

**Clinical and Financial
Evidence for Improving
Quality and Efficiency
in Your ICU**

December 2007

*VISICU® and eICU® are registered trademarks of VISICU, Inc. All rights reserved. All other brand names, product names, company names, trademarks and service marks are the property of their respective owners.
APACHE® is a registered trademark of Cerner Corporation.*

The focus on healthcare quality and cost is creating an opportunity to differentiate physicians as leaders in the charge for patient safety and improved healthcare delivery. It is generating tangible results by focusing on a different way of managing critical care.

Recognizing the growing emphasis on clinical transformation, leaders are rising to the challenge to drive change – through evidence-based standards of care. This folio contains scientific abstracts, presented over the last two years, that have highlighted improvements in care delivery, cost reduction, and education obtained by eICU® Programs around the country.

MORTALITY OUTCOMES

Community Health System	1
Academic Health System	2
Rural Health System	4
Cardiopulmonary Resuscitation	5

BEST PRACTICES

Ventilator Bundle	6
Glycemic Control & DVT Prophylaxis	7
Rapid Response Teams	9
Sepsis Bundle	10

FINANCIAL OUTCOMES

Length of Stay	14
Pro-Fee Billing Reimbursement	18
Staff Satisfaction	20
Severity Adjustment	22

MEDICAL EDUCATION

Resident	23
Fellow	24

COMMUNITY & RURAL OUTREACH 25

eICU® RESEARCH INSTITUTE 26

The eICU Research Institute amalgamates data from across the eICU Program base and represents one of the largest and most comprehensive critical care databases in the world.

REMOTE ICU CARE CORRELATES WITH REDUCED HEALTH SYSTEM MORTALITY AND LENGTH OF STAY OUTCOMES

Gregory H. Howell, MD*, Vincent M. Lem, MD and Jennifer M. Ball, RN, BSN, Saint Luke's Health System, Kansas City, MO
Chest. 2007;132(4):443b-444b.

PURPOSE: Providing around-the-clock intensivist-led care is considered the “gold standard” for improving ICU outcomes. However, the shortage of intensivists limits the current capability to provide this level of care in individual hospitals, let alone in a multi-hospital system. Our health system implemented the eICU® tele-intensivist program as a mechanism to leverage our limited intensivists, and standardize clinical practice and processes to our seven hospitals. We then evaluated changes in ICU outcomes over time to assess the impact of these programmatic changes.

METHODS: We compared Apache III severity-adjusted ICU and hospital mortality rates and ICU and hospital length of stay (LOS) for this seven-hospital health system (84 ICU beds) over five quarters (2006-2007). Mortality was examined with logistic regression controlling for predicted mortality and LOS was compared with a K-Wallis and nptrend (non-parametric trend analysis) test to look for changes over time.

RESULTS: 3692 ICU patients were severity-adjusted (Apache III score quarterly range 44.5-51.4) and compared across five quarters (Q1 2006 to Q1 2007). Severity-adjusted ICU mortality went from 1.0 to .68, hospital mortality from .95 to .77, ICU LOS from 1.18 to .96 and hospital LOS from 1.09 to .84. Severity-adjusted ICU and hospital mortality ($p=0.02$ and $p<0.001$ respectively) and ICU and hospital LOS data (both= $p<0.001$) were significantly reduced over time.

CONCLUSION: Implementation of a remote ICU care program enabled provision of around-the-clock intensivist monitoring for all ICU patients in our health system. It also allowed us to centralize best practice oversight, and improve compliance of these best practices. These changes in ICU care correlated with reduced mortality and improved operational performance, as reflected in decreases in both ICU and hospital LOS.

CLINICAL IMPLICATIONS: Centralized remote care can be used to leverage intensivist resources across multiple hospitals and this correlates with improved outcomes. ICU and hospital LOS reductions should be associated with financial benefit.

DISCLOSURE: Gregory Howell, No Financial Disclosure Information; No Product/Research Disclosure Information

EFFECT OF TELEMEDICINE ON MORTALITY AND LENGTH OF STAY IN A UNIVERSITY ICU

Benjamin A Kohl, Jacob T Gutsche, Patrick Kim, Frank D Sites, Edward A Ochroch, Anesthesiology and Critical Care, University of Pennsylvania, Philadelphia, PA
Crit Care Med. 2007;35(12):A22.

INTRODUCTION: The purpose of this study was to evaluate the efficacy of ICU telemedicine (eICU) in an academic surgical ICU (SICU).

HYPOTHESIS: The addition of an eICU, staffed by board-certified intensivists, to an academic ICU will decrease patient mortality and length of stay.

METHODS: We retrospectively evaluated data from 2,811 patients over 3 years. APACHE III scores were calculated for all patients and predicted mortality and length of stay were obtained accordingly. Statistics were performed using StatsDirect statistical software (England: StatsDirect Ltd. 2005).

RESULTS: Actual ICU mortality and length of stay, as well as hospital mortality and length of stay decreased after eICU (VISICU, Baltimore, MD) implementation (Table 1). Additionally, the observed to APACHE III predicted values for all of these variables decreased (Figure 1).

CONCLUSIONS: The implementation of a remote ICU system within an academic SICU is associated with improved patient outcome.

Outcome	Pre-eICU (n=189)	Post-eICU (n=2.622)	p
ICU Mortality (%)	8.4	3.1	0.0003
Hospital Mortality (%)	11.1	6.0	0.01
ICU LOS (d)	7.53/1.95 [0.17-180.4]	3.78/1.77 [0.17-156.3]	0.007
Hospital LOS (d)	21.0/11.0 [0.52-190.4]	16.57/9.2 [0.46-345.8]	0.04

ICU and hospital LOS are presented as Mean/Median (range) in days.

OUTCOMES OF SICU PATIENTS AFTER IMPLEMENTATION OF AN ELECTRONIC ICU (“eICU®”) SYSTEM AND OFF-SITE INTENSIVIST

Vincente Gracias, et al. University of Pennsylvania Health System
Presented at: IATSIC-AAST Conference; August, 2007; Montréal.

BACKGROUND: Surgical intensive care units (SICUs) which utilize the intensivist model (i.e., a team dedicated to SICU patients and led by an attending intensivist) have improved patient outcomes versus non-intensivist models. Intensivist models vary in intensivist coverage of nights and weekends. We recently implemented an electronic ICU (eICU) system, in which an off-site intensivist has real-time electronic access to patient bedside data and plans of care; has visual access to patient rooms; and provides decision support to the on-site team and home-call intensivist. We hypothesized that the eICU system would decrease mortality among SICU patients.

METHODS: We retrospectively reviewed admissions to an eICU-equipped SICU at our university hospital for a 12 month period before and after launch of eICU. During both periods, a SICU fellow and resident(s) were on-site “24-7,” and intensivists were on-site on weekdays and on pager call at night. The off-site eICU intensivist provided coverage from 19:00 to 07:00 on weeknights and all weekend.

RESULTS: 2643 patients were admitted to the SICU during the two-year study period (Table). After implementation of eICU, hospital mortality decreased significantly, despite increases in clinical volume and APACHE II scores in the latter period.

CONCLUSION: An eICU system with off-site intensivist coverage on nights and weekends was associated with decreased hospital mortality of SICU patients. As one of many components in the delivery of critical care, the eICU system may improve outcomes by allowing a SICU to function “at the attending level” 24 hours a day.

	Before eICU	After eICU	p	RR	RR 95% CI
SICU admissions					
Total	1050	1593			
Unscheduled	58.7%	52.3%	<0.002		
Age, years*	56.4 +/- 19.4	54.9 +/- 19.9	NS		
APACHE II*	10.5 +/- 7.9	12.0 +/- 7.6	<0.001		
Mortality	5.5%	2.6%	<0.001	0.48	0.32 – 0.70

RELATIONSHIP BETWEEN LEVELS OF CONSULTATIVE MANAGEMENT AND OUTCOMES IN A TELEMEDICINE INTENSIVIST STAFFING PROGRAM (TISP) IN A RURAL HEALTH SYSTEM

Edward T. Zawada, Jr, MD, FCCP, Michael L. Aaronson, MD, Pat Herr, RN, CCRN, David K. Erickson, MD Avera ICU Research Group Avera Health System, Sioux Falls, SD
Chest. 2006;130(4):226s.

PURPOSE: A TISP was initiated to improve the quality of care and patient safety in seriously ill patients hospitalized in a rural health care system of 4 main hospitals in the upper Midwest. The TISP shared the expertise of an experienced intensivist team including 24-hour vigilance of patients for early diagnosis and intervention to correct adverse clinical trends. An “open” model was chosen in which the attending physicians could choose the level of consultative management from three categories.

METHODS: Three levels of consultative management were available. Category I required the telemedicine intensivist team to intervene only for life-threatening emergencies or to appraise the primary attending of any adverse clinical trend. Category II allowed the intensivist team to adjust any existing therapy. Category III empowered complete clinical decision-making to the TISP.

RESULTS: Mortality was reduced 76.5% from that predicted by Apache III severity scoring for the hospital with the highest number of attending physicians choosing Category III management. In the hospital with mostly Category I consultation, the mortality was reduced 16 % from that predicted. Reduction of ICU length of stay was 33% vs. -2% in the two hospitals respectively. There was a significant difference in ventilator days per ventilated patients between the two hospitals. Significant differences between the two hospitals was seen in compliance with several evidence-based ICU therapies including DVT prophylaxis, stress ulcer prophylaxis, use of low tidal volumes, and beta-blocker use in acute coronary syndrome.

CONCLUSION: In a rural health care system greater discretion by a TISP to supervise and intervene in seriously ill patients results in improved outcomes.

CLINICAL IMPLICATIONS: In a rural setting where availability of intensivists and experienced critical care nursing is scarce, telemedicine intensivist consultation can improve outcomes.

DISCLOSURE: Edward Zawada Jr, None.

REMOTE ICU MANAGEMENT IMPROVES OUTCOMES IN PATIENTS WITH CARDIOPULMONARY ARREST

James P. Shaffer, Michael J. Breslow, Jon W. Johnson, Frank Kaszuba
Crit Care Med. 2005;33(12):A5.

INTRODUCTION: Remote ICU management is a mechanism to provide intensivist oversight to ICU patients and has been associated with improvements in both mortality and length of stay.

HYPOTHESIS: The clinical vigilance associated with this care model should reduce the number of codes and improve outcomes of patients sustaining cardio-respiratory arrest.

METHODS: Health First is an integrated network on Florida's East Coast which activated a system-wide remote ICU management program (eICU[®]) in June 2004. We compared the following parameters within five ICU's pre and post eICU activation: total code events, codes per patient, codes per patient day, initial resuscitation success, and hospital discharge rates. Each of the results was analyzed by calculating the 95% confidence intervals of the odds ratios.

RESULTS: Between October 2002 and May 2004 (pre eICU) there were 186 codes in 6,205 patients (21,308 patient days). From June 2004-July 2005 (post eICU) there were 83 codes in 3,954 patients (15,495 patient days). Both codes/patient and codes/patient day were lower in the post eICU period. The odds ratio (OR) for a code per patient and per patient day in the post eICU period compared to the pre-eICU period was 0.70 (95% confidence interval, [CI], 0.54- 0.91) and 0.61 (95% CI, 0.47-0.79) respectively indicating statistical significance in both of these parameters. Initial resuscitation was successful in 51.6% in the pre-eICU period and 65.6% in the post-eICU period. The comparative pre-post OR for 24 hour survival was 0.72, (95% CI 0.44-1.18) which was suggestive of improvement but not statistically significant.

CONCLUSIONS: Remote ICU management was associated with a significant decrease in the number of cardio-respiratory arrests occurring in monitored ICU patients. Our data suggests that this extra layer of support can detect deleterious changes and allow rapid intervention to prevent detrimental outcomes. Further study in multiple centers employing this care model will be necessary to provide a more descriptive understanding of how this system can optimize critical care services.

ICU PROCESS IMPROVEMENT: USING TELEMEDICINE TO ENHANCE COMPLIANCE AND DOCUMENTATION FOR THE VENTILATOR BUNDLE

Brian A. Youn, MD, FCCP, Parkview Hospital, Fort Wayne, IN
Chest. 2006;130:226s-C.

PURPOSE: Outcomes are improved when ventilated patients receive the best practices combination known as the Ventilator Bundle. However, many ICU's struggle with implementation and documentation of this best practice guideline. Compliance often falls short because of incomplete or missing physician orders, missed doses of medications, failure to use devices, and lack of accurate documentation for applied treatments and/or contraindications. Despite staff educational efforts, chart audits for compliance and documentation rarely reach 100%.

METHODS: We hypothesized that physician order compliance and documentation could be improved using our ICU telemedicine center to implement three components of the ventilator bundle- head of bed (HOB) elevation, deep vein thrombosis (DVT) prophylaxis, and peptic ulcer disease (PUD) prophylaxis. We performed this intervention in three phases. Phase I introduced remote intensivist led, daily multidisciplinary rounds (MDR's) on all patients. Phase II empowered the MDR remote intensivist to prescribe vent bundle orders on all patients. Phase III added twice daily RN remote bedside rounds to assist with documentation. The virtual RN rounds functioned as a reminder for vent bundle compliance, to confirm medication administration, and to document HOB elevation and DVT device application when ordered. A daily vent bundle progress note was placed in the patient chart. Monthly chart reviews were performed on all ICU mechanically ventilated patients.

RESULTS: Results were compared monthly as percentage compliance per ventilator day. Percentage compliance improved from baseline to phase III for HOB, DVT, and PUD from 59%, 76%, and 84% to 100%, 100% and 99% respectively. $P < .001$ for Chi-square and nptrend analysis.

CONCLUSION: This telemedicine-based performance improvement program enhanced compliance and documentation with three vent bundle components. Raising awareness (MDRs) had the least effect on compliance, while writing orders and then documenting that these orders were carried out showed the greatest effect.

CLINICAL IMPLICATIONS: A centralized tele-ICU program can be instrumental in achieving greater compliance with quality indicators in the ICU and should be evaluated for its effect on other ICU best practices.

DISCLOSURE: Brian Youn, None.

CENTRALIZED, REMOTE ICU INTERVENTION IMPROVES BEST PRACTICES COMPLIANCE

Glenn M. Giessel, MD* and Barbara Leedom, RN, Pulmonary Associates of Richmond, Richmond, VA
Chest. 2007;132(4):444a.

PURPOSE: Payors and quality organizations are calling for greater compliance with ICU quality measures (best practices) to improve patient outcomes. In spite of these calls, implementation of best practices remains difficult, particularly in community hospital ICUs without dedicated intensivists, daily multi-professional rounds or other process-directed care modalities. We hypothesized that process-directed care from a remote location (eICU[®] facility) would enable better compliance with ICU best practices.

METHODS: We compared DVT compliance in two groups during a one month period. The first group (control) represented 67 beds in 8 ICUs that were not networked into our eICU facility and the second group (intervention arm) represented 69 beds in 7 ICUs that were networked into our remote facility. All ICU patients charts were reviewed for anticoagulant medications and devices (SCDs) ordered and meds administered; and patients were excluded if they were actively bleeding or coagulopathic (INR>1.5, and/or platelet count <50K). The intervention arm included the eICU facility nursing staff reviewing networked patients for DVT prophylaxis. When ICU patients were identified that did not have DVT prophylaxis in place (meds administered or visual assessment of SCDs) and were not coagulopathic or actively bleeding the eICU staff either contacted the attending physician (daytime hours) or the eICU physician wrote the prophylaxis orders (nighttime). The proportion of patients receiving appropriate DVT prophylaxis in monitored units was compared to non-monitored units by constructing a contingency table and tested with Fisher's exact test.

RESULTS: 220 patients charts were reviewed in the control group and 202 charts were reviewed in the intervention group. DVT prophylaxis compliance was 75% in the control and 95% in the intervention group. Relative risk of receiving DVT prophylaxis was 1.26 ($p<.0001$).

CONCLUSION: Improved compliance with DVT prophylaxis is obtained when these process activities are coordinated from a central location.

CLINICAL IMPLICATIONS: Centralized remote implementation of best practices may be beneficial for improving compliance for other ICU best practices and in other staffing environments.

DISCLOSURE: Glenn Giessel, None.

ROLE OF A TELEMEDICINE INTENSIVE CARE UNIT PROGRAM (TISP) ON GLYCEMIC CONTROL (GC) IN SERIOUSLY ILL PATIENTS IN A RURAL HEALTH SYSTEM

Michael L. Aaronson, MD, Edward T. Zawada, Jr, MD, FCCP*, Pat Herr, RN, CCRN Avera ICU Research Group Avera Health System, Sioux Falls, SD
Chest. 2006;130:226s-A.

PURPOSE: A TISP was launched in 2004 to improve quality of care in rural hospitals. GC was a priority because it has been shown to improve morbidity, mortality, and ICU length of stay. We describe the impact on GC after initiation of TISP.

METHODS: Ten rural hospitals are linked by the TISP. The flagship hospital provides the staff of ten intensive care physicians and fifteen nurses who provide 24-hour supervision of 61 beds in hospitals separated by as much as 350 miles with populations to as low as 1,000. The GC protocol was based on the consensus of the Society of Clinical Endocrinology. Insulin administration is begun when glucose reaches 120 mg/dL to achieve a goal of 70-110 mg/dL. Human regular insulin is administered with three levels of aggressiveness depending upon the intensivist's judgment. Modifications occur daily during remote "glucose rounds." If glucose levels are not at goal and the patient is on the highest level of insulin administration, insulin glargine is added to the current sliding scale at an amount equal to 80% of the daily human regular insulin requirement and the sliding scale is lowered 1 tier. If glucose levels are greater than 150 mg/dL or there is wide variability, an insulin drip protocol is begun.

RESULTS: Average daily glucose levels fell from 144 mg/dL in the flagship hospital to 124 mg/dL. In the more remote hospitals, average daily glucose levels were reduced from 161 mg/dL to 139 mg/dL.

CONCLUSION: Improved GC in seriously ill patients was achieved by the introduction of the TISP.

CLINICAL IMPLICATIONS: Improved best practices outcomes can be seen in seriously ill patients in rural hospitals by a TISP.

DISCLOSURE: Edward Zawada Jr, None.

UTILIZING ROBOTS AND AN ICU TELEMEDICINE PROGRAM TO PROVIDE INTENSIVIST SUPPORT FOR RAPID RESPONSE TEAMS

Brian A. Youn, MD, FCCP, Parkview Hospital, Fort Wayne, IN
Chest. 2006;130:102s-A.

PURPOSE: The Institute for Healthcare Improvement has identified Rapid Response Teams (RRT) as an intervention that improves the care of hospitalized patients. Many RRTs utilize nurses and respiratory therapists because of the limited availability of physician support. We proposed using our remote intensivist in conjunction with a mobile telemedicine presence for real-time support to our RRTs.

METHODS: Our remote tele-intensivist currently covers 44 ICU beds in 5 hospitals with a combined hospital bed capacity of 752. Intensivist support for the system-wide RRT was initiated in October 2005 utilizing robots that are brought to the patient's bedside along with the RRT team. The tele-intensivist can visualize the patient and any bedside monitors and can be seen and heard by the patient and care-givers in the hospital. We evaluated the preliminary outcomes and nursing satisfaction to this new RRT methodology.

RESULTS: There were 64 RRT calls from med/surg floors over the first 16 weeks of the program. Preliminary results found that the remote intensivist provided immediate care orders in 70% of the cases, and 55% of the cases required transfer to another hospital unit (ICU or telemetry). Since initiating this program, out of unit cardiac arrests have declined from a nine-month prior average of 38% to currently 28%. A nine-month prior average of codes per 1000 discharges has dropped from 11% to 8.7%. Nursing satisfaction scores averaged 4.7-5.0 (1-5 scale, with 5 strongly agrees) for improved communication and collaboration and better patient outcomes.

CONCLUSION: Mobile telemedicine units in conjunction with a remote intensivist can provide expert support to multiple hospitals RRTs concomitantly. Intensivist assessments and orders provide more timely urgent care interventions. This program has positively impacted preliminary data on out of unit cardiac arrests, codes per 1000 discharges and nursing satisfaction.

CLINICAL IMPLICATIONS: Use of telemedicine technology can provide intensivist coverage to multiple hospitals from a central location and represents a significant capability for extending intensivist care out to floor-based patients in need.

DISCLOSURE: Brian Youn, None.

SCREENING FOR SEVERE SEPSIS; AN INCIDENCE ANALYSIS

Teresa Rincon, Grace Bourke, Daniel Ikeda, Adam Seiver, Sutter Health, Sacramento, CA
Crit Care Med. 2007;35(12):A257.

INTRODUCTION: The Surviving Sepsis Campaign (SSC) and the Institute for Healthcare Improvement (IHI) recommend a severe sepsis screening process followed by aggressive implementation of the bundle for the treatment of this complex disease state. Institutions struggle with implementation of a sepsis screening process. The incidence of this disease state is unknown.

HYPOTHESIS: We hypothesize that we can define the true incidence of severe sepsis using an electronic screening tool looking at 161 ICU beds at 10 hospitals.

METHODS: An electronic screening tool based on the IHI screening form was developed and utilized for this process. The tool was linked to a database for rapid analysis. All ICU patients were screened for severe sepsis upon admission into one of 12 ICUs located in 10 hospitals by a nurse located in the Sutter eICU center (VISICU®). Patients with infectious processes who did not meet severe sepsis screening criteria were screened every 12 hours. Patients without an infectious process were screened every 3 days. Upon identification of a patient with criteria for severe sepsis, critical care physicians in the eICU confirmed the diagnosis.

RESULTS: From 1Q 2006 through 2 Q 2007 the Sac eICU performed 37,362 screens on 15,085 patients. 2560 patients were identified as positive for severe sepsis (17% severe sepsis rate). Of the 15,085 patients 844 (5.6%) met the criteria at time of triage or during the emergency room (ER) stay, 1336 (8.9%) met criteria upon ICU admit or during the ICU stay, and 380 (2.5%) met criteria in an area outside the ICU or ER. This process includes a filter for false positive screens.

CONCLUSIONS: The incidence of severe sepsis in an ICU represents a large component of an ICU population. Our data suggests that the incidence for severe sepsis is higher than what has been previously reported. Identifying and targeting this population for timely intervention will have a significant impact on the survival of at risk patients.

IMPROVING COMPLIANCE WITH SURVIVING SEPSIS CAMPAIGN GUIDELINES VIA REMOTE ELECTRONIC ICU MONITORING

Bela Patel, Internal Medicine, Division of Pulmonary, Critical Care and Sleep Medicine, The University of Texas-Medical School Houston, Houston, TX; Lillian Kao, Surgery, Critical Care, The University of Texas Health Science Center Houston, Houston, TX; Eric Thomas, Internal Medicine, The University of Texas Health Science Center Houston, Houston, TX; Tammy Campos, Memorial Hermann Texas Medical Center, Houston, TX
Crit Care Med. 2007;35(12):A275.

INTRODUCTION: Mortality from severe sepsis remains high. The surviving sepsis campaign guidelines are evidenced based recommendations to improve outcomes. However, in many centers compliance with the speed of initiation of the 6 hour sepsis resuscitation bundle is low.

HYPOTHESIS: Integrating the electronic ICU into the multidisciplinary workflow of sepsis management in an academic 16 bed MICU will improve compliance with the resuscitation sepsis bundle.

METHODS: All patients admitted to the MICU during May 1 to August 15 2007 were screened for sepsis by the electronic ICU monitoring staff. Compliance with sepsis bundles was evaluated. Communication verbally or via fax order transmittal was established to ensure compliance. Interval monitoring of targets (CVP, ScVO₂, MAP) with EGDT pathway implementation occurred approximately every 15-30 minutes.

RESULTS: The overall mean compliance with the resuscitation 6 hour bundle increased from 3 to 29% during the 15 week period by integrating remote electronic ICU Monitoring into the sepsis management workflow. The intervention improved compliance with all of the bundle elements. Serum lactate within 6 hours improved from mean 67% to 90%. Blood cultures prior to antibiotics improved from 67% to 75%. Antibiotics within time guidelines improved from mean 26% to 51%. Treatment of hypertension with fluids and/or vasopressors per guideline improved from mean 39% to 67%. CVP target within time guideline improved from mean 13% to 45%. ScVO₂ target within time guideline improved from mean 4% to 29%.

CONCLUSIONS: Remote Electronic ICU monitoring may improve overall compliance with the resuscitation sepsis bundle.

CENTRALIZED, REMOTE CARE IMPROVES SEPSIS IDENTIFICATION, BUNDLE COMPLIANCE AND OUTCOMES

Teresa Rincon, BSN, CCRN*, Grace Bourke, MBA and Daniel Ikeda, MD, Sutter Health, Sacramento, CA

Chest. 2007;132(4):557b-558b.

PURPOSE: Sepsis is responsible for 215,000 deaths per year and the Surviving Sepsis Campaign was initiated to standardize care and improve outcomes in this patient population. We previously reported on reduced sepsis mortality (CCM 2006, Vol. 34, A2 & A108) in our ICU patients and we hypothesized that the improvement in outcomes correlated with the development of a centralized process for identifying sepsis patients and implementing the sepsis bundle in a more timely fashion during the same time period.

METHODS: We screened high risk patients in eight hospitals (118 ICU beds) from our eICU® center. When patients were identified who met sepsis criteria they were then tracked for compliance with the sepsis bundle. The eICU physician would either implement the bundle (order blood cultures, baseline labs, measure lactate and administer antibiotics within 2 hours) if given the authority (high category of intervention) or would contact the attending physician and advise for timely bundle implementation. Data was extracted and analyzed by nptrend and reports were provided back to the facilities on a monthly basis.

RESULTS: 8116 of 8134 ICU admissions were screened from Jan-Nov 2006 (99.8%), and of those screened 1120 patients met criteria for sepsis (13.8%). Sepsis bundle implementation showed the following changes over the 11 months: Antibiotics within 2 hours went from 51% to 79% ($p < .001$), blood cultures drawn before antibiotics from 63% to 74% ($p < .001$), lactate measurement from 49% to 55% ($p = .07$), and baseline labs from 78% to 84% ($p = .003$).

CONCLUSION: Accurate sepsis identification can be achieved from a central location and correlates with both improved sepsis bundle compliance and reduced mortality.

CLINICAL IMPLICATIONS: Centralized remote identification of at-risk patients may be beneficial for improving adherence to best practices for identification and management of sepsis as well as other common conditions.

DISCLOSURE: Teresa Rincon, No Product/Research Disclosure Information; Consultant fee, speaker bureau, advisory committee, etc. Eli Lilly Medical Advisory Board and Speaker Bureau

IMPLEMENTATION OF A STANDARD PROTOCOL FOR THE SURVIVING SEPSIS 6 AND 24 HR BUNDLES IN PATIENTS WITH AN APACHE III® ADMISSION DIAGNOSIS OF SEPSIS DECREASES MORTALITY IN AN OPEN ADULT ICU

Daniel Ikeda, Saman Hayatdavoudi, John Winchell, Alexandra Rojas, Teresa Rincon, Alan Yee, Sutter Health, Sacramento, CA
Crit Care Med. 2006;34(12):A108.

INTRODUCTION: Numerous studies have shown that individual components of the Surviving Sepsis 6 and 24 hr Bundles decrease mortality.

HYPOTHESIS: We hypothesized that use of a protocol implementing the Surviving Sepsis 6 and 24 hr Bundles in patients with APACHE III® admission diagnosis of sepsis will show a measurable decrease in mortality in an open adult Intensive Care Unit (ICU).

METHODS: In this prospective study we used a protocol to manage 266 consecutive patients admitted to a tertiary community hospital 24 bed open adult ICU from 7/1/2004 - 6/30/2006 with an APACHE III admission diagnosis of Sepsis. The historical control cohort was 48 consecutive ICU patients admitted between 1/1/2004 – 6/30/2004 with an APACHE III admission diagnosis of Sepsis. The protocol implemented the surviving sepsis 6 and 24 hr Bundle guidelines, using pre-printed order sets and shared patient management by critical care physicians located in the Sutter eICU (VISICU®), a remote electronic monitoring unit.

RESULTS: The actual ICU mortality was 40.07% in the control period, compared to 18.86% for the study period ($x^2 = 28.98$, $p < 0.001$). APACHE III (Cerner®) predicted ICU mortality was 24.18% for historical control vs. 23.11% for the study group. Divided into 6-month intervals the actual ICU mortality was 22.27%. (7/1/04 - 12/31/04), 16.34% (1/1/05 - 6/30/05), 17.21% (7/1/05 – 12/31/05) and 16.22% (1/1/06 - 6/30/06). An estimated 56 lives were saved over this 30-month period

CONCLUSIONS: Utilization of a protocol applying the Surviving Sepsis 6 and 24 hr bundle guidelines in patients with an APACHE III admission diagnosis of Sepsis was associated with a significant sustained decrease in mortality compared to a historical control in a tertiary community hospital open adult ICU.

ECONOMIC IMPACT OF eICU® IMPLEMENTATION IN AN ACADEMIC SURGICAL-ICU

Benjamin A Kohl, Frank D Sites, Jacob T Gutsche, Patrick Kim, Anesthesiology and Critical Care, University of Pennsylvania, Philadelphia, PA
Crit Care Med. 2007;35(12):A26.

INTRODUCTION: We have recently shown an improvement in mortality and length of stay after implementing eICU (VISICU, Baltimore, MD) in a large academic surgical ICU. The purpose of this study is to measure the economic impact of this transition.

HYPOTHESIS: Implementation of eICU in an academic surgical ICU, allowing round-the-clock intensivist oversight, will decrease ICU and hospital costs.

METHODS: We retrospectively compared a random sample of 189 patients pre-eICU to 2,622 patients 3 years post eICU using a multiplier of 13.87 to normalize populations. Assumptions based upon published literature include an average surgical ICU cost per day of \$1,500-\$2,000 and an average daily cost on a general floor of \$500-\$600. Because of the disparate sizes in populations a multiplier of 13.87 was used to standardize the numbers. There was no significant change in practice paradigm during the time period. APACHE III scores were used to calculate predicted length of stay in ICU and hospital.

RESULTS: An almost 10% reduction in ICU stay and 20% reduction in floor stay occurred after implementation of eICU. This translated into a savings of \$706,272-\$941,697 for the ICU and \$2,134,339-\$2,842,940 for the floor

CONCLUSIONS: Implementation of an eICU in an academic SICU resulted in significantly reduced costs.

THE ECONOMIC AND CLINICAL VALUE OF A REMOTE INTENSIVE CARE UNIT

John A Hitt, Ed Zawada, Pat Herr, Brian Pederson, Avera McKennan Hospital, Sioux Falls, SD

Crit Care Med. 2007;35(12):A20.

INTRODUCTION: Remote monitoring of intensive care patients is increasingly prevalent and we have previously demonstrated care improvement and reductions in mortality (Chest130;226S-a,226S-b).

HYPOTHESIS: The cost benefit for remote monitoring needs further study and an economic and clinical benefit can be shown.

METHODS: Avera McKennan Hospital (AMH) is a 490 bed community teaching hospital in Sioux Falls, SD. AMH is the hub of a network of smaller community hospitals in 4 states. AMH established a remote monitored intensive care unit (RMU) in 2004 using VISICU technology. The AMH RMU monitors 67 beds (27 at AMH; 40 across network). We accounted for all the start up and ongoing annual costs allocated to AMH for the RMU network. We modeled costs savings using an estimated \$1600 cost per intensive care unit (ICU) day for a one year period before and after RMU implementation and compared it to our hospital accounting system (TSI). We scored charts retrospectively in from the pre-period and prospectively in the post-period using the APACHE III severity scoring system.

RESULTS: AMH accounting systems were used to calculate initial setup costs for RMU at AMH: 1) VISICU Software \$950,000 2) Network setup \$400,000, 3) ICU modifications \$140,000. Annual costs for the RMU program: 1)license .fees \$200,000, 2)RMU staffing \$1,250,000(14 FTEs), 3)Miscellaneous \$100,000. Clinical benefit Pre: Post length of stay (LOS) decreased 1.13:0.60(observed vs. expected $p < .001$). ICU predicted days in post period were 5487 and actual days were 2826. Annual savings estimate calc $5487 - 2826$ (days avoided) = $2581 \times \$1600$ per ICU day = \$4,100,000. The TSI estimated annual cost savings was \$450,000-650,000.

CONCLUSIONS: Cost savings with RMU is demonstrable. The magnitude of the savings and resultant return on investment can vary greatly depending on the assumptions made, accounting methods used. Decreases in mortality (cost per life saved) must be valued in addition to financial savings and support the cost effectiveness of RMU. Simultaneous care improvements contributed to the savings.

FINANCIAL BENEFIT OF A TELE-INTENSIVIST PROGRAM TO A RURAL HEALTH SYSTEM

Edward T. Zawada, MD, FCCP*, Pat Herr, RN, CRRN, David Erickson, MD and John Hitt, MD, Avera ICU Research Group Avera McKennan Hospital & University Health Center, Sioux Falls, SD
Chest. 2007;132(4):444.

PURPOSE: Providing around the clock intensivist care to a rural health system represents a significant staffing challenge. Our health system implemented a tele-intensivist program in 2004 to leverage our limited intensivist staff and improve clinical outcomes. We have previously reported on the clinical benefits of our program (*Chest* Vol. 130:226S). However, the current healthcare environment requires that new technologies also save money to be sustainable. Length of stay (LOS) is the single most important determinant of hospital cost, and we hypothesized that this care delivery model would also reduce length of stay across our health system.

METHODS: This study compared severity-adjusted LOS (APACHE-III) one year before and two years following implementation of the tele-intensivist program. For the pre-period, 200 randomly selected ICU patients (50 charts from each quarter for four quarters prior to program activation) from the tertiary (24 beds) and each of 3 regional hospitals (10 beds, 10 beds, and 6 beds) were compared to continuous APACHE-III scoring in the post period. Data were analyzed using a rank sum test on the difference of expected and observed LOS.

RESULTS: ICU LOS ratios (observed/expected) pre and post were 1.13 and 0.60 (-46.8%) in the tertiary hospital, 1.35 to 0.86 (-36.4%), 1.42 to 0.93 (-34.7%) and 0.96 to 0.89 (-7.6%) in the regional hospitals. Hospital LOS ratios were 0.62 to 0.53 (-21%) in the tertiary hospital, 0.79 to 0.63 (-20.3%), and 0.67 to 0.62 (-7.4%), and 0.79 to 0.80 (1.4%) in the regional hospitals. Both ICU and hospital LOS were reduced ($p < 0.001$) and across the health system were associated with an annual reduction in 4146 ICU days and 572 hospital days.

CONCLUSION: Remote telemedicine intensivist staffing reduces severity-adjusted ICU and hospital lengths of stay and is associated with a substantial number of saved days across the health system.

CLINICAL IMPLICATIONS: Further analyses are required to determine the etiology of saved days, but based upon LOS reduction our tele-intensivist program demonstrates a financial benefit.

DISCLOSURE: Edward Zawada, No Financial Disclosure Information; No Product/Research Disclosure Information

REMOTE ICU CARE CORRELATES WITH REDUCED HEALTH SYSTEM MORTALITY AND LENGTH OF STAY OUTCOMES

Gregory H. Howell, MD*, Vincent M. Lem, MD and Jennifer M. Ball, RN, BSN, Saint Luke's Health System, Kansas City, MO
Chest. 2007;132(4):443b-444b.

Please see abstract on page 2

THE EFFECT OF INSTITUTING AN ICU ELECTRONIC MEDICAL RECORD ON PROFESSIONAL FEE BILLING

Joseph J Hine, Pulmonary and Critical Care Medicine, Medical College of Wisconsin, Milwaukee, WI
Crit Care Med. 2006;34(12):A21.

INTRODUCTION: Electronic medical record (EMR) systems have been hypothesized to improve the quality of documentation, patient care and patient safety. However, despite the financial benefit resulting from better documentation, this aspect of EMRs has not been examined in an intensive care unit (ICU) setting. The purpose of this study was to determine the effect of instituting an intensive care-specific EMR on capturing professional fee (pro-fee) billing charges.

HYPOTHESIS: ICU EMR will improve pro-fee billing charges.

METHODS: This was a single center, retrospective study performed in the medical intensive care unit (ICU) of the Medical College of Wisconsin. A retrospective analysis of submitted critical care time related pro-fee charges (CPT codes 99291 and 99292), was performed (Pre: Oct - July 2004/2005 and Post: Oct - July 2005/2006). Prior to the initiation of the EMR (VISICU, Inc) critical care time related pro-fees were captured via manual chart abstraction by professional fee abstracters. There was no change in attending coverage or coding staff during the study period. The results for two ten month periods were analyzed using nonparametric rank sum test.

RESULTS: Each month was analyzed for total patient admissions and critical care time related pro-fee billing charges. The EMR was introduced in October of 2005. Prior to the institution of EMR, the average monthly pro-fee billing charge was \$174,000. After initiation of the EMR, the average pro-fee billing charge rose to \$227,000/month (31% increase, $p=.004$).

CONCLUSIONS: The addition of an EMR to an academic, medical intensive care unit service significantly increased the professional fee billings. Institution of an EMR in ICUs should increase revenue capture for intensivists, pulmonary departments and/or hospitals.

	Months	Average Monthly Admissions	Monthly Time-Related Professional Charges	Annualized Billing
Pre	10	120	\$174,000	\$2,088,000
Post	10		\$227,000	\$2,724,000

* $p = .004$

THE EFFECT OF INSTITUTING AN ICU ELECTRONIC MEDICAL RECORD ON BILLING AND COMPLIANCE

Benjamin A. Kohl, MD, University of Pennsylvania, Philadelphia, PA
Chest. 2006;130:112s-A.

PURPOSE: Electronic medical record (EMR) systems have been shown to improve the quality of patient care and patient safety. Despite compelling evidence of return on investment, EMRs have not been universally accepted. The purpose of this study was to determine what effect instituting an intensive care specific EMR in an academic medical center has on capturing billable encounters (BE).

METHODS: This was a single center, retrospective study occurring in the surgical intensive care unit (ICU) of the University of Pennsylvania. A retrospective analysis of all BE was performed through the study period. Prior to the initiation of the EMR, BE were captured via manual chart abstraction by professional fee abstracters certified by the American Academy of Professional Coders (AAPC). There was no change in attending coverage or coding staff during the study period.

RESULTS: Each year was divided into quarters for analysis. The EMR was introduced in the second quarter of 2005. CPT code 99291 designates critical care services provided for between 30 and 74 minutes (after which it is billed as 99292). Prior to the institution of EMR, the average number of CPT 99291 being captured was 935.4 (range 836-1136). After initiation of EMR, the average number of CPT 99291 being captured rose to 1663.6 (range 1275-2266). The total number of billable events which were captured was 4,382 prior to the EMR and 4,937 after introduction of EMR. The documentation supported critical care code billing in 55% of the encounters prior to initiation of the ICU EMR and 77% afterwards. When comparing these numbers to the total BE, this change is statistically significant by Fisher exact test at $p < 0.0001$ [OR 2.61, CI 2.39-2.85].

CONCLUSION: The addition of EMR to an academic medical center surgical intensive care unit significantly increased the capture of billable critical care services as measured by CPT 99291. **CLINICAL IMPLICATIONS:** Institution of EMR in academic ICUs may increase hospital revenue by properly capturing billable events.

DISCLOSURE: Benjamin Kohl, None.

CRITICAL-CARE NURSES' JOB SATISFACTION AND ITS EFFECT ON RETENTION

Wanda F Lewis, eICU, Memorial Hermann Healthcare System, Houston, TX
Crit Care Med. 2007;35(12):A22.

INTRODUCTION: The purpose of this quantitative correlational study was to examine the relationship between job satisfaction of critical-care nurses and its effect on retention of nurses.

HYPOTHESIS: The demographic and employment variables under study were age, years as a registered nurse, years as a critical-care nurse, years as a registered nurse, years as a critical-care nurse, years in current unit, gender, ethnicity, salary, and education. The null and alternative hypotheses were derived for the first and second research questions. 1. What are the relationships between job satisfaction and demographic and employment variable among critical-care registered nurses? 2. To what extent can critical-care registered nurses' retention intention be predicted by job satisfaction?

METHODS: A quantitative correlational study, one-way ANOVAs, Tukey's HSD, F static, and logistic regression were used to derive relationships between job satisfaction and retention of the critical-care registered nurse. Where there was a statistical significance, the one-way ANOVAs were followed-up with Tukey's HSD test. The population consisted of 200 hundred critical-care nurses who were members of the American Association of Critical-Care Nurses.

RESULTS: Satisfaction with pay was the most important area of satisfaction, followed by satisfaction with autonomy. Results indicated that the satisfaction scales were not predictive of whether or not an individual would stay in critical-care nursing for 5 years. One satisfaction scale, satisfaction with task requirements, was related to plan on staying-with the current organization for 2 years, with higher level of satisfaction with task requirements substantially increased the likelihood that the individual planned to stay.

CONCLUSIONS: The current study has shown a significant relationship between pay and compensation and autonomy as attributes that determine job satisfaction of practicing critical-care registered nurses, there is a statistical significant relationship exists between pay and compensation and autonomy as measured by the IWS questionnaires. Retention was predicted by satisfaction with task requirements.

THE IMPACT OF A TELE-ICU PROVIDER ATTITUDES ABOUT TEAMWORK AND SAFETY CLIMATE

Eric J Thomas, Ming Ying L Chu-Weininger, Joseph Lucke, Laura Wueste, Medicine, University of Texas Health Science Center at Houston, Houston, TX; Lisa Weavind, Janine Mazabob, Memorial Hermann Healthcare System, Houston, TX
Crit Care Med. 2007;35(12):A145.

INTRODUCTION: Little is known about how a tele-ICU may affect ICU physicians and nurses in the outlying units. The tele-ICU may impact communication and teamwork for better, or for worse. In addition, the tele-ICU should result in changes that improve the quality and safety. Our goal was to measure provider attitudes about teamwork and safety climate in three intensive care units (ICUs) before and after the implementation of remote monitoring by intensivists using telemedicine technology (tele-ICU).

HYPOTHESIS:

METHODS: The design was a controlled pre tele-ICU and post tele-ICU cross-sectional survey of physicians and nurses in ICUs in three hospitals. The outcomes were teamwork and safety climate scores (TWS and SCS) measured by the Safety Attitudes Questionnaire.

RESULTS: The mean (SD) TWS score was 69.7 (25.3) and 78.8 (17.2), pre and post tele-ICU, respectively ($p = 0.009$). The mean SCS score was 66.4 (24.6) and 73.4 (18.5), pre and post tele-ICU, respectively ($p = 0.045$). While SCS scores within the ICUs improved, the overall SCS scores for these hospitals decreased from 69.0 to 65.4. The hospitals were not administering the teamwork portion of the survey prior to tele-ICU. Three of the non-scaled items were significantly different pre and post tele-ICU at $p < .001$. The item means (SD) pre and post tele-ICU were: 'others interrupt my work to tell me something about my patient that I already know' 2.5 (1.2) and 1.6 (1.3); 'I am confident that my patients are adequately covered when I am off the unit' 3.2 (1.3) and 4.2 (1.1); and 'I can reach a physician in an urgent situation in a timely manner' 3.8 (1.2) and 4.6 (0.6).

CONCLUSIONS: Implementation of a tele-ICU was associated with improved teamwork climate and safety climate, especially among nurses. Providers were also more confident about patient coverage and physician accessibility, and did not report unnecessary interruptions.

ECONOMIC IMPLICATIONS OF DATA COLLECTION FROM A REMOTE CENTER UTILIZING TECHNOLOGICAL TOOLS

Teresa Rincon, Barbara Welcher, Dana Srikanth, Adam Seiver, Sutter Health, Sacramento, CA

Crit Care Med. 2007;35(12):A161.

INTRODUCTION: The use of complex predictive models to predict survival is widely accepted. Results from these can lack statistical significance due to low patient volume. Lack of resources and funding, potential for error with manual data collection processes and educational deficits may also decrease utilization.

HYPOTHESIS: We hypothesize that centralized remote data collection methods utilizing advanced technology can improve efficiency, accuracy and costs without increasing tasks and resources at the bedside.

METHODS: In 2006, the Bay Area eICU® hub, began a pilot utilizing an APACHE III® data collection methodology imbedded in a software application tool. This tool is used for remote Teleintensive care monitoring of adult ICU patients. The Bay Area eICU center was able to score 60% of the total patient population (containing the likelihood of ascertainment bias to an acceptable level). 100% of patients at 4 hospitals in 2006 were scored at the Sacramento eICU hub, but a mixed process of remote data collection and on site chart analysis was required. Over 1700 charts were reviewed at these sites in 2006. In addition to regular eICU staff, 2 full-time clerical and 1.5 full-time RN was necessary for data collection.

RESULTS: After implementation of an imbedded APACHE III data collection tool in 2Q 07 at the Sac hub, a decrease in two clerical and 1.5 RN was achieved by 3Q 07. Despite a decrease in resources the eICU center achieved APACHE I11 scoring for 161 ICU beds at 10 hospital campuses with an average capture rate of 78.59%. Annual per bed licensing fee was also decreased by 50% and an overall reduction was achieved for a total estimated savings of \$132,859 for 2007. Projected savings for 2008 is; \$318,248,

CONCLUSIONS: We have found that utilizing a technological tool for APACHE III data collection has enhanced resource use while decreasing overall costs at a large hospital system.

RESIDENT PERCEPTION OF THE EDUCATIONAL AND PATIENT CARE VALUE FROM REMOTE TELEMONTORING IN A MEDICAL INTENSIVE CARE UNIT

Adan Mora, MD*, Saadia A. Faiz, MD, Todd Kelly, MD, Richard J. Castriotta, MD, FCCP and Bela Patel, MD, FCCP, The University of Texas Medical School at Houston, Houston, TX

Chest. 2007;132(4):443a.

PURPOSE: To assess residents' perception of remote telemonitoring with regard to the educational value it may contribute in their residency training and to improved patient care.

METHODS: An anonymous electronic survey was sent to 133 residents who train in the medical intensive care units (MICU) affiliated with The University of Texas Medical School at Houston. One MICU has telemonitoring provided by fellows and academic or private intensivists via VISICU system of eICU®. The other MICU does not have eICU® involvement but is staffed by the same cohort of residents.

RESULTS: Ninety-six residents (72%) responded to the survey, including internal medicine, internal medicine/pediatrics, emergency medicine, anesthesia and preliminary residents responded. Sixty nine (71.9%) had telemonitoring experience. Of those with telemonitoring experience, a majority of residents perceived telemonitoring improves patient care (82.3%), and improves the care they deliver to patients while on call (73.8%). The events/interactions in which at least 60% of the residents believed telemonitoring was helpful or of some benefit were: ventilator management (70%), initial management of an unstable patient (64%), code supervision (64%), management of acute respiratory change (62%), blood gas interpretation/ acid base management (62%), early goal directed therapy and guidance (61%) and respiratory failure recognition (60%). It was least helpful with end of life issues (45%) and supervision on line placement (42%). 62% of residents preferred to train in a unit with remote telemonitoring. Upon completion of residency, 66.7% of residents expressed a desire to have remote telemonitoring involved in the care of their patients.

CONCLUSION: Remote MICU telemonitoring in a residency training program was perceived by residents to have a substantial impact in their education and to improve patient care.

CLINICAL IMPLICATIONS: Remote telemonitoring contributes to bedside residency education in critical care medicine and is perceived by residents to improve patient care.

DISCLOSURE: Adan Mora, No Financial Disclosure Information; No Product/Research Disclosure Information

FELLOWSHIP EDUCATION IN REMOTE TELEMONITORING UNITS

Saadia A. Faiz, MD, Anthony Zachria, DO, Liza Weavind, MD and Bela Patel, MD University of Texas at Houston Health Science Center, Houston, TX
Chest. 2006;130:113s-A.

PURPOSE: To address the shortage of intensivists, remote telemonitoring units have evolved and provide monitoring by intensivists. This survey aims to evaluate the experience of fellows exposed to this new modality of critical care.

METHODS: An anonymous electronic survey was sent to all VISICU unit medical directors and four Pulmonary & Critical Care program directors to enlist their fellows.

RESULTS: Sixteen fellows (13 pulmonary & critical care, 1 critical care, 1 trauma, 1 other) responded. All were part of a university based teaching program using VISICU and from 2 major cities: Houston, Kansas City. Most had experience via their fellowship program as a one month rotation, while three were moonlighters. Research opportunities were available to most (14/16). Most worked with both private and academic physicians. Eleven felt that the rotation was a good educational experience, but only nine felt that it should be a formal rotation. They felt that it improved their knowledge base (9/16), enhanced their communication skills (9/16), and reinforced the importance of professionalism (7/16). Fifteen fellows felt their exposure would be helpful after their training was completed. During the rotation, the majority worked with an intensivist, although four worked alone. In comparison to the ICU, some felt more exhausted (6/16), some felt the same (5/16), and some felt less exhausted (5/16). In the future, most would consider working as a part-time intensivist (14/16), but few would consider working full time (4/16). Most of the respondents would want to work in a place with remote telemonitoring units (14/16), and they all felt it improved patient care. Of note, thirteen fellows felt it served to further protect against medical liability.

CONCLUSION: Rotations in remote telemonitoring units should be included in training curriculum. The experience enhances skills, prepares for the future, and ameliorates communication and professionalism. Fellows feel it improves patient care and will likely be a part of their post-graduate practice.

CLINICAL IMPLICATIONS: Formal training for critical care fellows in remote telemonitoring units may bridge the nationwide shortage of accessible intensivists.

DISCLOSURE: Saadia Faiz, None.

DELIVERING INTENSIVIST SERVICES TO PATIENTS IN MULTIPLE STATES USING TELEMEDICINE

Dellice Dickhaus, Advanced ICU Care, St Louis, MO
Crit Care Med. 2006;34(12):A24.

INTRODUCTION: A shortage of intensivists has been identified nationwide. This shortage can be felt most acutely by community hospitals. However, research has shown that ICU's where intensivists manage the patient's care, there are improved outcomes.

HYPOTHESIS: The need for critical care expertise in community hospitals can be met by bringing intensivists to patients utilizing telemedicine technology. This can be done from a central location which has a rich population of intensivists.

METHODS: A free-standing eICU[®] operations center was established in St. Louis, Missouri to connect board-certified intensivists to patients in community hospitals. The hospitals are located in Jefferson City, MO (167 beds) and Weston, WI (86 beds). Licensure, hospital privileges, and malpractice coverage were obtained for all the intensivists in both states. The intensivists in St. Louis were connected electronically utilizing T1 lines. Utilizing the VISICU software package, trended and current patient data were regularly reviewed in real time. In addition, the eICU staff monitored and evaluated patients visually using a high-resolution camera and spoke with bedside clinicians and patient's families by 2-way speakers in each of the patient's rooms. Physician orders by the intensivist were signed electronically.

RESULTS: Two community hospitals, in two different states are now being served by an established group of intensivists. Early results at the Jefferson City hospital indicate a 17% decrease in LOS as well as a decrease in mortality. The hospital in Weston, WI has an intensivist on-site. The combination of the on-site intensivist in one state, and an intensivists in another state, who are connected through telemedicine technology has provided intensivist staffing recommended by Leapfrog.

CONCLUSIONS: This is a viable solution to the shortage of intensivists, particularly in community hospitals across the United States. There are significant challenges with licensing, credentialing, and malpractice coverage across state lines, which may limit the ability to expand this model on a broader scale.

SEVERE SEPSIS (SS) IS UNDERREPORTED IN THE ICU

Omar Badawi, Randy Holl, Erkan Hassan, Research & Development, VISICU, Baltimore, MD; Marc Zubrow, Christiana Care Health System, Wilmington, DE; Adam Bress, University of Maryland School of Pharmacy, Baltimore, MD
Crit Care Med. 2007;35(12):A256.

INTRODUCTION: The incidence of SS in ICUs varies from 2% to 11%. Underreporting may contribute to this variability.

HYPOTHESIS: A greater number of ICU patients meet physiologic criteria (PC) for SS than receive the diagnosis. The organ dysfunction (OD) present influences documentation of SS.

METHODS: Retrospective, multi-center study using the eICU® Program Network database for patients in an ICU using software designed to identify systemic inflammation (SI) from 11/06 to 7/07. SI was defined by an algorithm aggregating the degree of abnormality in: HR, RR, WBC, temperature, INR, glucose, ileus and altered mental status. OD associated with SS was defined using accepted clinical criteria. Patients met criteria for SS if they had a documented diagnosis of SS at admission or during the ICU stay (DS group), or met PC for SS (PCS group). The PCS group had SI, OD and a concurrent infectious diagnosis, but no diagnosis of SS (ie. Undocumented SS). McNemar's test was used to assess concordance.

RESULTS: 25,582 patients were included from 52 hospitals. 1,222 (4.8%) of patients had SS. 558 (2.2%) of these patients (PCS group) were not diagnosed with SS ($p < 0.01$). CV/shock was documented in 491 (74%) of DS patients. No other single OD was identified in >5% of DS patients. In contrast, PCS patients had a more diverse set of ODs present (Table 1).

CONCLUSIONS: Nearly 1/2 of ICU patients who met PC for SS did not have the diagnosis documented. Clinicians may be underreporting SS by focusing on CV OD. Associating other ODs with SS would increase reporting, potentially leading to improved treatment, reimbursement and severity scoring.

Table 1. Four most common ODs in PCS group

Organ Dysfunction	Percent of Patients in PCS Group*
Neurologic	53%
Cardiovascular/Shock	37%
Respiratory	22%
Lactic Acidosis	15%

* > 1 OD possible per patient

ICU LENGTH OF STAY (LOS) OUTLIERS: INCIDENCE AND IMPLICATIONS

Michael J. Breslow, MD*, Edward Larsen, Robb Fromm, MD and Brian Rosenfeld, MD, VISICU, Inc., Baltimore, MD
Chest. 2007;132(4):442.

PURPOSE: Most ICU patients have a stay of 2-4 days, after which they are able to leave the ICU. Although less prevalent, patients with long stays account for a disproportionate number of ICU days and costs. While there is wide recognition of the large impact of outliers, little is known about the makeup of this important sub-group of ICU patients.

METHODS: APACHE® III mortality and LOS data were collected from 20 health systems in the eICU Program Network (154 ICUs) throughout 2006. LOS outliers were patients with ICU stay > 6 days. Patients were grouped based on predicted ICU mortality: < 10% (low risk), 10-50% (medium) and > 50% (high). Outlier data in the three risk groups were examined in aggregate and at the ICU level: ICUs with < 200 patients were excluded from the ICU level analysis. ICU outlier incidence data were compared to mortality performance using least squares regression analysis.

RESULTS: 63,865 ICU admissions were included in the analysis. 8149 patients had an ICU LOS > 6 days (12.7%) and accounted for 50% of all ICU days. The incidence of outliers in low, medium and high risk patients was 8.6, 28.1 and 33.1%, respectively. 54% of all outliers were low risk patients. There was considerable inter-ICU variability in the incidence of low risk outliers (sd = 5.4%). Deaths in low risk outliers exceeded predicted mortality by 400%. There was a positive correlation between ICU standardized mortality ratio and the incidence of low risk outliers (R = 0.63).

CONCLUSION: More than half of all outliers had predicted mortality < 10%. These low risk outliers accounted for 25% of all ICU days. They also had a significantly higher mortality rate than expected. The incidence of low risk outliers varied considerably among ICUs, and was associated with worse ICU mortality performance.

CLINICAL IMPLICATIONS: These data suggest that high quality ICU care can reduce the incidence of low risk outliers, and thus have a beneficial effect on ICU resource utilization.

DISCLOSURE: Michael Breslow, No Product/Research Disclosure Information; Shareholder I am a shareholder in VISICU, Inc., a company that sells ICU software and services to hospitals; Employee I am an employee of VISICU, Inc., a company that sells ICU software and services to hospitals; Fiduciary position (of any organization, association, society, etc, other than ACCP I am a member of the Board of Directors of VISICU, Inc., a company that sells ICU software and services to hospitals.

GREATER COLLABORATION BETWEEN REMOTE INTENSIVISTS AND ON-SITE CLINICIANS IMPROVES BEST PRACTICE COMPLIANCE

Omar Badawi, VISICU. Baltimore, MD; University of Maryland, School of Pharmacy: Baltimore, MD; Ealaf Shemmeri, University of Maryland Medical System, Baltimore, MD
Crit Care Med. 2006;34(12):A20.

INTRODUCTION: A primary goal of intensive care unit (ICU) remote management systems is to improve compliance with best practices. This study evaluates how the level of partnership between remote intensivists and ICU clinicians affects glycemic control (GC) and deep vein thrombosis (DVT) prophylaxis.

HYPOTHESIS: A positive relationship exists between the level of partnership of remote intensivists with ICU clinicians and achieving best practice treatment goals.

METHODS: A retrospective, multi-center evaluation was conducted using the eICU® Program Network database. Patients were excluded if their attending physician had not assigned a level of partnership for remote intensivists. Level of partnerships were: Minimal (intervene only in emergencies); Moderate (intervene on emergencies and implement therapies consistent with the attending physician's care plan); Intense (full management authority in patient care). Primary outcomes were number of days with an average daily glucose < 110 mg/dL and number of at-risk patients administered DVT prophylaxis within 48 hours. The relationship between level of partnership and outcomes were assessed with the non-parametric test for trend.

RESULTS: A total of 7,222 patients met inclusion criteria representing 14 hospitals and 26 ICUs. DVT prophylaxis initiated within 48 hours of ICU admission was significantly more common in the intense level of partnership group (80% of patients compared with 75% in the moderate and 68% in the minimal groups; $p < 0.001$). Tight GC was achieved significantly more often in the intense level of partnership group (26% of ICU days compared to 17% in the moderate and 18% in the minimal groups; $p < 0.001$).

CONCLUSIONS: Greater partnership between remote intensivists and ICU clinicians significantly improves rates of DVT prophylaxis and tight GC. These data suggest that compliance with best practices can be improved with greater collaboration between remote intensivists and on-site ICU clinicians.

DOES BETTER CARE MEAN SHORTER LENGTH OF STAY?

Brian Rosenfeld, VISICU, Baltimore, MD
Crit Care Med. 2006;34(12):A140.

INTRODUCTION: Standardized mortality ratios-SMR (APACHE® III) can be used to measure ICU quality of care. Similar correlations between observed to predicted length of stay (LOS) provide additional insight into ICU performance. Previous work (Knaus et al. *Annals of Int Med* 1993) suggested that there was no correlation between hospital mortality performance and ICU LOS. We re-examined this relationship in light of ensuing changes in hospital critical care.

HYPOTHESIS: ICUs that deliver better care will have lower lengths of stay.

METHODS: This was a multi-center, retrospective study utilizing data from the eICU® Program Network. APACHE III algorithms were used to generate SMRs and LOS ratios for 19 health systems, comprising 126 ICUs and 25,404 patients during 2006. Data for each health system were examined in aggregate (actual:predicted mortality and LOS ratios calculated for all patients) for two successive quarters. Least square analysis was used to assess the correlation between mortality and LOS performance; and the significance was determined using the regression F test.

RESULTS: ICU mortality and ICU LOS performance were positively correlated ($R=.61$, $p<.0001$), as was hospital mortality and ICU LOS ($R=.52$, $p<.0001$). The correlation between hospital mortality and hospital LOS was not significant.

CONCLUSIONS: ICUs and hospitals that have better mortality performance have lower ICU lengths of stay. This suggests that better care may result in shorter LOS. Changes in patient safety following the Institute of Medicine report, newer care modalities and/or evidence-based critical care medicine changing the practice patterns of ICU clinicians may be responsible.

SICKER PATIENTS - DOES BETTER CARE MEAN LONGER STAYS?

Michael Breslow, Rob Fromm, VISICU, Inc., Lutherville, MD
Crit Care Med. 2006;34(12):A126.

INTRODUCTION: Payors, regulators and quality organizations are calling for widespread use of ICU quality measures. Mortality and length of stay (LOS) metrics are of particular interest. The APACHE® III algorithms, which demonstrate high precision and calibration when applied to large populations of patients, can be used to generate standardized mortality ratios (SMR - actual deaths:predicted deaths) and actual:predicted [A:P] LOS performance. While there is widespread agreement that high quality care reduces mortality, the relationship between quality of care and ICU LOS may be more complex.

HYPOTHESIS: High quality care may result in longer LOS for severely ill patients.

METHODS: APACHE III algorithms were used to generate SMRs and A:P LOS data for 163 ICUs. ICUs with less than 125 scored patients were excluded from analysis. ICUs were segregated into 3 equal groups, based upon SMR performance. For each ICU, LOS performance (A:P) was calculated separately for patients with predicted ICU mortality rates of <15%, 15-50% and >50%, respectively. LOS performance for each risk group was then compared in the best and worst performing ICUs (by SMR).

RESULTS: 23,188 patients from 74 ICUs were included in the analysis. The 24 ICUs with the lowest SMRs had A:P LOSs of 0.90, 0.99 and 1.39 in the low, medium and high mortality risk groups, respectively. The 24 ICUs with the highest SMRs had A:P LOSs of 1.29, 1.45 and 1.02, respectively.

CONCLUSIONS: High quality ICUs, as assessed by low SMRs have lower than predicted LOS for low risk patients but longer LOS in high severity patients. Poorer performing ICUs do not exhibit this behavior. We speculate that high quality care may extend life in patients at high risk of dying.

1. Kohl, B. Effect of Telemedicine on Mortality and Length of Stay in a University ICU. *Crit Care Med.* 2007;35(12):A22.
2. Rincon, T, Bourke, G, Ikeda, D, et al. Screening for Severe Sepsis: An Incidence Analysis. *Crit Care Med.* 2007;35(12):A257.
3. Patel, B, Kao, L, Thomas, E, et al. Improving Compliance with Surviving Sepsis Campaign Guidelines Via Remote Electronic ICU Monitoring. *Crit Care Med.* 2007;35(12):A275.
4. Kohl, B, Sites, F, Gutshe, J, et al. Economic Impact of eICU Implementation in an Academic Surgical ICU. *Crit Care Med.* 2007;35(12):A26.
5. Hitt, J, Zawada, E, Herr, P, et al. The Economic and Clinical Value of a Remote Intensive Care Unit. *Crit Care Med.* 2007;35(12):A20.
6. Lewis, W. Critical-Care Nurses' Job Satisfaction and Its Effect on Retention. *Crit Care Med.* 2007;35(12):A22.
7. Rincon, T, Welcher, B, Srikanth, D, et al. Economic Implications of Data Collection From Remote Center Utilizing Technological Tools. *Crit Care Med.* 2007;35(12):A161.
8. Thomas, E, Chu-Weininger, M, Lucke, J, et al. Impact of a Tele-ICU Provider Attitudes About Teamwork and Safety Climate. *Crit Care Med.* 2007;35(12):A145.
9. Badawi, O. Severe Sepsis (SS) is Underreported in the ICU. *Crit Care Med.* 2007;35(12):A256.
10. Giessel, G, Leedom, B. Centralized, Remote Intervention Improves Best Practices Compliance. *Chest.* 2007;132(4):444a.
11. Howell, G, Lem, V, Ball, J, Pagels, G, et al. Remote ICU Care Reduces Health System Mortality and Length of Stay Outcomes. *Chest.* 2007;132(4):443b-444b.
12. Breslow, M, Larsen, E, Fromm, R, et al. ICU Length of Stay (LOS) Outliers – Incidence and Implications. *Chest.* 2007;132(4):442.
13. Rincon, T, Bourke, G, Ikeda, D. Centralized, Remote Care Improves Sepsis Identification, Bundle Compliance and Outcomes. *Chest.* 2007;132(4):557b-558b.
14. Zawada, E, Herr, P, Erickson, D, et al. Financial Benefit of a Tele-Intensivist Program to a Rural Health System. *Chest.* 2007;132(4):444.
15. Mora, A, Faiz, S, Kelly, T, et al. Resident Perception of the Educational and Patient Care Value from Remote Telemonitoring in a Medical Intensive Care Unit. *Chest.* 2007;132(4):443a.
16. Awad, O, Maselli-Caceres, D, Estrada-Y-Martin, R. Patient's Acceptance for the Advanced Monitoristems in Electronic Intensive Care Units (eICU). *Chest.* 2007;132(4):444b.
17. Gracias, V. Outcomes of SICU Patients After Implementation of an Electronic ICU ("eICU") System and Off-Site Intensivist. Presented at: IATSIC-AAST Conference; August, 2007; Montréal, QC, Canada.
18. Zawada, E, Aaronson, M, Herr, P, et al. Relationship Between Levels of Consultative Management and Outcomes in a Telemedicine Intensivist Staffing Program (TISP) in a Rural Health System. *Chest.* 2006;130(4):226s.
19. Breslow, M, Fromm, R. Sicker Patients - Does Better Care Mean Longer Stays? *Crit Care Med.* 2006;34(12):A126.
20. Rosenfeld, B. Does Better Care Mean Shorter Length of Stay? *Crit Care Med.* 2006;34(12):A140.
21. Breslow, M, Holl, R, Kuan, D. A Vital Sign Alerting System for Managing Large Numbers of Critical Care Patients Remotely. *Crit Care Med.* 2006;34(12):A79.
22. Badawi, O. Greater Collaboration Between Remote Intensivists and On-Site Clinicians Improves Best Practice Compliance. *Crit Care Med.* 2006;34(12):A20.

23. Hine, J. The Effect of Instituting an ICU Electronic Medical Record on Professional Fee Billing. *Crit Care Med.* 2006;34(12):A21.
24. Ikeda, D, Hayatdavoudi, S, Winchell, J, et al. Implementation of a Standard Protocol For The Surviving Sepsis 6 and 24 Hr Bundles in Patients With an Apache III@ Admission Diagnosis of Sepsis Decreases Mortality in an Open Adult ICU. *Crit Care Med.* 2006;34(12):A2.
25. Hayatdavoudi, S, Ikeda, D, Seiver, A, et al. Impact of a Protocol Treating Severe Sepsis on Renal Function and Survival of Septic Shock Patients in an Open Adult ICU. *Crit Care Med.* 2006;34(12):A18.
26. Ikeda, D, Hayatdavoudi, S, Winchell, J, et al. The Impact of Using a Standard Protocol For the Surviving Sepsis 6 and 24 Hr Bundles in Septic Patients on Total ICU Risk Adjusted Mortality. *Crit Care Med.* 2006;34(12):A108.
27. Dickhaus, D. Delivering Intensivist Services to Patients in Multiple States Using Telemedicine. *Crit Care Med.* 2006;34(12):A24.
28. Casal, R, Lodato, R, Weavind, L, et al. Utilization of Low Tidal Volume Strategy in Patients With Various Indications For Mechanical Ventilation and in Different ICU Settings Assessed By Remote Telemonitoring. *Chest.* 2006;130:134s-A.
29. Youn, B, Roche, J. ICU Process Improvement: Using Telemedicine to Enhance Compliance and Documentation for the Ventilator Bundle. *Chest.* 2006;130:226s-C.
30. Zawada, E, Aaronson, M, Herr, P, et al. Relationship Between Levels of Consultative Management and Outcomes in a Telemedicine Intensivist Staffing Program (TISP) in a Rural Health System. *Chest.* 2006;130:226s-B.
31. Aaronson, M, Zawada, E, Herr, P. Role of a Telemedicine Intensive Care Unit Program (TISP) on Glycemic Control (GC) in Seriously Ill Patients in a Rural Health System. *Chest.* 2006;130:226s-A.
32. Faiz, S, Zachria, D, Weavind, L, et al. Fellowship Education in Remote Telemonitoring Units. *Chest.* 2006;130:113s-A.
33. Faiz, S, Baig, M, Weavind, L, et al. Temporal Variability of Remote Electronic Telemonitoring Unit Interventions Between Weekdays and Weekends. *Chest.* 2006;130:112s-C-113s-C.
34. Kohl, B. The Effect of Instituting an ICU Electronic Medical Record on Billing and Compliance. *Chest.* 2006;130:112s-A.
35. Youn, B, Roche, J. Utilizing Robots and an ICU Telemedicine Program to Provide Intensivist Support For Rapid Response Teams. *Chest.* 2006;130:102s-A.
36. Shaffer, J, Breslow, M, Johnson, J et al. Remote ICU Management Improves Outcomes in Patients With Cardiopulmonary Arrest. *Crit Care Med.* 2005;33(12):A5.
37. Cowboy, E, Rajamani, M, Shanmugam, N. Impact of Remote ICU Management on Ventilator Days. *Crit Care Med.* 2005;33(12):A1.

ABOUT VISICU

VISICU, Inc. (NASDAQ: EICU) is a healthcare information technology and clinical solutions company focused on transforming the delivery of critical care through its eICU® Program. Through remote monitoring and clinical intelligence technologies, scarce critical care resources are being leveraged to provide improved coverage and early intervention. The eICU Program is enabling critical care teams to provide safer, more effective patient care in conjunction with the Leapfrog Group's ICU patient safety standards.

For more information, visit www.VISICU.com.

217 E. Redwood Street, Suite 1900
Baltimore, MD 21202-3315
410-276-1960
866-484-7428
www.VISICU.com



smart systems, saving lives

eICU®, Smart Alerts®, smart systems, saving lives® and VISICU® are registered trademarks of VISICU, Inc. eCareManager™, eLert™, eCareMobile™, and eSearch™ are trademarks of VISICU, Inc.

© 2007 VISICU, Inc.
M.04.01.071205.V1