International comparisons of selected service lines in seven health systems

ANNEX 14 – CASE STUDIES: eICU UNITS IN THE USA

Evidence Report

October 27th, 2014

eICU – why this case study?

Why this case study?

- The eICU model may provide an opportunity to improve quality and efficiency of critical care:
  - Lower length of stay on the critical care unit and lower overall length of hospital stay
  - Reduction in rates of complications and mortality
  - Opportunity to share senior clinician workforce across multiple sites
  - Opportunity to support critical care beds in locations where 24/7 consultant coverage may not be available

Potential impact on costs

- Lower length of stay in critical care should reduce costs for providers and provide a basis for reduced spend by commissioners (as critical care is subject to local price negotiations)
- With agreement from standards-setting bodies, 24/7 consultant-level intensivist coverage within the critical care unit could be provided off-site from a central ICU hub which would lower workforce costs (and recruitment challenges) for individual critical care units as costs (and recruitment) would be shared with other sites/Trusts

Issues of comparability

- The eICU model has been tried most extensively in the US and most of the evidence on its use is based on US studies
- The US model of critical care (without eICU) is different to the NHS with lower levels of consultant-level coverage at night in many units
- Hospital chains and affiliated networks of hospitals are more common in the US than in the NHS, and this may make eICU easier to implement

Potential impact on quality

- It is difficult to make comparisons to the NHS without detailed information on outcomes in NHS critical care units, but studies in the US suggest that eICU can reduce rates of critical care-related complications and mortality through enhanced levels of monitoring (both automated monitoring and senior clinician oversight) of biomedical signs and adherence to protocols, as compared to ICUs without 24/7 on-site consultant intensivist cover

Executive summary

- Telemedicine technology ("eICU") to support the delivery of intensive care through remote monitoring and tele-consultations has been in use in the US for over 25 years, in many different health systems. In contrast, while some NHS Trusts have already installed and use eICU technology to support the management of their ICU units (predominantly within a single organisation), the use of eICU technology is very limited

- The technology of eICU provides three core functions:
  - Bi-directional video and audio link between hub and spoke sites
  - Continuous monitoring of a wide range of critical care indicators with automated alarm systems and decision-support tools when indicators reach specified risk levels
  - Range of performance management tools

- Support from the eICU hub is supplemental to "on site" staffing (an extra pair of eyes) – and in the US is predominantly used to provide consultant-level Intensivist coverage overnight when the critical care unit would historically (prior to the implementation of eICU) been staffed by specialist critical care nurses and on call physicians, but not dedicated Intensivists. In some systems, critical care clinicians rotate between hub and spoke sites. When based in the eICU hub, they would monitor patients and supervise care remotely; in the spoke sites they would be delivering care to patients directly at the bedside.

- Research suggests that eICUs can improve quality (mortality, discharge to home, complication rates, adherence to protocols) and efficiency (reduced length of stay), compared to usual ICU care, when implemented with high levels of clinician engagement and as part of quality-focused programme. There is no clear evidence for improved outcomes (vs usual ICU care) if engagement and participation is lower[1]

1 Kahn JM, The use and misuse of ICU telemedicine, JAMA, 2011, 305 (21), 2227-2228

Contents

- **Impact – why this case study?**
- Description – what did they do?
- Enablers – how were they able to do this?

The impact of eICU has been measured in clinical trials compared to closed-model intensivist-led ICU (1/4)

Study design

- Prospective, unblinded, stepped-wedge study of 6,290 adults admitted to any of 7 ICUs located on 2 campus sites on a 834-bed teaching hospital between April 2005 and September 2007
  - 3 medical ICUs
  - 3 surgical ICUs
  - 1 cardiovascular ICU
- Intervention group (n = 4761): all adults admitted to an ICU bed post-implementation of tele-ICU during the study period (implementation of tele-ICU was staggered and occurred between July 2006 and April 2007 for each of the 7 units) except patients under 18 years and those admitted to a pre- and post-intervention unit during the same hospital stay
- Control group (n = 1529): representative sample of pre-intervention cases identified from consecutive hospital discharge cases from an administrative database used to record cases in each of the ICUs
- In this study, all structural elements of the ICU except the tele-ICU intervention itself were established prior to study enrollment:
  - Critical care governance model
  - Team structure and staffing model (intensivist-led closed model)
  - Call schedules
  - Interdisciplinary ward rounds

Results

- Outcomes measured:
  - Case-mix and severity adjusted hospital mortality
  - Hospital and ICU length of stay
  - Adherence to best practice protocols
  - Critical care related complications
- Results:
  - 11.8% (95% CI: 10.9%-12.8%) in the tele-ICU group compared to 13.6% (95% CI: 11.9%-15.4%) in the pre-intervention group. Adjusted odds ratio of 0.40 (95% CI: 0.31-0.52)
  - Shorter length of stay: 9.8 days vs 13.3 days for tele-ICU group compared to pre-intervention group
  - Similar results for medical, surgical and cardiovascular ICUs

Note on interpretation of results:

- In this study, full participation in the eICU was actively encouraged and supported across all sites, and eICU technology was used to monitor adherence to best practice clinical processes. Equivalent benefits have not been consistently found in programmes without these element.[1]

1 Kahn JM, The use and misuse of ICU telemedicine, JAMA, 2011, 305 (21), 2227-2228

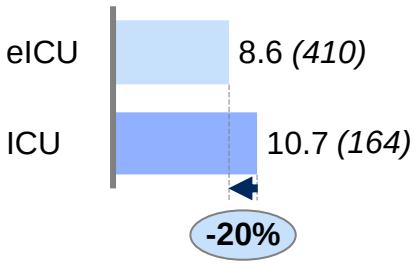
SOURCE: Lilly et al, Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes, JAMA, 2011, Vol 305 (21), 2175-83

eICU can lead to lower mortality rates and ALOS when implemented well (2/4)

eICU (n = 4,761)
ICU[3] (n = 1,529)

Impact on mortality

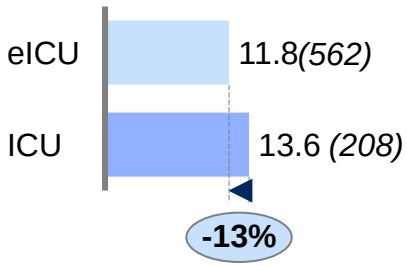
ICU mortality rate
% (*n*)



Adjusted OR
(95% CI)[1]
0.37 (0.31-0.52)

P value
0.005

Hospital mortality rate
% (*n*)

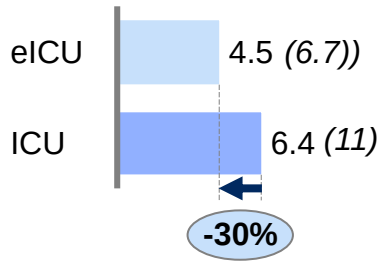


Adjusted OR
(95% CI)[1]
0.40 (0.31-0.52)

P value
0.003

Impact on average length of stay

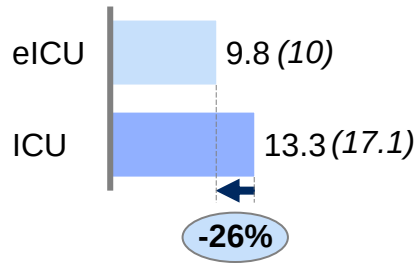
ICU average (mean) length of stay
Days (*Standard Deviation*)



Adjusted HR
(95% CI)[2]
1.26 (1.17-1.36)

P value
<0.001

Hospital average (mean) length of stay
Days (*Standard Deviation*)



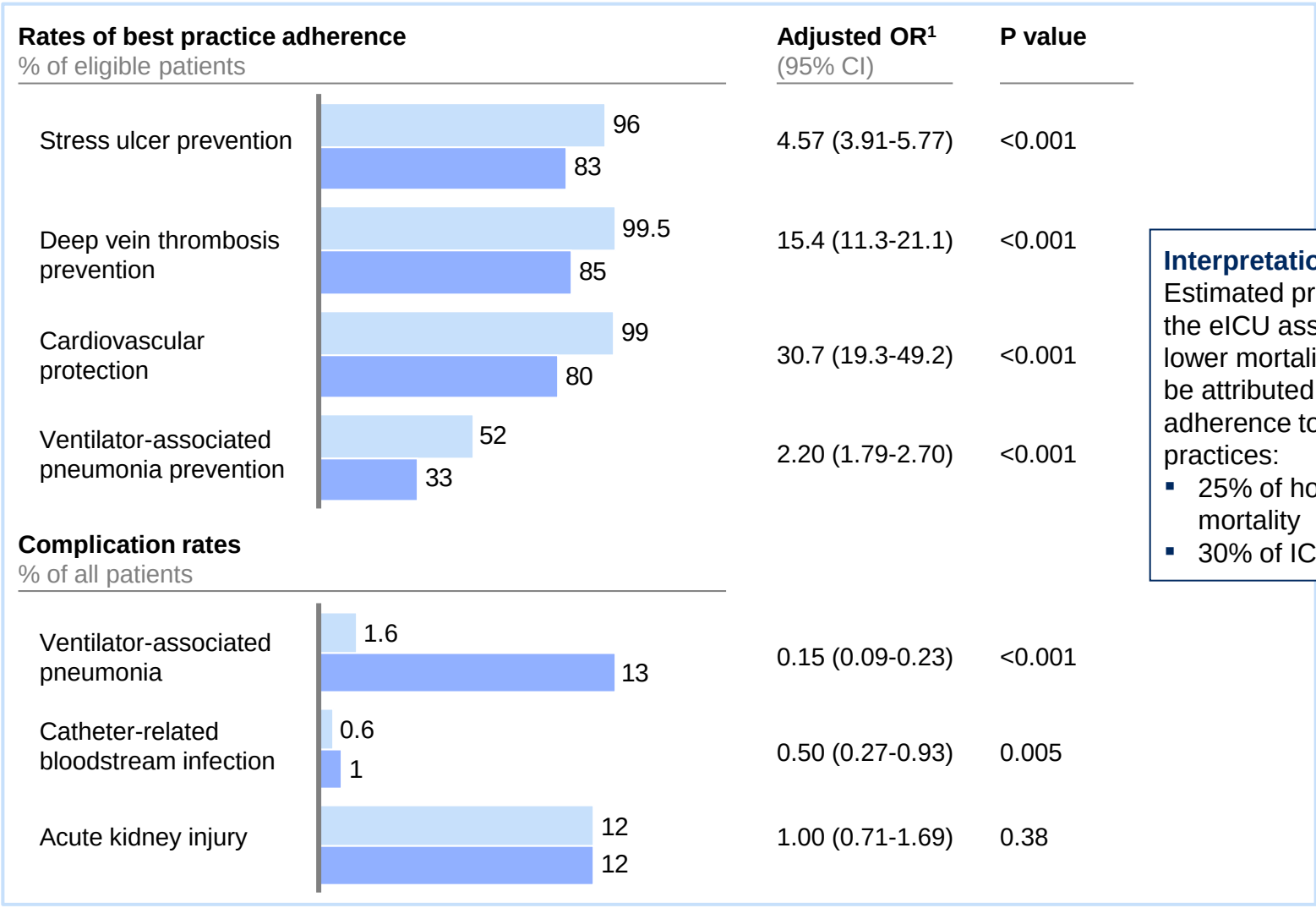
Adjusted HR
(95% CI)[2]
1.44 (1.33-1.56)

P value
<0.001

1 Effect estimate (Odds Ratio) adjusted for differences in acuity score, admission source, admission ICU, and other predictive factors.
2 Effect estimate (Hazard Ratio) adjusted for differences in acuity score, admission source, admission ICU, and other predictive factors.
3 Control group based on "before" data from the same ICUs in the intervention group but prior to implementation of the eICU program

SOURCE: Lilly et al, Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes, JAMA, 2011, Vol 305 (21), 2175-83

eICU can improve adherence to best practice protocols and reduce complication rates in critical care patients (3/4)



Interpretation

Estimated proportion of the eICU association with lower mortality that could be attributed to adherence to these best practices:

- 25% of hospital mortality
- 30% of ICU mortality

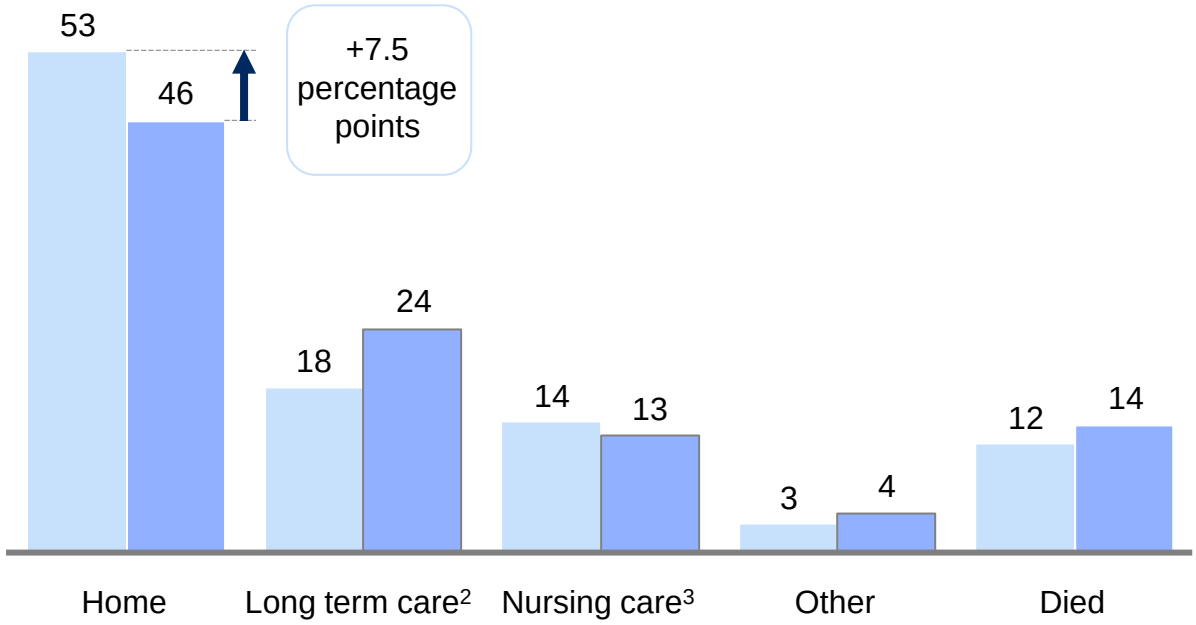
1 Effect estimate (Odds Ratio) adjusted for differences in acuity score, admission source, admission ICU, and other predictive factors.
2 Control group based on "before" data from the same ICUs in the intervention group but prior to implementation of the eICU program

SOURCE: Lilly et al, Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes, JAMA, 2011, Vol 305 (21), 2175-83

Patients treated in the eICU are more likely to be discharged to their own home than standard ICU patients (4/4)

eICU (n = 4,761)
ICU[1] (n = 1,529)

Location of care after hospital discharge
% of patients (# of patients)



Note: For each comparison, the p value was <0.001
1 Control group based on "before" data from the same ICUs in the intervention group but prior to implementation of the eICU program
2 Long term care or rehabilitation facility
3 Defined as "skilled nursing facility" in the US

SOURCE: Lilly et al, Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes, JAMA, 2011, Vol 305 (21), 2175-83

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eICU technology has been in use in the USA for more than two decades with around 40 eICU networks currently in operation

- The eICU program leverages technology to **clinically transform the ICU**, using a proactive care model that allows care providers to do more
- An eICU control center can **provide care to patients in multiple hospitals** using two-way cameras, video monitors, microphones, and smart alarms connected by high speed data lines
- Typically, the eICU control center will include one physician, one nurse, and one data clerk per 70 beds

History and reach

25	**Years since eICUs** were first developed
40	**Hospital networks** have implemented an eICU program
350	**Hospitals** where an eICU program is implemented
4000+	**Miles separating one particular eICU centre** from its closest monitored hospital
400,000	**Patients receiving care** through an eICU each year

SOURCE: Philips; Kahn JM, The use and misuse of ICU telemedicine, JAMA, 2011, 305 (21), 2227-2228

Sutter Health's e-ICU networks in Northern California

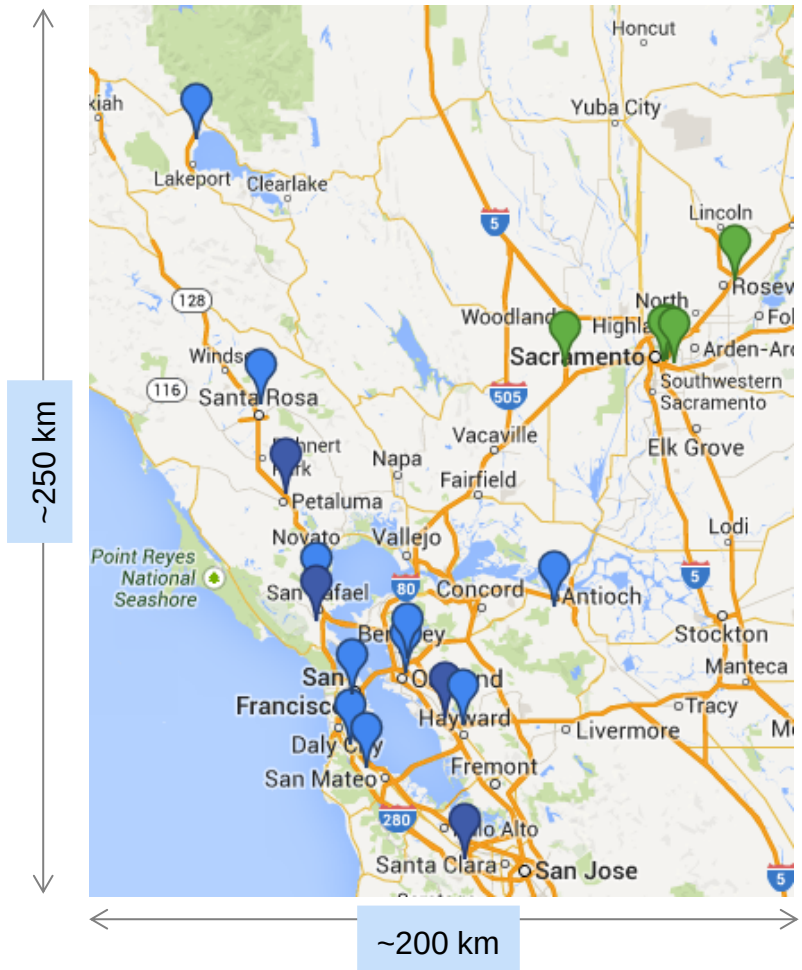
Overview of the Sutter's eICU network

- Operational since 2003 in Sacramento and since 2005 in the Bay Area
- Sacramento area eICU connects 5 Sutter hospital sites
- Bay Area eICU connects 15 hospital sites:
  - Acute hospitals in the Sutter network (11 sites)
  - Non-Sutter affiliate hospitals (4 sites)
  - 404 critical care beds in the eICU network
  - 272 average daily eICU patient census
  - eICU network encompasses 57 Critical Care Nurses and 49 MDs
- The programme continues to expand with three rural hospitals joining the network in 2014

Staffing model

- Staffing in the eICU hub:
  - ≥2 Board-certified (equivalent to consultant level) Intensivists on duty each night from 4pm to 7am[1]
  - 24/7 staffing by registered Critical Care Nurses
- Staffing in spoke sites:
  - Varies by hospital
  - Typically, consultant Intensivist (plus other ICU admitting specialties) presence during the day and registered Critical Care Nurses plus physicians on call at night

Map of hospital locations in the eICU system



1 Other networks have different hours of operation adapted to meet the staffing models in the spoke units (e.g. 7pm-7am in Geisinger)

SOURCE: Sutter Health

There are different options for how to share responsibility for care delivery and decision-making between hub and spoke sites

Category 1
Higher level of on-site physician responsibility

- The on-site responsible physician takes initial calls for all issues, regardless of time of day
- For urgent or emergent situations, the eICU physician would start an indicated intervention and contact the local responsible physician to discuss the patients change in condition

Category 2
Higher level of eICU physician responsibility

- The eICU physician:
  - Takes calls for issues as they arise
  - Maintains current care plan (determined by on site physician)
  - Initiates new therapy (as needed)
- The on-site responsible physician is consulted on clinical issues which dictate significant shift in management plans as they arise

Alternative options

- Health systems take different approaches to joint management of patients in the eICU
- Some systems use up to four distinct categories to differentiate levels of eICU involvement
- Some health systems (usually those with multiple sites but a single organisational structure) take a single, unified approach to all eICU patients

Cross-category elements

- On site clinicians are responsible for care-giving and interactions with the family; eICU clinicians provide cognitive support
- The attending physician is always the ultimate authority for all clinical decisions; differences of opinion (between eICU and attending physician) should be discussed, and if agreement is not reached, the eICU physician may document their concerns[1]
- The on site physician selects the preferred category of management
- The on site physician is responsible for developing and driving the care plan
- The eICU physician has privileges at participating hospitals giving them the right to prescribe treatment, add to patient notes, and input data to patient charts
- All staff work in accordance with JCAHO (The Joint Commission) and Leapfrog guidelines including twice daily (morning and evening shift changes) verbal and written patient hand-overs in which both eICU and on site physicians participate
- Patient confidentiality, privacy and data security processes follow HIPAA guidelines

1 Confidential record for review by the Hospital Quality Review Committee

SOURCE: Sutter Health; Geisinger Health System; Kahn JM, The use and misuse of ICU telemedicine,JAMA, 2011, 305 (21), 2227-8

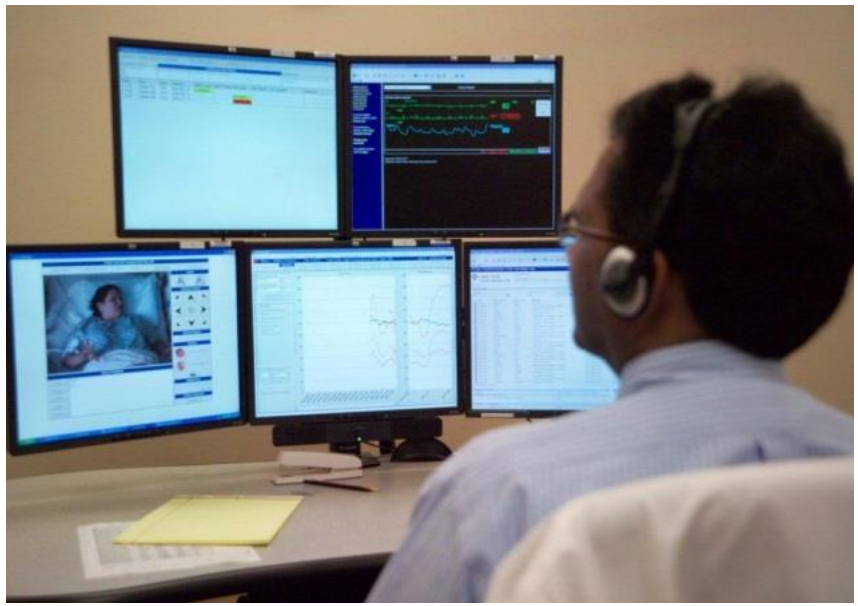
eICU technology supports tele-consultations as well as continuous automated monitoring

ILLUSTRATIVE[1]

Video
- Bi-directional full motion video and audio (of patient area and eICU physician) allows:
  - Visual examination
  - Tele-consultation
- Camera and micro-phone communication system activated on request:
  - Scheduled eICU ward round
  - When clinical data indicates a potential problem
- On site camera and microphone have clear indicators to show if they are on/off
- There is no audio or visual recording facility

Radiology images
- Integrated PACS system (digital images)

eICU hub workstation



Embedded risk stratification and prediction tools
- Based on APACHE IV methodology
- Reports observed versus expected outcomes relative to national benchmarks

Automated performance monitoring – including:
- ICU ALOS over time
- ICU mortality over time

Automated alerts and decision support tools
- Based on continuous monitoring of selected risk indicators and algorithms:
  - Vent bundles
  - Severe sepsis
  - Low tidal volume for ALI/ARDS[2]
  - Glucose control
  - MI[3] protocol

Real time audits
- Adherence to established best practice protocols
- Care plan reviews for patients admitted at night
- Monitoring of bedside clinician responses to in-room alarms - and intervention when responses delayed and data indicates that the patient is unstable

1 Design and functionality can be tailored to individual system needs and preferences 2 Acute Lung Injury/Acute Respiratory Distress Syndrome 3 Myocardial Infarction

SOURCE: Sutter Health; Geisinger Health System; Kahn JM, The use and misuse of ICU telemedicine,JAMA, 2011, 305 (21), 2227-8; Lilly et al, Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes, JAMA, 2011, Vol 305 (21), 2175-83

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Successful implementation of an eICU network requires more than a single investment in technology

Investment in technology

- eICU systems require capital investment in software, technology and systems support and training
- Some NHS Trusts have already invested in eICU technology – but thus far we are not aware of any cross-Trust (or cross-site) networked implementation[1]

Physician engagement

- Physician engagement is critical to successful implementation, to ensure acceptance of eICU hub supported care and willingness to allow eICU to take (desired level of) responsibility for patient care
- Health systems that have made greater efforts to engage physicians in the eICU concept have reported better outcomes than those with voluntary participations and more limited engagement efforts[2]

Shared network and governance arrangements

- There is no single, established model for cross-site governance, but clearly all sites participating in an eICU network need to have clear protocols and agreements defining approach to shared responsibility
- Some systems, rotate eICU staff between hub and spoke sites, which may enhance implementation (but requires additional levels of collaboration)

Aligned standards

- Most eICU spoke sites do not provide consultant-level on site intensivist cover at night (but rely on the eICU hub to provide this). Consequently, standards in place need to recognise remote working as an acceptable way to deliver expertise

1 See for example: http://www.guysandstthomas.nhs.uk/news-and-events/2013-news/20130703-eICU.aspx
2 Kahn JM, The use and misuse of ICU telemedicine, JAMA, 2011, 305 (21), 2227-2228