Clinical and Financial Evidence for Improving Quality and Efficiency in the ICU
The focus on healthcare quality and cost is creating an opportunity to differentiate physicians and nurses as leaders in the charge for patient safety and improved healthcare delivery. The eICU® Program 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 and looking at hard outcomes. This folio contains scientific abstracts that highlight improvements in care delivery, cost reduction, and education obtained by eICU Programs around the country. Many of these abstracts are now in manuscript form and/or under review by major medical journals.

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

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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 (Philips 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.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pre-eICU (n=189)</th>
<th>Post-eICU (n=2,622)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU Mortality (%)</td>
<td>8.4</td>
<td>3.1</td>
<td>0.0003</td>
</tr>
<tr>
<td>Hospital Mortality (%)</td>
<td>11.1</td>
<td>6.0</td>
<td>0.01</td>
</tr>
<tr>
<td>ICU LOS (d)</td>
<td>7.53/1.95 [0.17-180.4]</td>
<td>3.78/1.77 [0.17-156.3]</td>
<td>0.007</td>
</tr>
<tr>
<td>Hospital LOS (d)</td>
<td>21.0/11.0 [0.52-190.4]</td>
<td>16.57/9.2 [0.46-345.8]</td>
<td>0.04</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th></th>
<th>Before eICU</th>
<th>After eICU</th>
<th>p</th>
<th>RR</th>
<th>RR 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SICU admissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1050</td>
<td>1593</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unscheduled</td>
<td>58.7%</td>
<td>52.3%</td>
<td>&lt;0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, years*</td>
<td>56.4 +/- 19.4</td>
<td>54.9 +/- 19.9</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APACHE II*</td>
<td>10.5 +/- 7.9</td>
<td>12.0 +/- 7.6</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>5.5%</td>
<td>2.6%</td>
<td>&lt;0.001</td>
<td>0.48</td>
<td>0.32 – 0.70</td>
</tr>
</tbody>
</table>
NEHI RESEARCH UPDATE: TELE-ICU PROJECT WITH UNIVERSITY OF MASSACHUSETTS MEMORIAL MEDICAL CENTER

PROBLEM: Pressure on ICUs means higher costs, lower quality intensive care units (ICUs) consume six percent of health care spending in the United States. We know that ICUs managed by intensivists – health care providers trained in intensive care medicine – see 40 percent lower mortality and better quality care. Yet the combination of a severe nationwide intensivist shortage and changes in demographics creating sicker, older patients is pressuring ICUs across the country. That pressure is evident in the lower quality of care: Only 29 percent of hospitals with ICUs nationwide currently meet the Leapfrog criteria for quality.

NEHI RESEARCH: “Always on” intensivists to address these increased costs and lower quality of care at ICUs, NEHI has partnered with the UMass Memorial Medical Center (UMMMC) to study the use of tele-ICU, a suite of technologies that allow intensivists to remotely monitor and track patients in ICUs where staff intensivists are not available. UMMMC, which has the only tele-ICU support center in Massachusetts, is currently studying whether the use of tele-ICUs improves care and lowers costs, both in its seven internal ICUs and in two affiliated community hospitals.

EARLY RESULTS: Tele-ICUs save lives and money. Dr. Craig Lilly, director of the eICU Support Center at UMMMC, provided a preliminary update on the research to the NEHI Tele-ICU Advisory Group at its first meeting on November 17. According to Lilly, the use of tele-ICUs has led UMMMC to rethink and re-engineer ICU care delivery to increase the use of best practices, reduce complications, improve cost structure and save lives. The examination of 6,422 patient records before and after the use of the tele-ICU intervention reveals that the technology has, in fact, led to measurable improvements in the delivery of care at the seven UMMMC ICUs:

- Hospital length of stay was reduced by nearly four days
- Cost savings averaged $5,000 per patient
- 309 lives were saved in 2007 alone
- More patients were discharged to home rather than to a post-acute facility

Similarly, early data from one of the UMMMC affiliated community hospitals showed reduced mortality and increased adherence to clinical practice guidelines (physician best practices) in the ICU following implementation of tele-ICU technology. According to Lilly, the re-engineering of ICU care enabled by tele-ICU technology benefits patients, providers, institutions and payers by significantly improving quality and reducing the costs of care. In the coming months, NEHI will continue its collaboration with UMMMC to examine the impact of tele-ICU use at two affiliated community hospitals. Full results of that research are expected in early 2009 and will be shared with members prior to publication.

ABOUT NEHI:

Founded in 2002, the New England Healthcare Institute – known as NEHI – is a nonprofit, independent health policy institute dedicated to transforming health care for the benefit of patients and their families. NEHI is focused on enabling innovation that will improve healthcare quality and lower healthcare costs. These data were presented at their Q4 2008 meeting.
REMOTE ICU CARE CORRELATES WITH REDUCED HEALTH SYSTEM MORTALITY AND LENGTH OF STAY OUTCOMES

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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.
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.
EFFECT OF A TELE-ICU (TICU) FACILITATED PROGRAM ON CARE AND DOCUMENTATION OF ICU PATIENTS AND PRESSURE ULCERS (PU)

Kathryn Brown, Jude Gamel, Sheryl Arbogast, Donna Butler, Terri Ross, The Christ Hospital, Janet Spinks, Valencia McCree, Erkan Hassan, Philips VISICU
Crit Care Med. 2010;38(12):588

INTRODUCTION: PUs are expensive, costing up to $8.5 Billion/year. Assessment and intervention on all PUs is necessary but stage III/IV PUs present on admission (POA) must be documented to receive CMS payment.

HYPOTHESIS: This initiative was designed to improve 4 areas of PU practice: 1) Collaboration between bedside and remote clinicians in the identification/staging of PU; 2) Detailed wound description in the chart; 3) Documentation of status (improved or not); 4) Physician documentation required for CMS.

METHODS: Remote/bedside hospital administrators and clinicians developed a PU management program in a 555 bed tertiary care hospital with 3 ICUs (48 beds) and a tICU. Rigorous definitions of roles/responsibilities, pt. assessment, metrics, and education tools were developed. Each patient with a PU (POA/hospital acquired [HA]) or at high risk for a PU was reviewed daily for the presence or absence of the study objectives. Baseline (Phase I) data were collected (10/09 –1/10). Education on the initiative occurred in 2/10. tICU RNs were trained as extended wound care clinicians in the evaluation and staging of PUs. Post data (Phase II) were collected over 4 months (3/10 –7/10).

RESULTS: In Phase I, 1777 MICU pts had 58 (3.4%: 43 POA/15 HA) PUs. In Phase II, 3182 pts (all ICU’s) had 86 (2.7%: 55 POA/31 HA) PUs. Neither age nor gender was significantly different between groups. Collaboration and wound assessment documentation significantly improved from 62.1% to 96.5% & 24.1% to 60% respectively (P<0.05). Wound documentation achieved 95.4% compliance; however, the 75.9% Phase I rate precluded a statistical difference. Physician wound documentation remained low (20.7% vs 23.3%). No difference was found in physician documentation based on the stage of PUs regardless of POA or HA.

CONCLUSIONS: tICU RNs trained as extended wound care clinicians, in a collaborative PU management program with bedside RNs, are effective and significantly improves initial and ongoing wound assessment. Improved physician documentation should result in higher DRG reimbursement for pts with PU-POA.
IMPROVED SCREENING AND MANAGEMENT OF SEVERE SEPSIS (SS): COMBINING AN INTEGRATED MULTIDISCIPLINARY TEAM AND TECHNOLOGY.

Crystal Jenkins, Robert Groves, Banner Health System, Erkan Hassan, Omar Badawi, Philips Visicu, Baltimore, MD, Donald Maxwell, Banner Desert Medical Center, Mesa, AZ


INTRODUCTION: Institutions continue to struggle with screening, identification and bundle compliance of patient’s (Pt) with SS. Current literature focuses on pts presenting with SS. Those developing SS after ICU admission have not been adequately evaluated, but present an opportunity to improve SS mortality.

HYPOTHESIS: The objectives of this project in a 34 bed med/surg ICU were: 1) develop and assess a multidisciplinary SS management program using a remote ICU team (eICU); 2) assess the value of continued SS screening during ICU stay.

METHODS: Roles and responsibilities for screening, diagnosis and management of SS, metrics, and educational efforts were developed by clinicians in the ED, ICU and eICU. Collaborative partnerships were developed between the ICU, ED and eICU to optimize notification of pts with SS, and aid in compliance with the 6 and 24 Hr SS bundles. Additionally, the eICU screened all ICU pts every 2 hrs via a validated electronic screening prompt (SP - developed using a radial basis function kernel support vector machine algorithm generated from > 6,000 pts). Data was collected from 4/09 to 7/09.

RESULTS: 70 Pts (44 men/26 women, mean (SD) age 57.1 (17.4) yrs, mean APACHE II score 21.5 (6.0)) with 74 episodes of SS were included. Pts were identified in the following locations: ICU (38 pts 51.4%); ED (26 pts 35.1%); eICU 10 pts (13.5%). Overall, 46 episodes (62.2%) met the 6 Hr bundle (baseline rate= 35.3%)(P=0.005). Based on location of identification 50% of ED, 65.8% of ICU and 80% of eICU episodes met the 6 Hr bundle (NS). 45 (60.8%) cases occurred < 24 hrs of admission - 4 cases (9%) identified by the eICU. 29 cases were identified > 24 hrs following admission (mean 6.8 days) of which 6 (20.7%) were identified by the eICU. Of the 28 cases not meeting the 6 Hr SS bundle, 19 (67.8%) failed due to inappropriate bundle orders or unmet MAP, CVP or SvO2 goals. 10 Pts died (14.3%, 3 deaths were in the ICU, 1 pt remained in the hospital at 30 days).

CONCLUSIONS: A collaborative sepsis management program is effective and significantly improves 6 Hr bundle compliance. Centralized ongoing remote screening after admission via a SP improves identification of SS, and may contribute to improved bundle compliance. Addressing identified causes of noncompliance provides an opportunity for further improvement.
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 (Philips 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.
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

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 elICU® center. When patients were identified who met sepsis criteria they were then tracked for compliance with the sepsis bundle. The elICU 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

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 (Philips 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 (x2 = 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.
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.
A CONSULTATIVE TELEMEDICINE SERVICE IMPROVES COMPLIANCE WITH BEST PRACTICE GUIDELINES IN A HIGHLY STAFFED INTENSIVE CARE UNIT

Asad Latif, Mark Romig, The Johns Hopkins Medical Institutions; Peter Pronovost, Johns Hopkins University; Adam Sapirstein, Johns Hopkins School of Medicine

Crit Care Med. 2010:38 (12): 582

INTRODUCTION: Telemedicine in the intensive care unit (ICU) is in the nascent stages of its development and usage. Little is known about its potential to improve quality of care in the ICU environment.

HYPOTHESIS: A consultative ICU telemedicine service improves compliance with best care practices in a highly staffed ICU of an academic medical center.

METHODS: We conducted a prospective study over a 10 week period. Best practice measures were defined relating to mechanical and pharmacological deep venous thrombosis (DVT) prophylaxis, gastric and decubitus ulcer prophylaxis, and prophylaxis against ventilator associated pneumonias (VAP). Baseline rates were collected during the first 2 weeks of the study period. A remote, consultative ICU telemedicine service was then implemented using two-way audio-visual communication, existing electronic documentation and real-time physiologic monitoring. Staffing was by an intensivist and nurse between 7p-7a daily. Compliance with the best practice measures was checked and recommendations to improve observed deficiencies were made for the 8 week intervention period. Pre and post-intervention data was analyzed using the Chi-square test.

RESULTS: Baseline metrics were gathered for 125 patients pre- and 605 patients post-intervention. Compliance was defined as either adherence to best practice or presence of a therapeutic contraindication. Compliance improved for both mechanical (93.6% vs 98.2%; p<0.01) and pharmacological (80.8% vs 88.8%; p<0.05) DVT prophylaxis. Patients ventilated >24 hours were assessed for VAP prophylaxis. Compliance to sedation holidays (69.7% vs 85.5%; p<0.05) and regular oral care (69.7% vs 90.9%; p<0.01) significantly improved, while there was no improvement in daily spontaneous breathing trials (66.7% vs 77.6%; p>0.05). There were no differences in compliance for stress ulcer prophylaxis (86.4% vs 81.5%; p>0.05), regular repositioning for decubitus ulcer prophylaxis (85.6% vs 90.9%; p>0.05) or elevation of the head of the bed > 30 degrees (75.2% vs 73.6%; p>0.05).

CONCLUSIONS: A consultative ICU telemedicine service made clinically significant improvements in adherence with and documentation of best care practices in a highly staffed academic ICU.

* Abstract references alternative teleICU model
EFFECT OF A TELEMEDICINE FACILITATED PROGRAM ON ICU LENGTH OF STAY (LOS) AND FINANCIAL PERFORMANCE


INTRODUCTION: The cost of ICU care is mainly dependent on length of stay. Opportunities to improve high quality care while decreasing ICU LOS are constantly being sought.

HYPOTHESIS: An organized, multidisciplinary approach utilizing technology tools to patient (pt) evaluation and discharge can decrease ICU LOS.

METHODS: A multi-professional workgroup of remote and bedside administrative leadership and clinicians developed a LOS Management program for a 32 bed med/surg ICU. A detailed process of roles and responsibilities, metrics (financial, operational, quality, satisfaction), and educational efforts was developed. The eICU team reviewed each patient and an electronic discharge management tool (eDMT) daily to determine if Pts required continued ICU care.

CARE. The eDMT displays multiple clinical parameters relevant to ICU discharge. Pts not requiring continued ICU stay were discussed during scheduled briefings between the eICU-RN and the ICU Charge Nurse. Primary physicians were then approached regarding Pt discharge. Disagreements were escalated to the ICU Medical Director, who facilitated pt progression. Data from the study period

(01/20/09 – 06/30/09) was compared to baseline data (01/01/08 – 03/01/08). Hospital & ICU bed cost/day 2008=$683.67 & $1,673.53 2009=$717.59 & $1,743.16 respectively.

RESULTS: A 30% reduction in ICU LOS occurred in 6 months with an absolute reduction of 2 full ICU days. Actual hospital LOS also decreased. These improvements resulted in better patient throughput and a

CORRESPONDING DECREASE IN ICU AND HOSPITAL COST/PT OF 38.7% and 26.4% respectively. In 6 months, a total cost savings of almost $3 million was observed.

CONCLUSIONS: Implementation of a collaborative bedside/remote multi-disciplinary clinical program leveraging the technology and clinical contributions of the eICU program leads to significant improvement of ICU LOS with associated financial benefit.

<table>
<thead>
<tr>
<th></th>
<th>Baseline (01/08 to 03/08)</th>
<th>Q1 (01/09 to 03/09)</th>
<th>Q2 (04/09 to 06/09)</th>
</tr>
</thead>
<tbody>
<tr>
<td># Pts (SICU/MICU)</td>
<td>356</td>
<td>442 (123/319)</td>
<td>477 (133/344)</td>
</tr>
<tr>
<td>Mean APACHE IV (SD)</td>
<td>57.2</td>
<td>52.9 (22.2)</td>
<td>53.6 (22.5)</td>
</tr>
<tr>
<td>ICU LOS Actual/Predicted (Ratio)</td>
<td>6.63/3.94 (1.68)</td>
<td>5.35/3.74 (1.43)</td>
<td>4.62/3.8 (1.22)</td>
</tr>
<tr>
<td>Hospital LOS Actual/Predicted (Ratio)</td>
<td>13.74/11.21 (1.23)</td>
<td>11.45/11.22 (1.02)</td>
<td>11.51/11.17 (1.03)</td>
</tr>
<tr>
<td># Total Hospital Deaths</td>
<td>51 (14.3%)</td>
<td>64 (14.5%)</td>
<td>56 (11.7%)</td>
</tr>
<tr>
<td>ICU Cost/Pt</td>
<td>$11,096</td>
<td>$9,325.91</td>
<td>$6,806.00</td>
</tr>
<tr>
<td>Hospital Cost/Pt</td>
<td>$15,956.89</td>
<td>$13,703.21</td>
<td>$11,750.20</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td></td>
<td>$996,126.56 for Q1</td>
<td>$2,998,511 for Q 1 &amp; 2</td>
</tr>
</tbody>
</table>
IMPLEMENTATION OF A REMOTE INTENSIVE CARE UNIT MONITORING SYSTEM CORRELATES WITH IMPROVEMENTS IN PATIENT OUTCOMES

Gregory Howell, MD, Thomas Ardilles, MD* and Aaron J. Bonham, MS, University of Missouri-Kansas City, Kansas City, MO

PURPOSE: Improving Intensive Care Unit (ICU) outcomes and reducing costs in an era of intensivist shortage is challenging. Remote telemonitoring in ICU care is emerging as an alternative to providing on-site 24-hour intensivist coverage. Our institution implemented a remote telemonitoring system for intensive care units in 2005. We wished to evaluate the impact of this program in terms of patient outcomes.

METHODS: A before-and-after comparison of outcomes 1 year prior to remote telemonitoring implementation to two years after implementation in three tertiary hospital ICUs. We evaluated severity-adjusted ICU and hospital length of stay (LOS) and ICU and Hospital Mortality. APACHE III methodology was used for severity adjustment. ANOVA and Logistic regression were used to conduct analyses.

RESULTS: Data were available on 700 patients in 2004 (pre), and 1672 patients in 2006, and 2920 patients in 2007 (post). Severity-adjusted ICU LOS improved from 0.84 in 2004 to 0.56 in 2006 to -0.03 in 2007 (p<0.001). Severity-adjusted hospital length of stay also improved from 0.97 to 0.32 to -0.64 (p=0.001). This LOS reduction translated into 4772 saved ICU days and 6091 saved floor days. Additionally, we found a trend toward improved ICU mortality (p=0.159) and improved hospital mortality (p=0.214).

CONCLUSION: Remote teleintensivist care correlated with an improvement of severity-adjusted ICU and hospital length of stay. There was also a trend toward improved mortality.

CLINICAL IMPLICATIONS: Leveraging one intensivist across multiple ICUs by remote telemonitoring is a safe and effective strategy to provide around-the-clock care in an era of reduced intensivist supply. LOS reductions can reduce costs and increase throughput.

DISCLOSURE: Thomas Ardilles, Other Assistance with data abstraction provided by Philips VISICU; No Product/Research Disclosure Information.
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

INTRODUCTION: We have recently shown an improvement in mortality and length of stay after implementing eICU (Philips 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.
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%), 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.

CLINICAL AND FISCAL IMPACT OF A RURAL TELE-INTENSIVIST STAFFING PROGRAM ON TRANSFER OF PATIENTS FROM THEIR COMMUNITY TO A TERTIARY CARE HOSPITAL

Edward T Zawada, Pat Herr, Avera eICU CARE Program, Avera McKennan Hospital & University Health Center, Sioux Falls, SD; Lisa Lindgren, Emergency Department, Avera McKennan Hospital & University Health Center, Sioux Falls, SD


INTRODUCTION: We initiated a rural tele-intensivist staffing program September 2004 to share critical care 24-hour physician and nursing expertise over a 4-state area.

HYPOTHESIS: ICU telemedicine reduces costs to rural hospitals by reducing air transport to their affiliated tertiary hospital.

METHODS: We ascertained the number of patients transferred 6 months before vs after activation until December 2007.

RESULTS: The average cost for an air transfer from each site was used to calculate the amount saved for each rural site. The amounts vary according to distance from the tertiary hospital. In the first 21/2 years after activation, 160 patients were prevented from transfer to a tertiary hospital for a savings of $1,202,379 which exceeded the expenditure for the program of these sites by more than $500,000.

CONCLUSIONS: Remote tele-intensivist staffing is a cost effective program for rural hospital sites.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Total # of ICU Patients Since Activation</th>
<th># That Would Have Previously Transferred</th>
<th>Live Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estherville</td>
<td>36</td>
<td>5</td>
<td>02/2006</td>
</tr>
<tr>
<td>Flandreau</td>
<td>17</td>
<td>14</td>
<td>08/2006</td>
</tr>
<tr>
<td>Marshall</td>
<td>183</td>
<td>46</td>
<td>09/2005</td>
</tr>
<tr>
<td>O’Neill</td>
<td>35</td>
<td>10</td>
<td>10/2005</td>
</tr>
<tr>
<td>Parkston</td>
<td>34</td>
<td>17</td>
<td>08/2005</td>
</tr>
<tr>
<td>Sioux Center</td>
<td>7</td>
<td>2</td>
<td>07/2007</td>
</tr>
<tr>
<td>Spencer</td>
<td>74</td>
<td>62</td>
<td>03/2006</td>
</tr>
<tr>
<td>Tyndall</td>
<td>8</td>
<td>4</td>
<td>09/2006</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Cost Per Transfer</th>
<th>Total Amount Saved</th>
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<tbody>
<tr>
<td>Estherville</td>
<td>$9,296</td>
<td>$46,480</td>
</tr>
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<td>Flandreau</td>
<td>$5,697</td>
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<td>$8,234</td>
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<td>$129,999</td>
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<td>Spencer</td>
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<td>$532,456</td>
</tr>
<tr>
<td>Tyndall</td>
<td>$7,644</td>
<td>$30,576</td>
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</table>
ICU TELEMEDICINE IMPROVES CARE TO RURAL HOSPITALS REDUCING COSTLY TRANSPORTS

Edward T Zawada, Pat Herr, Avera eICU CARE Program, Avera McKennan Hospital & University Health Center, Sioux Falls, SD

INTRODUCTION: Rural areas of the U.S. represent 25% of the population but only 10% of physicians. This imbalance is particularly severe for critical care physicians. This study evaluates the impact of a critical care telemedicine program based in Sioux Falls SD to 3 small (<100 beds) and 8 critical access hospitals (<25 beds) across a four-state region.

HYPOTHESIS: Telemedicine can be used to deliver critical care services to small rural hospitals to improve outcomes and reduce transfers.

METHODS: A survey tool was used to evaluate the impact of our remote ICU telemedicine program (Philips VISICU). The survey was sent to 11 networked hospital administrators and lead clinical staff. These hospitals had been receiving remote critical care services for 3-20 months. The survey included questions about ease of system use, impact on care, impact on families and frequency of patient transfer. Surveys used a 5 point scale (strongly agree-5, agree-4, to strongly disagree-1); data are presented as % strongly agree or agree (affirmative) with upper and lower quartiles. An estimate of the number of patients not transferred (who previously were) and the cost of patient transport to the closest tertiary facility were also obtained.

RESULTS: 10 of 11 sites responded (91%). Hospitals responded affirmatively to questions about ease of system use (90%, 4-4.75), improved quality of patient care (90%, 4-5) and impact on families (90%, 4-5). Survey respondents estimated that 37.7% (range 10-80%) patients who previously were transferred to a tertiary hospital were now being cared for locally because of the remote critical care expertise. This represented 145 patients. Given the average patient transport costs of $5800-$10,800 this represents an estimated annual cost savings of $1.25 million.

CONCLUSIONS: Hospital administrators and clinicians agreed that telemedicine critical care service was easy to use, improved care to their patients and reduced the number of transfers to tertiary facilities.
INCREASED DOCUMENTATION OF ICD-9-CM CODES 995.92 AND 785.52 WITH TEMPLATE-ORIENTED MONITORING AND SCREENING BY A TELE-ICU


INTRODUCTION: Severe sepsis accounts for approximately 215,000 deaths, two percent of hospital admissions, and tens of billions of dollars in costs each year. ICD-9-CM Codes 995.92 and 785.52 are likely underreported which may reduce accuracy in sepsis mortality statistics and revenue to hospitals. This pilot study evaluated a Tele-ICU-based process that uses template-oriented monitoring, screening to facilitate documentation of severe sepsis and septic shock.

HYPOTHESIS: Tele-ICU-based, template-oriented monitoring and screening increases documentation of ICD-9-CM Codes 995.92 and 785.52.

METHODS: A template to guide physician documentation of severe sepsis and septic shock in the eICU® of the Sutter Sacramento-Sierra Region (SSR) was created. Education of physicians and nurses in the template-oriented monitoring and screening process began in January 2009. Pilot began on February 1, 2009. ICD-9-CM Codes 995.92 and 785.52 in the Midas® data base were used to assess documentation for the four hospitals in the SSR. Using Midas data and ICU admissions data from the VISICU APACHE® we determined documentation rates (coded ICU discharges per interval) of severe sepsis and septic shock and mortality. Two complete years of before-data were compared to one-half year of post-data Jan-June 2009. Statistical analysis using variant of the chi square test was used.

RESULTS: Reported incidence per ICU admission: ICD-9-CM 785.52: for 2007-2008: 846/16,359 (5.2%) and 2009: 297/4057 (7.3%) p-value 0.0001. ICD-9-CM 995.92 for 2007-2008: 473/16,359 (2.9%) and 2009: 202/4057 (5.0%) p-value 0.0001. Reported actual mortality: ICD-9-CM 785.52 for 2007-2008: 350/846 (41.4%) and 2009: 102/297 (34.3%) p-value 0.03. ICD-9-CM 995.92 for 2007-2008: 149/473 (31.5%) and 2009: 42/202 (20.8%) p-value 0.03.

CONCLUSIONS: These data suggest that a Tele-ICU-based process increases the documentation of severe sepsis and septic shock and reduces reported mortality rates. It is likely that DRG-based reimbursement to our hospitals will increase as a result of the increased documentation. Further research is needed to: 1. confirm quantitatively the impact on reimbursement. 2. confirm that the accuracy of documentation is improved, and 3. determine whether the reduction in mortality rates are related to improved treatment of sepsis associated with this process for monitoring, screening and documentation or other factors.
A CONSULTATIVE TELEMEDICINE SERVICE IMPROVES COMPLIANCE WITH BEST PRACTICE GUIDELINES IN A HIGHLY STAFFED INTENSIVE CARE UNIT

Mark Romig, Asad Latif, Peter Pronovost, Randeep Gill, Adam Sapirstein, Johns Hopkins School of Medicine

**INTRODUCTION:** Telemedicine use in the ICU is increasing in efforts to improve delivery of intensivist resources. Little is known about the attitudes and perceptions of bedside staff working in these systems.

**HYPOTHESIS:** The use of nocturnal ICU telemedicine service improves ICU culture, staff satisfaction, and perceptions of quality of care in a highly staffed university hospital.

**METHODS:** The study used a pre-post design with concurrent controls in an academic medical center with full time intensivist staffing. We surveyed ICU staff using a previously validated tool before deployment and following a two month program of ICU telemedicine. Surveys were concurrently administered in a control ICU and in the test ICU in which a telemedicine center provided consultative care between 19:00–07:00 daily. The responses of individuals to questions exploring perceptions of patient care, effectiveness of care, relations, communication, psychological working conditions, burnout, job satisfaction, intention to quit, and education were compared before implementation and after completion of the telemedicine program. Responses were measured using a five point Likert scale and results were analyzed using paired t testing.

**RESULTS:** Nurses in the intervention ICU (n=27) showed statistically significant improvement in the relations and communication score (2.99 ±1.13 pre-intervention vs. 3.27 ±1.27 post-intervention p<0.01), the psychological working conditions and burnout score (3.10 ±1.10 pre vs. 3.23 ±1.11 post p<0.02), and the education score (3.52 ±0.84 pre vs. 3.76±0.78 post p<0.03) while nurses in the control ICU (n=11) showed a significant decline in the patient care and perceived effectiveness score (3.94 ±0.80 pre vs. 3.48 ±0.86 post p<0.01) and the education score (3.95 ±0.39 pre vs. 3.50 ±0.80 post p<0.05). There were no significant changes in bedside intensivist attitudes.

**CONCLUSIONS:** The introduction of ICU telemedicine services in a highly staffed academic ICU was associated with an improvement in nursing perceptions of working conditions and communications while these perceptions decreased in a control ICU. Telemedicine has the potential to improve ICU staff satisfaction in highly staffed ICUs.

*Abstract references alternative teleICU model*
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


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.
RESIDENT PERCEPTIONS OF AN INTEGRATED REMOTE ICU MONITORING SYSTEM

Chris Coletti, Dan Elliott, Marc Zubrow, Internal Medicine, Christiana CareHealth System, Newark, DE

INTRODUCTION: Remote ICU monitoring (eICU®) allows trained intensivists to manage critical patients from an off-site location. In addition to addressing the shortage of intensivists, an integrated eICU may support resident education in settings without 24-hour on-site intensivist coverage. However, there is little information to determine the impact of eICU implementation in teaching hospitals.

HYPOTHESIS: To assess resident perceptions of a work flow re-design in which an integrated eICU provider received first call for patient-related issues in a medical ICU during the overnight period.

METHODS: We surveyed residents who rotated through the medical ICU at a 1,100 bed, tertiary care teaching hospital one year after the implementation of the work flow change. Each question was graded on a 5-point Likert scale (1=Strongly disagree, 2=Disagree 3=neutral 4=Agree 5=Strongly Agree).

RESULTS: Thirty-five of sixty residents completed the survey (58% response rate). Sixty-three percent of residents reported improved ability “to focus on urgent patient issues” and 51% reported the change increased their ability to “experience uninterrupted periods of rest.” Though most residents were neutral (51%), 37% agreed that the eICU was a valuable educational experience. Seventy-seven percent reported that the eICU integration was associated with improved patient safety. Overall, 69% thought that the change “demonstrated an innovative approach to critically ill patients.”

CONCLUSIONS: Our results indicate that a work flow change in which the remote intensivist handles all minor patient care issues overnight may allow residents to focus on critical patient issues, and increase needed sleep. Though residents perceive that this is associated with improved patient safety, the implications for resident education remain unknown.
RESIDENT PERCEPTION OF THE EDUCATIONAL AND PATIENT CARE VALUE FROM REMOTE TELemonIToRING 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


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 the Philips 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 intensivist, 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 Philips 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 Philips 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.
TRENDS IN BEST PRACTICE ADHERENCE IN A LARGE COHORT OF ICUS: 2005 – 2010

Omar Badawi, Michael Breslow, Philips VISICU, Haani Jaber, North Florida Regional Medical Center, Erkan Hassan, Philips VISICU

Crit Care Med. 2010;38(12):814

INTRODUCTION: Despite identification of multiple clinical practices known to improve ICU outcomes, little is known about the use of these therapies in routine practice. The uniform data structure in the >1M patient eICU® Program database allows for standardized reporting of adherence rates providing insight into use of these therapies in a large ICU cohort.

HYPOTHESIS: There is inconsistent use of ICU best practices, but increased prioritization has had a beneficial effect on usage over time.

METHODS: Retrospective, multi-center analysis of existing data in the eICU Program database. Explicit criteria were developed using evidence-based medicine (EBM) standards for the following metrics: % of patients (pts) at risk for VTE treated within (w/n) 24 hrs of admission; % of ventilated pts given stress ulcer prophylaxis (SUP) w/n 24 hrs; % of PRBC transfusions with a hgb < 7 g/dL in eligible pts; % of ABGs with a TV < 6.5 mL/kg (LTVV) in pts with ARDS or ALI. Each pt discharged between 2005 and 2010 was evaluated and adherence to each metric was reported at quarterly intervals to each eICU program and benchmarked against the entire eICU population. Negative binomial regression was used to assess trends in quarterly adherence.

RESULTS: 1,060,663 patients from 321 ICUs (195 hospitals) were analyzed. Annual patient counts were 57,251; 134,410; 194,819; 247,194; 273,978; 153,011 between 2005 and Q2 2010 respectively. Overall, 81.9% of 648,575 pts at risk for VTE were treated w/n 24 hrs with adherence increasing from 60.4% in 2005 to 91.7% in 2010 (p<0.001). 95.7% of 131,096 of at risk pts received SUP w/n 24 hrs, increasing from 92.5% to 96.5% (p=0.01). 9.9% of 153,683 PRBCs transfused were associated with a hgb < 7g/dL, increasing from 3.5% to 13.0% (p<.001). 23.9% of 3,791 ABGs indicated LTTV, increasing from 21.3% to 26.3% (p=0.051) between 2006 and 2010 (2005 data N/A).

CONCLUSIONS: This large ICU cohort demonstrates adherence to EBM has improved over time yet remains suboptimal for LTTV and restrictive transfusion strategies. Baseline adoption rates of EBM, presence of a tele-ICU, and/or quarterly measurement and reporting of compliance with internal and external benchmarking to peers may have contributed to this trend.
GREATER COLLABORATION BETWEEN REMOTE INTENSIVISTS AND ON-SITE CLINICIANS IMPROVES BEST PRACTICE COMPLIANCE

Omar Badawi, Philips 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.
ADOPTION RATE OF BLOOD TRANSFUSION EVIDENCE IN THE INTENSIVE CARE UNIT

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Chest. 2008 135: 60004s.

PURPOSE: Restrictive blood transfusion strategies improve outcomes in intensive care unit (ICU) patients yet the 2004 CRIT trial reported that while 44% of ICU patients receive transfusions, only <8% were at the recommended hemoglobin concentration (Hgb) <7g/dL. The objective of this study was to describe current transfusion practices and determine if adherence with guidelines has improved over time.

METHODS: We performed a retrospective multicenter analysis of quarterly ICU blood transfusion data from the eICU® Program Network database over 3 years (1/05 to 12/07). Patients with hemorrhage, trauma, acute coronary syndrome, burns or admission to a neurocritical care unit were excluded. A transfusion (defined as each unit of blood administered) was considered appropriate if the lowest Hgb in the 24 hrs preceding each transfusion was <7g/dL. The primary outcome was the percentage of appropriate transfusions. The secondary outcome was the trend in appropriate transfusions over time. A subgroup analysis compared transfusion practices between community and academic hospitals. Negative binomial regression was used to examine trends and Chi-square to compare groups.

RESULTS: 46,283 patients from 175 hospitals and 316 ICUs received 128,231 blood transfusions between 2005 and 2007. Of these transfusions, 11.8% were appropriate (Hgb <7g/dL) while 65.6% were associated with a Hgb <9g/dL. Between 1/05 and 12/07, appropriate transfusions increased at a rate of 5.9% per quarter (6.9% to 15.2%; p<0.0001). 15.2% of transfusions were appropriate in academic hospitals compared with 9.5% in community hospitals (p<0.0001).

CONCLUSION: Restrictive transfusion strategies are not widely followed, however, in this population adherence has more than doubled between 2005 and 2007. Transfusions administered in academic hospitals were more likely to be associated with a Hgb <7g/dL.

CLINICAL IMPLICATIONS: Adoption of guidelines is increasing but the majority of transfusions still occur with a Hgb >7g/dL. Further strategies are needed to reduce the number of transfusions associated with a Hgb >7g/dL in both academic and community hospitals.

DISCLOSURE: Jeannette Ploetz, Employee; Dr. Badawi: Philips VISICU employee; Dr. Rosenfeld: Philips VISICU employee; No Product/Research Disclosure Information.
USING ANNOTATED ELECTRONIC PATIENT DATA TO DEVELOP A PREDICTIVE MODEL FOR IDENTIFYING SEVERE SEPSIS.

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INTRODUCTION: Routine screening of ICU patients for severe sepsis (SS) with 2 SIRS criteria has low specificity and is labor intensive. As a result, many ICUs do not screen for SS proactively, but rely on clinical acumen alone. An automated screening tool with high sensitivity and specificity could facilitate earlier recognition and treatment of SS in ICU patients.

HYPOTHESIS: A predictive model for SS developed from annotated electronic patient data can perform with higher sensitivity and specificity than traditional screening criteria.

METHODS: Multi-center retrospective cohort study of consecutive ICU patients admitted to a large health system between 5/08 and 8/08. Manual screening of all patients was performed by the remote clinical team (eICU) using IHI criteria upon ICU admission, every 12 hrs if infected or every 3 days in all others. All positive screens were validated by an intensivist. Ten parameters of systemic inflammation were captured electronically from the EMR every 30 mins and annotated with manual screen results. Screened patients were randomized 1:1 into training and test sets for cross validation. Predictive models using logistic regression and radial basis function kernel support vector machine (SVM) learning generated area under the receiver operating curves (AUC) and specificity after setting sensitivity to 90%. Sensitivity and specificity were generated for 2 SIRS and 3 SIRS screening criteria.

RESULTS: 6,112 patients from 22 hospitals were screened, with 874 cases of SS identified. AUCs for the logistic regression and SVM models on the test set were 0.85 and 0.92 respectively.

CONCLUSIONS: A model with excellent discrimination for SS was developed from electronically captured physiologic data. Machine learning techniques generated the highest sensitivity and specificity. Use of this model in an electronic screening tool should improve the efficiency of SS screening in ICU patients. The impact of the screening tool on SS related outcomes requires prospective validation.
SEVERE SEPSIS (SS) IS UNDERREPORTED IN THE ICU

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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 ½ 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

<table>
<thead>
<tr>
<th>Organ Dysfunction</th>
<th>Percent of Patients in PCS Group*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic</td>
<td>53%</td>
</tr>
<tr>
<td>Cardiovascular/Shock</td>
<td>37%</td>
</tr>
<tr>
<td>Respiratory</td>
<td>22%</td>
</tr>
<tr>
<td>Lactic Acidosis</td>
<td>15%</td>
</tr>
</tbody>
</table>

* > 1 OD possible per patient
PREDICTING DEATH OR READMISSION WITHIN 48 HOURS OF ICU DISCHARGE.

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INTRODUCTION: Early discharge (d/c) from the ICU can lead to complications including ICU readmission or death. An effective decision support tool applicable to a broad ICU population has yet to be identified.

HYPOTHESIS: A d/c readiness index can predict the risk of ICU readmission or death within 48 hrs of ICU d/c.

METHODS: Retrospective, multi-center cohort exploratory study of ICU patients in the eICU Program Network database d/c’d between 1/1/05 and 12/31/07 with an APACHE III score. Exclusion criteria: DNR status on ICU d/c. Data evaluated included patient demographics, ICU admission diagnosis, APACHE III score and physiologic variables from the last 24 hrs of the ICU stay. A logistic regression model was created from the predictive variables identified by regression tree. The tree and logistic models were validated by bootstrap methods. Bias and model discrimination were assessed by measures of deviation of the bootstrap sample and c-index respectively.

RESULTS: 123,848 ICU stays met criteria with 3,888 of these resulting in death or readmission within 48 hrs of ICU d/c. Predictors included admission APACHE III score, admission diagnosis, age, and the lowest HR, average HR, lowest SBP, highest FiO2 and lowest SaO2 in the last 24 hrs. The logistic regression model produced a c-index of 0.71 (95% CI: 0.70-0.72) with a bias corrected c-index of 0.71 and a calibration slope of 0.99. When analyzed separately, the c-index for predicting death and readmission within 48 hrs was 0.89 (0.87-0.90) and 0.61 (0.60-0.62) respectively.

CONCLUSIONS: Age, APACHE III score, ICU admission diagnosis and cardio-respiratory physiologic variables present in the last 24 hours of the ICU stay are predictive of early post-discharge death or readmission. A logistic regression model using these variables showed moderate discrimination and excellent generalizability for the combined endpoint but very good discrimination for identifying death within 48 hrs of ICU d/c. Further analysis is required in order to create a clinical decision support tool that can assist with d/c readiness assessment.
ICU LENGTH OF STAY (LOS) OUTLIERS: INCIDENCE AND IMPLICATIONS

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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; I am an employee of Philips VISICU, Inc., a company that sells ICU software and services to hospitals.
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2009


2008


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Philips provides healthcare information technology and clinical solutions focused on transforming the delivery of critical care through its eICU Program. Through remote monitoring technology and clinical intelligence, experienced critical care resources are leveraged to provide enhanced intensivist coverage and early intervention – improving patient outcomes while reducing costs. Hospitals monitoring more than 350,000 patients annually have partnered with Philips to implement eICU programs.