during its operations in the following year.

38. Source: Dr. Liza Weavind, Medical Director, Memorial Hermann eICU®. Unpublished data

39. They operate two command centers – one in Sacramento and one near San Francisco – to facilitate access by the intensivists who also work in their physical ICUs.

40. Personal Communication, June 2006, Dr. Callahan. Data being prepared for publication.

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