

Clinical and Financial Evidence for Improving Quality and Efficiency in the ICU

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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. 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, presented over the last four years, 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 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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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 (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.

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

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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

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. UMMC, 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 UMMC, 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 UMMC 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 UMMC 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 UMMC 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 UMMC 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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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.

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

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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

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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.

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

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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

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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 (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

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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

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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 (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 ($x^2 = 28.98$, $p < 0.001$). 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.

IMPLEMENTATION OF A REMOTE INTENSIVE CARE UNIT MONITORING SYSTEM CORRELATES WITH IMPROVEMENTS IN PATIENT OUTCOMES

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Chest. 2008; 134:s58003.

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

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Crit Care Med. 2007;35(12):A26.

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%), 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.

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

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Crit Care Med. 2008;36(12):A86.

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 2 1/2 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 1

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

Table 2

Hospital	Cost Per Transfer	Total Amount Saved
Estherville	\$9,296	\$46,480
Flandreau	\$5,697	\$79,758
Marshall	\$8,234	\$378,764
O'Neill	\$10,889	\$108,890
Parkston	\$7,647	\$129,999
Sioux Center	\$6,228	\$12,456
Spencer	\$8,588	\$532,456
Tyndall	\$7,644	\$30,576

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

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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 (Philips 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

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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

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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

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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

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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 PERCEPTIONS OF AN INTEGRATED REMOTE ICU MONITORING SYSTEM

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Crit Care Med. 2008; 36(12): A71.

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

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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 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

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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 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.

DELIVERING INTENSIVIST SERVICES TO PATIENTS IN MULTIPLE STATES USING TELEMEDICINE

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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 Philips 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.

ICU TELEMEDICINE IMPROVES CARE TO RURAL HOSPITALS REDUCING COSTLY TRANSPORTS

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Crit Care Med. 2008; 36(12): A172.

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.

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 >7 g/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.

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 $\frac{1}{2}$ 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

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

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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.

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

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

DOES BETTER CARE MEAN SHORTER LENGTH OF STAY?

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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?

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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.

eICU PROGRAM PUBLISHED ABSTRACTS

2008

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