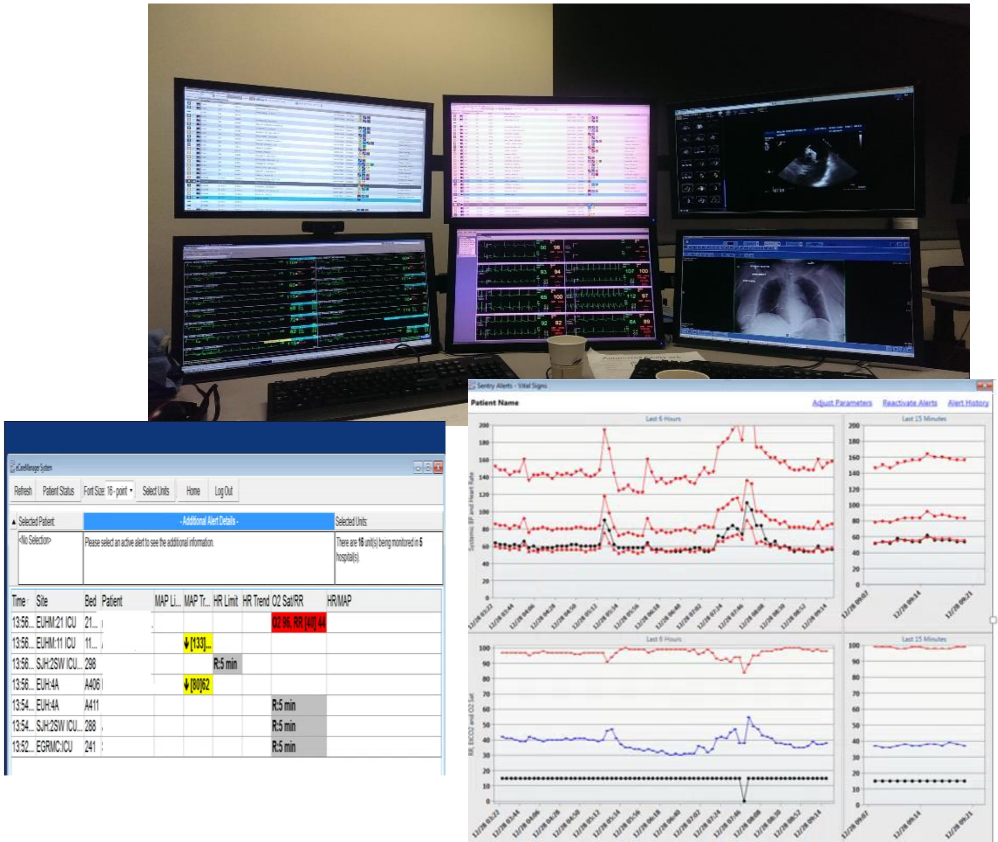
New healthcare delivery models:
Interprofessional, regional, international



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10 Nov 2017

Disclosures: None

Disclosure/Disclaimer

- Neither speaker has financial interests or other conflicts relevant to this talk
  - Dr. Buchman is Editor-in-Chief of ***Critical Care Medicine*** and also serves as an advisor to the not-for-profit James S. McDonnell Foundation, a grantmaking philanthropy, www.jsmf.org
- All opinions are personal and do not represent those of Emory, SCCM, CMS, or ***Critical Care Medicine***

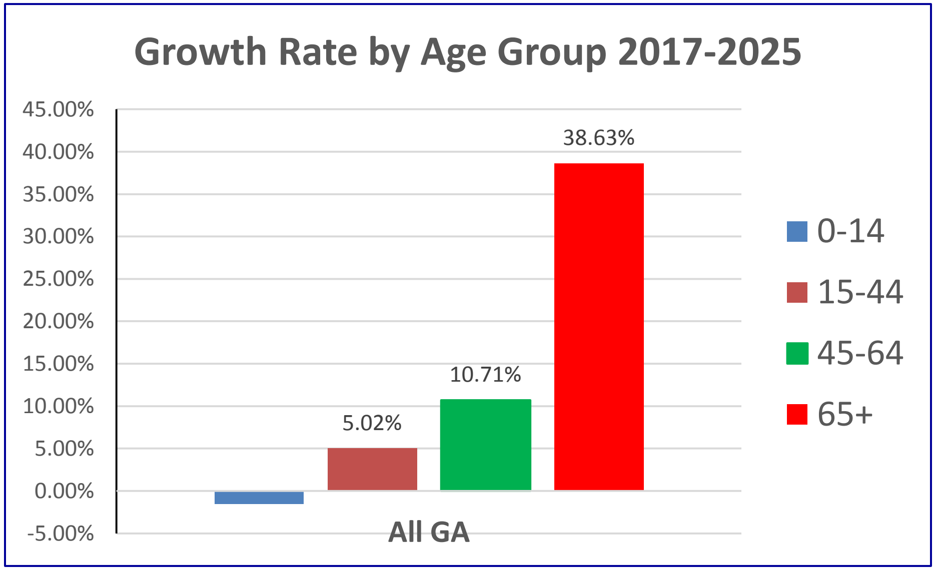
Talk Map

- Why eICU
- Outcomes based on recent research/Emory outcomes
- The International Experience
- What has been learned
- What remains uncertain
- Where are we going….

Georgia's needs growing much faster than provider supply

Patient Population

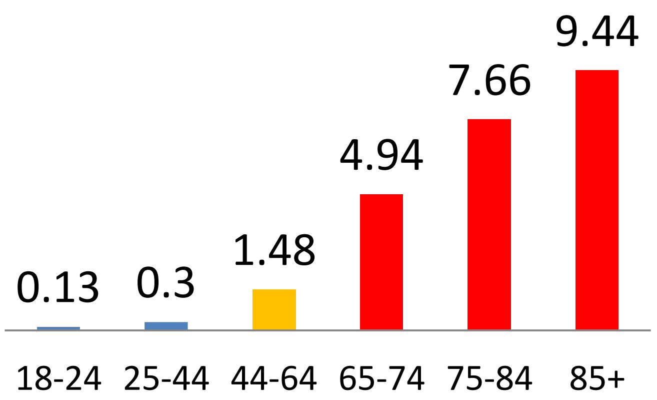
The "Over 65's" projected to increase by 39% in the next 8 years



Physician Demand

CCM MDs needed /100,000 population:

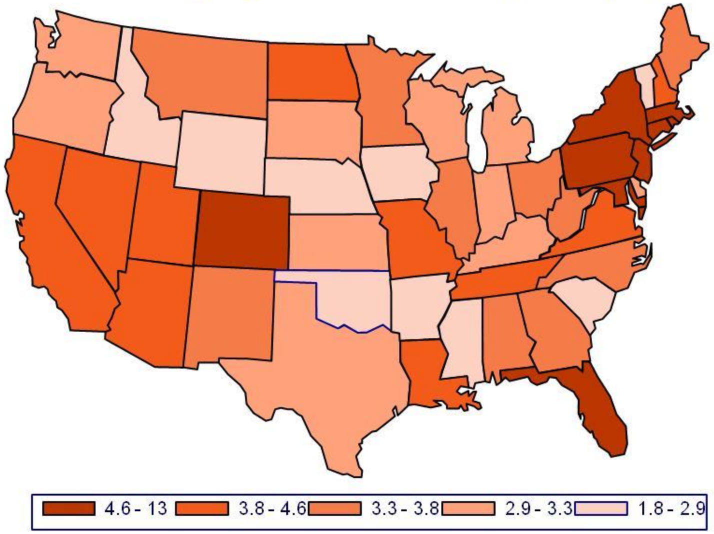
Older Georgians require <u>much</u> more CCM service



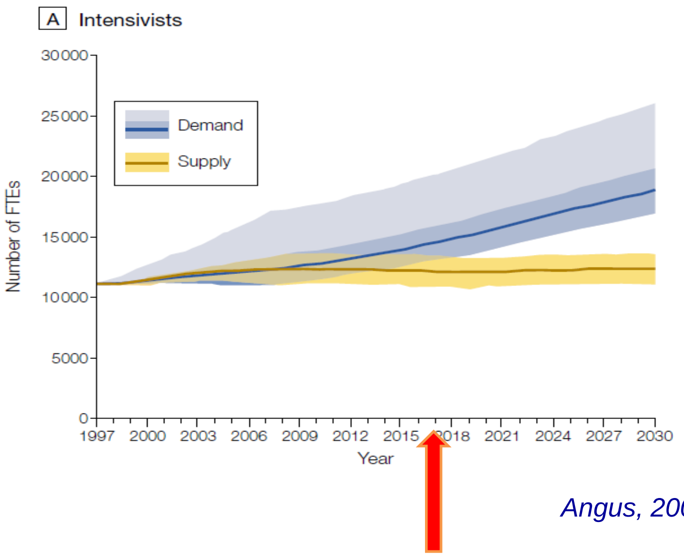
HRSA, 2006

Physician Gap

Number of CCM physicians / 100,000 population



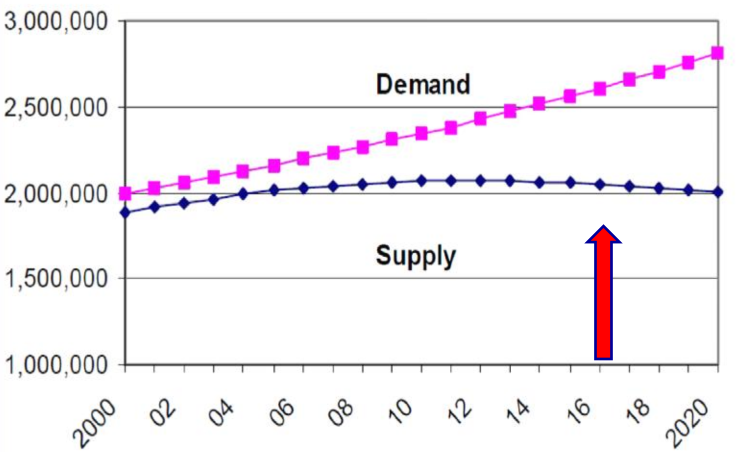
AMA Masterfile



Angus, 2000

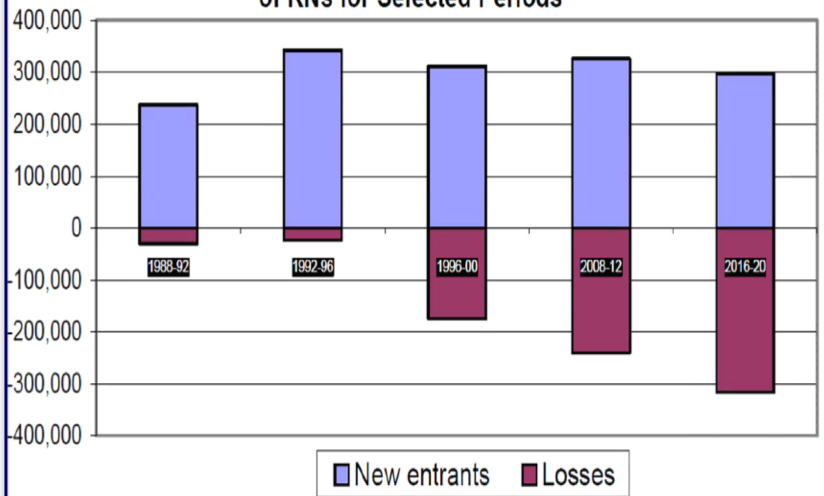
Nursing Gap

Chart 1: National Supply and Demand Projections for FTE Registered Nurses: 2000 to 2020



Source: Bureau of Health Professions, RN Supply and Demand Projections

Chart 5: New Entrants and Losses From the Licensed Pool of RNs for Selected Periods



Source: Bureau of Health Professions, RN Sample Surveys and supply projections.

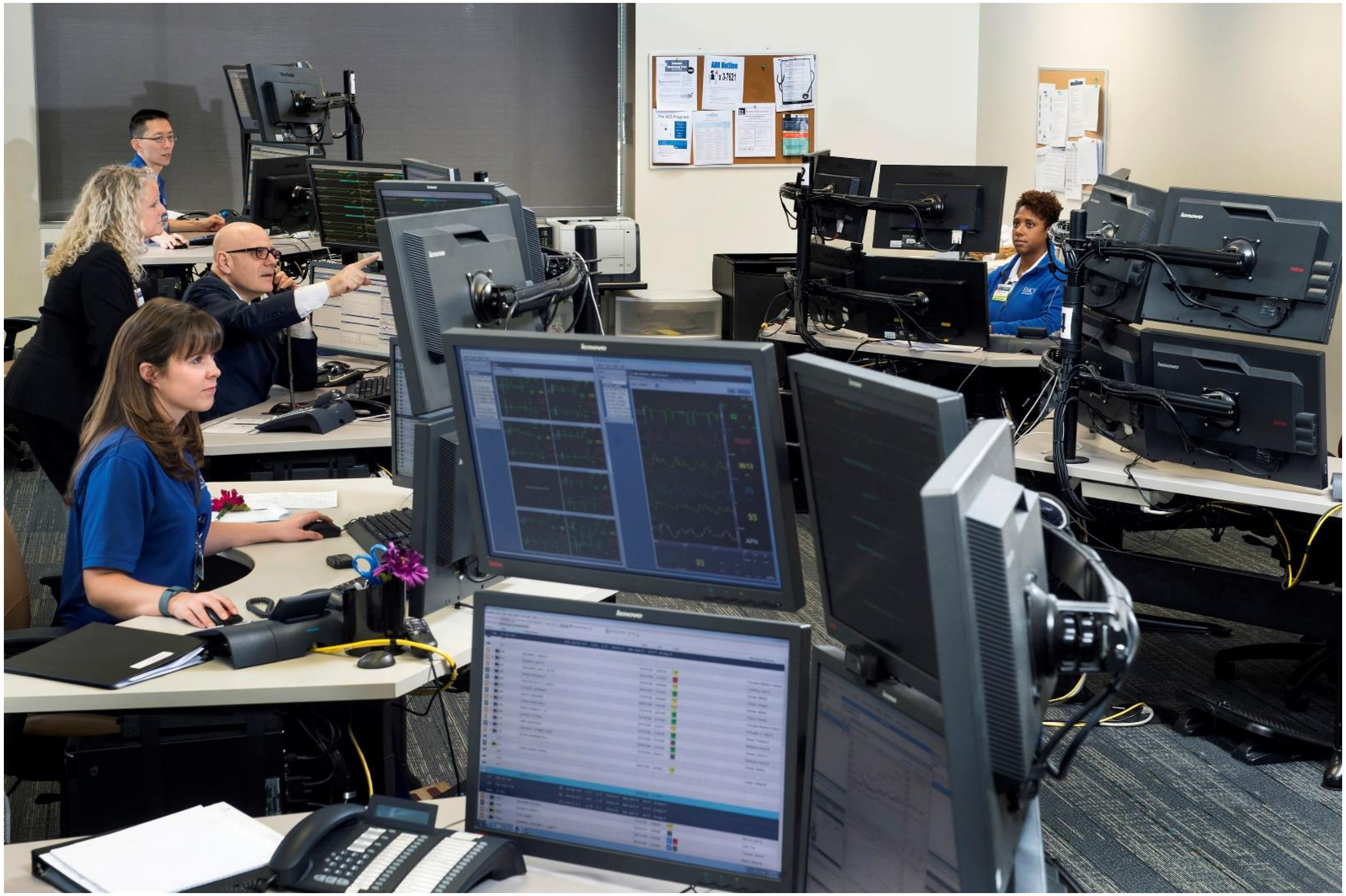
Here we are…

Up to 30% of inpatient hospital costs on <15% of the beds, lots of machines, but where are the clinicians?…

Bring Expertise to the bedside

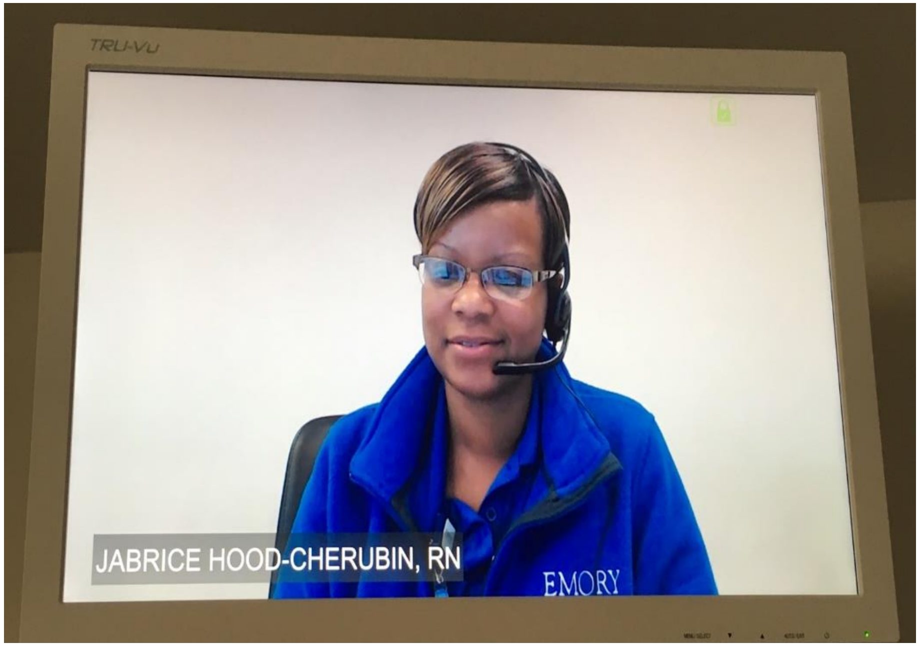
The Emory Program:
eRNs: 24 x 7 x 365
eMDs: nights weekends and holidays

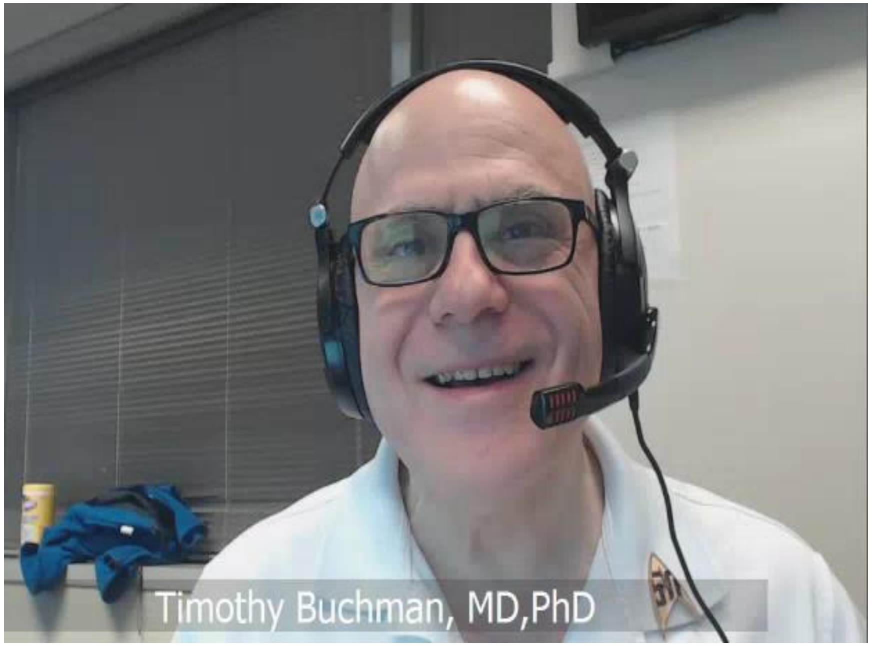
Industry standard convergent eICU platform
Multiple EMR, physiologic monitors
16 locations, 136 beds in 5 hospitals
(2 university, 1 hybrid, 2 community)



In Room Equipment

Bidirectional Audio Visual Capability



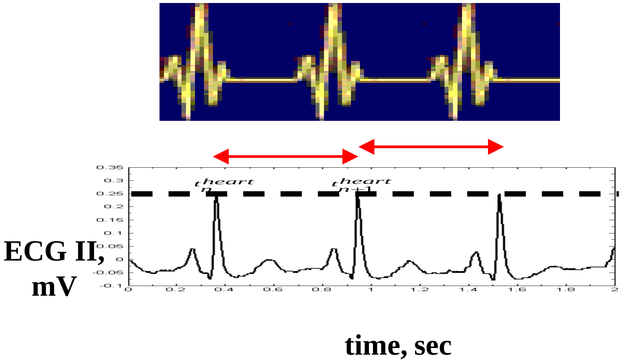


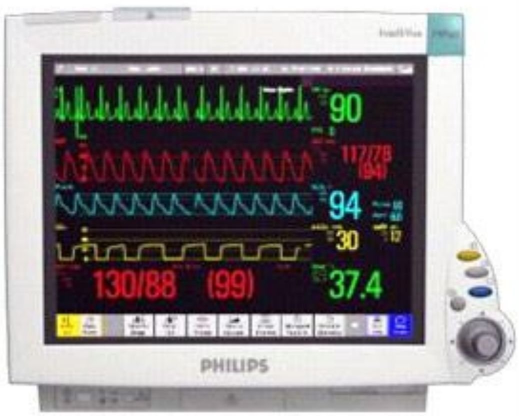
What we see:
"Air Traffic Control for the ICU"

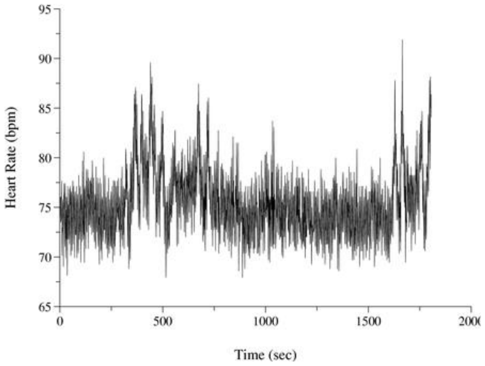
SAFETY OFFICER

Detecting state at the bedside: what needs to be done

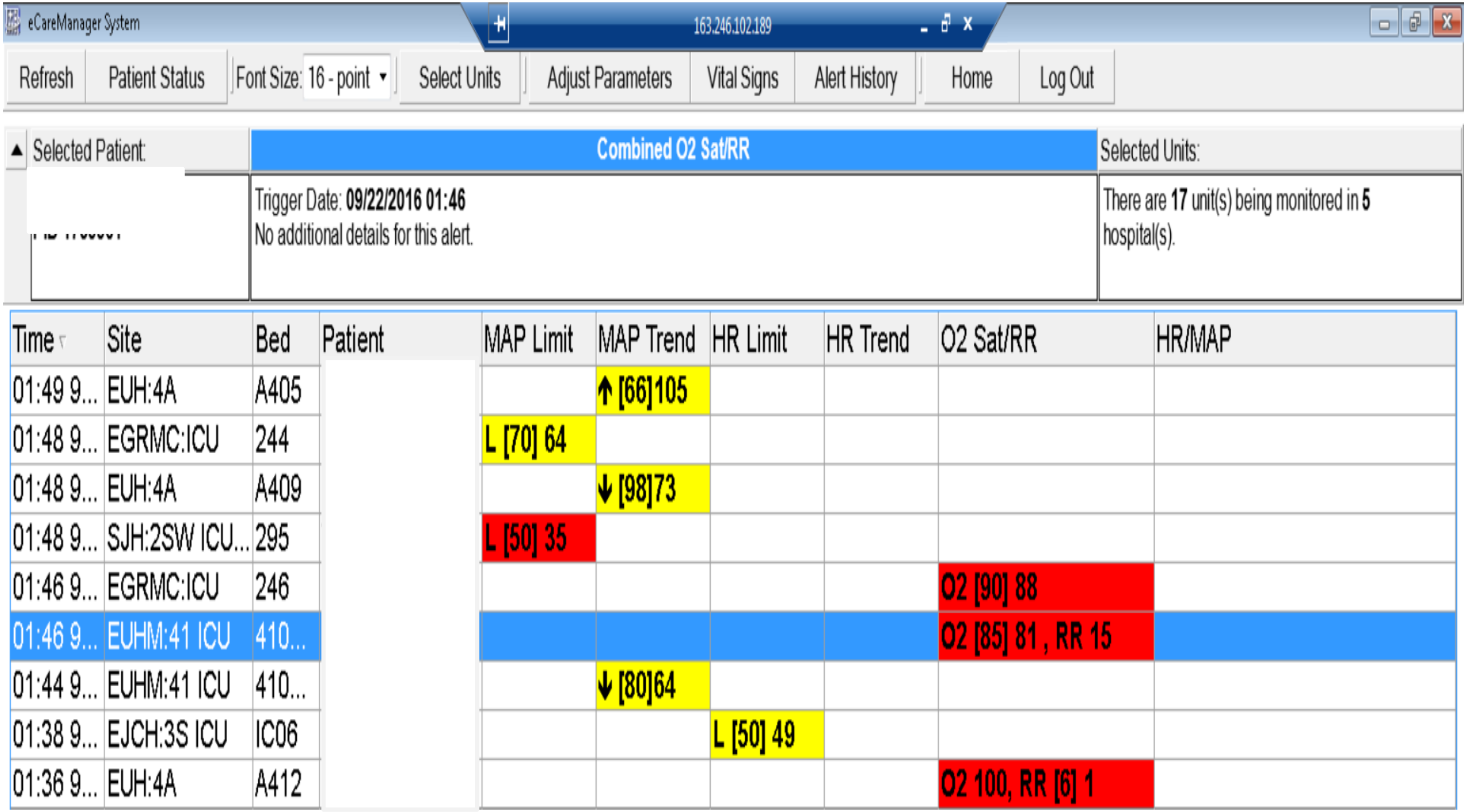
- Physiologic time series
  - Heart (EKG)
  - Vasculature (Blood Pressure)
  - Lungs (CO_2)
  - Brain (EEG)
  - …



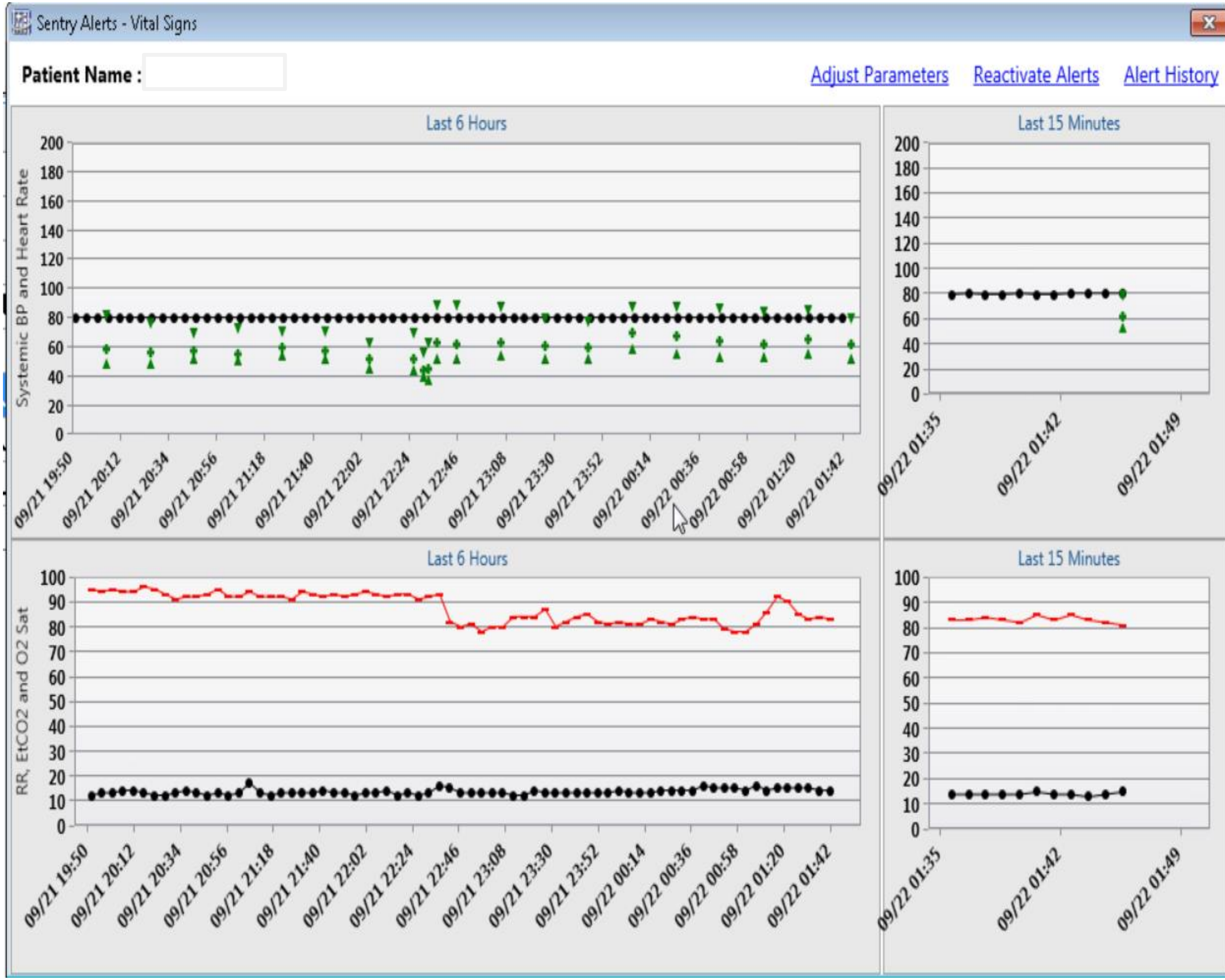




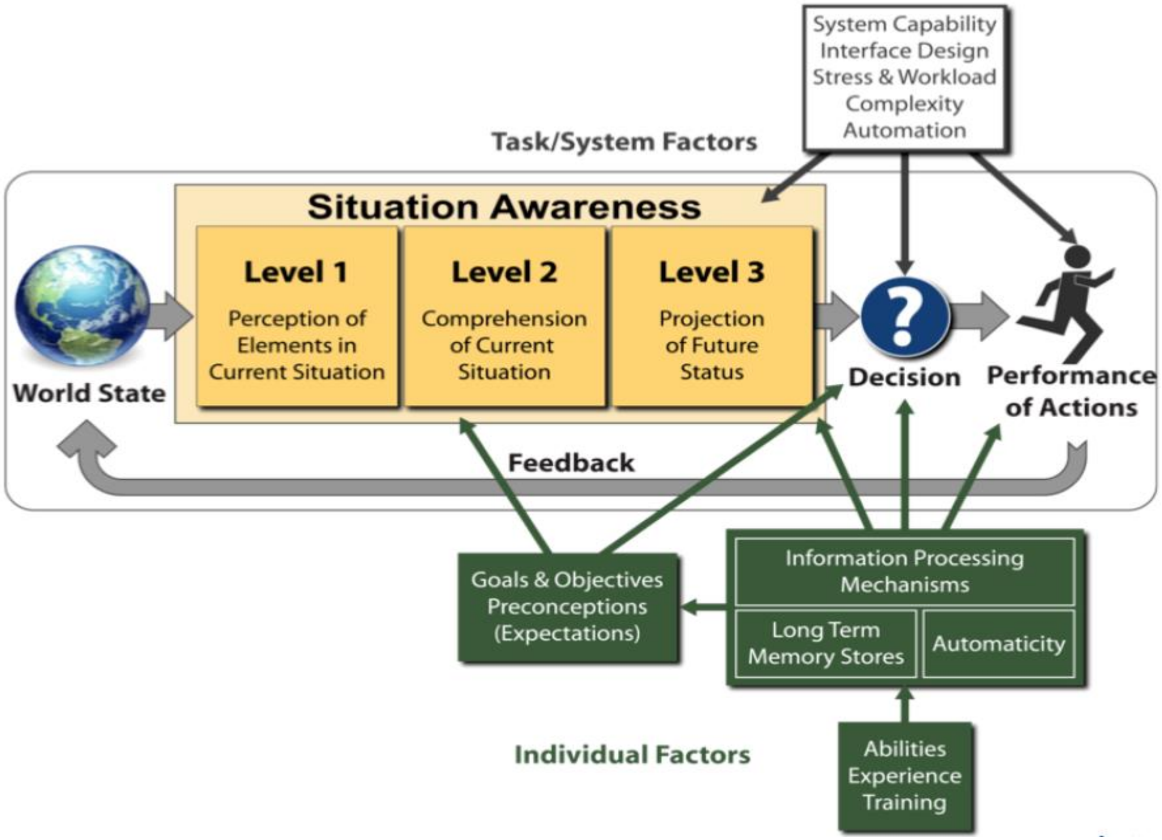
Beat-to-beat heart rate



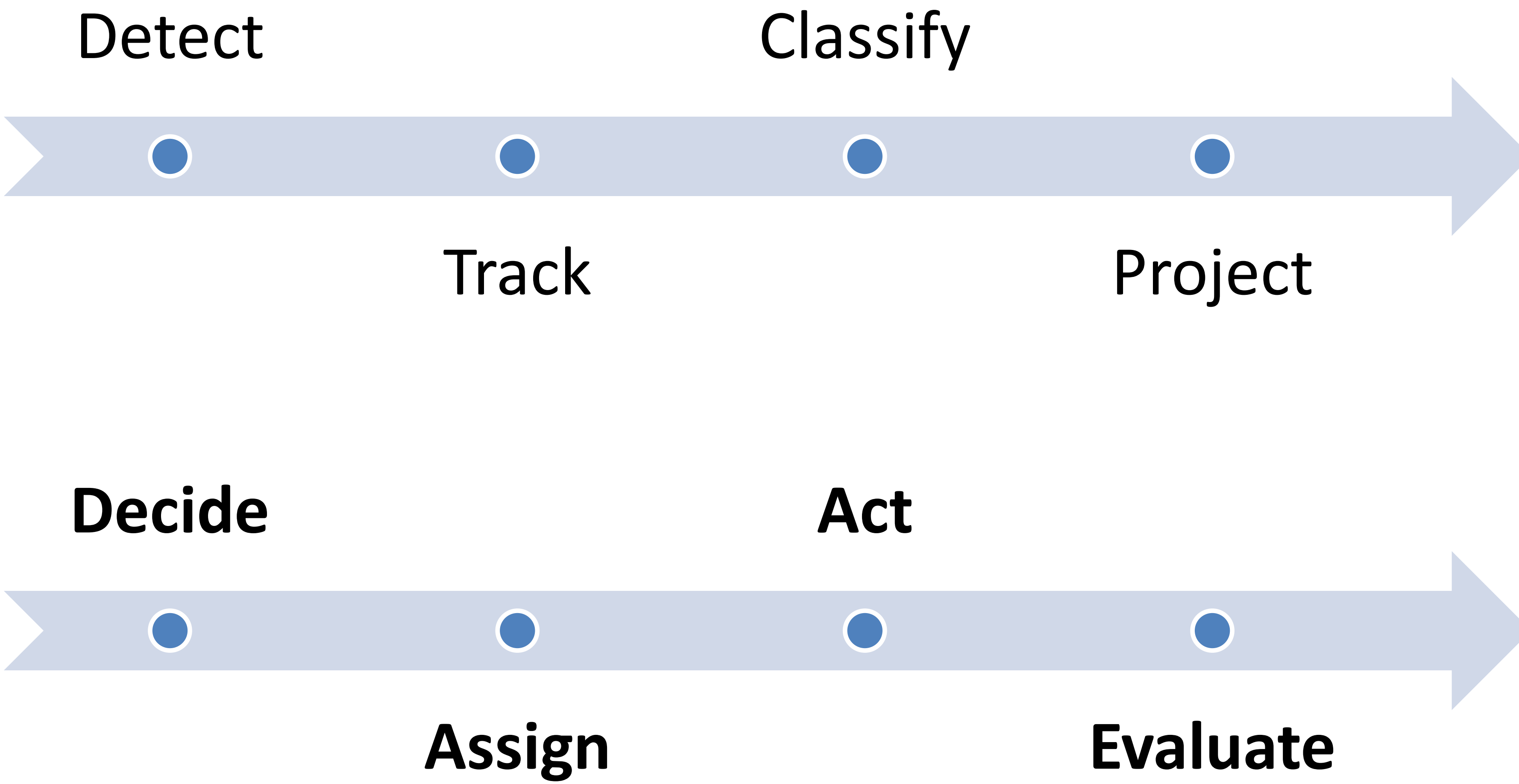
Data displays that mirror how we think about patients' needs


Sentry Alerts - Vital Signs
Patient Name :
Adjust Parameters
Reactivate Alerts
Alert History
Last 6 Hours
Systemic BP and Heart Rate
200
180
160
140
120
100
80
60
40
20
0
09/21 19:50
09/21 20:12
09/21 20:34
09/21 20:56
09/21 21:18
09/21 21:40
09/21 22:02
09/21 22:24
09/21 22:46
09/21 23:08
09/21 23:30
09/21 23:52
09/22 00:14
09/22 00:36
09/22 00:58
09/22 01:20
09/22 01:42
Last 15 Minutes
09/22 01:35
09/22 01:42
09/22 01:49
Last 6 Hours
RR, EtCO2 and O2 Sat
100
90
80
70
60
50
40
30
20
10
0
Last 15 Minutes

Situation Awareness
Human Factors 37: 32-64 (1995)

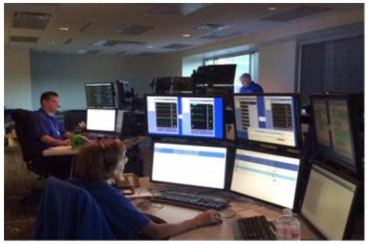


What we are (really) doing: Detection/Correction of Anomalies



Since go live May 2014

In the Clinical Operations Room:
92,852 eRN hours
19,656 eMD hours



15,244 Intervention Care Hours

13,256 eMD Interventions

On Camera
2,439 eMD Hours 3,702 eRN Hours

Care Quality Improvements

- Decrease in severity-adjusted/actual mortality
- Decrease in severity-adjusted/actual LOS
- Increase in adherence to best practice for VTE

June 1, 2011, Vol 305, No. 21 >

Caring for the Critically Ill Patient | June 1, 2011

Hospital Mortality, Length of Stay, and Preventable Complications Among Critically Ill Patients Before and After Tele-ICU Reengineering of Critical Care Processes FREE

Craig M. Lilly, MD; Shawn Cody, MSN/MBA, RN; Huifang Zhao, PhD; Karen Landry; Stephen P. Baker, MScPH; John McIlwaine, DO; M. Willis Chandler, MBA; Richard S. Irwin, MD; for the University of Massachusetts Memorial Critical Care Operations Group

[+] Author Affiliations

JAMA. 2011;305(21):2175-2183. doi:10.1001/jama.2011.697.

Text Size: A A A

Article | Figures | Tables | Supplemental Content | References

ABSTRACT

ABSTRACT | METHODS | RESULTS | COMMENT | CONCLUSIONS | ARTICLE INFORMATION | REFERENCES

Context The association of an adult tele-intensive care unit (ICU) intervention with hospital mortality, length of stay, best practice adherence, and preventable complications for an academic medical center has not been reported.

Objective To quantify the association of a tele-ICU intervention with hospital mortality, length of stay, and complications that are preventable by adherence to best practices.

Design, Setting, and Patients Prospective stepped-wedge clinical practice study of 6290 adults admitted to any of 7 ICUs (3 medical, 3 surgical, and 1 mixed cardiovascular) on 2 campuses of an 834-bed academic medical center that was performed from April 26, 2005, through September 30, 2007. Electronically supported and monitored processes for best practice adherence, care plan creation, and clinician response times to alarms were evaluated.

Main Outcome Measures Case-mix and severity-adjusted hospital mortality. Other outcomes included hospital and ICU length of stay, best practice adherence, and complication rates.

Related Content

See Also...

Editorial
The Use and Misuse of ICU Telemedicine
JAMA. 2011;305(21):2227-2228. doi:10.1001/jama.2011.716.

Articles Related By Topic

Filter By Topic >

Effect of High-Dose Vitamin D_3 on Hospital Length of Stay in Critically Ill Patients With Vitamin D Deficiency: The VITdAL-ICU Randomized Clinical Trial
JAMA. 2014;312(15):1520-1530. doi:10.1001/jama.2014.13204.

The JAMA Network

From: **Hospital Mortality, Length of Stay, and Preventable Complications Among Critically Ill Patients Before and After Tele-ICU Reengineering of Critical Care Processes**

JAMA. 2011;305(21):2175-2183. doi:10.1001/jama.2011.697

Table 1. Comparison of Intensive Care Unit (ICU) Processes Before and After Tele-ICU Intervention

Preintervention	Tele-ICU Intervention
Bedside monitor alarms	Physiological trend alerts Abnormal laboratory value alerts Review of response to alerts Off-site team rounds
Daily goal sheet	Electronic detection of nonadherence Real-time auditing Nurse manager audits Team audits
Telephone case review initiated by house staff or affiliate practitioner	Workstation review initiated by intensivist includes electronic medical record, imaging studies, interactive audio and video of patient, interaction with nurse and respiratory therapist, and assessment of response to therapy

The JAMA Network

From: **Hospital Mortality, Length of Stay, and Preventable Complications Among Critically Ill Patients Before and After Tele-ICU Reengineering of Critical Care Processes**

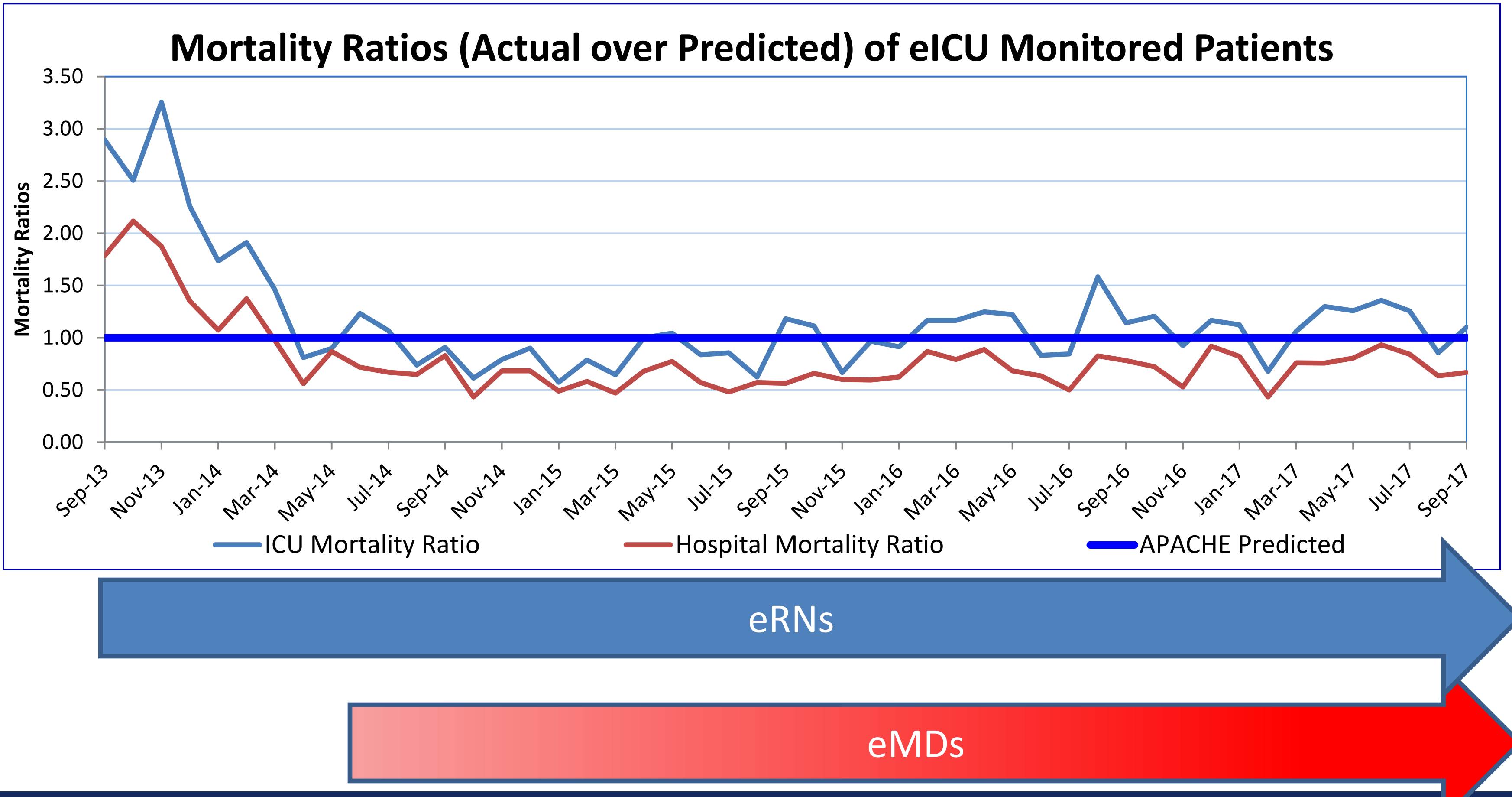
JAMA. 2011;305(21):2175-2183. doi:10.1001/jama.2011.697

Table 3. Mortality and Length-of-Stay Outcomes

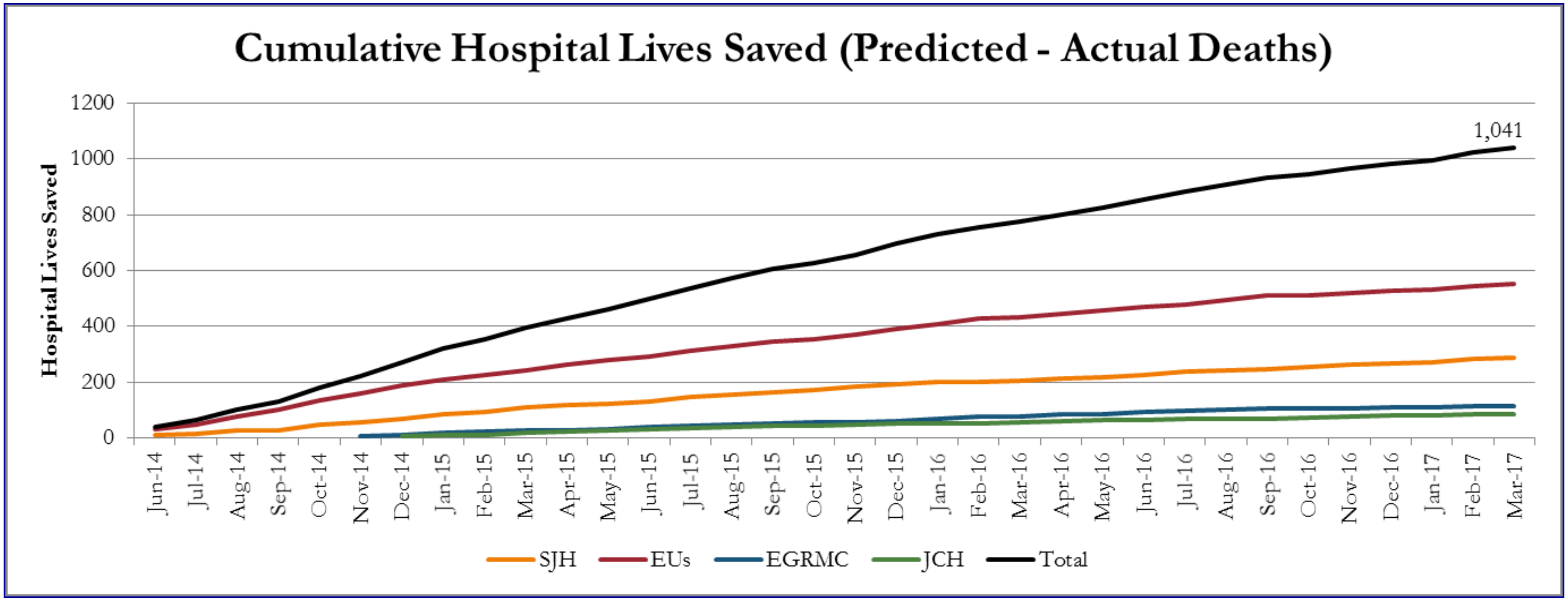
Outcome	Preintervention Group (n = 1529)	Tele-ICU Group (n = 4761)	Unadjusted *P* Value	Tele-ICU Effect Estimates[a]	*P* Value
	No. (%) of Patients				
Mortality rate					
Hospital	208 (13.6)	562 (11.8)	.07	0.40 (0.31-0.52)[b]	.005
ICU	164 (10.7)	410 (8.6)	.01	0.37 (0.28-0.49)[b]	.003
	Mean (SD) and Median [IQR], d				
Length of stay					
Hospital	13.3 (17.1) 7.9 [0.2-15.0]	9.8 (10) 6.8 [0.2-12.0]	<.001	1.44 (1.33-1.56)[c]	<.001
ICU	6.4 (11) 2.5 [0.2-6.5]	4.5 (6.7) 2.4 [0.1-4.6]	<.001	1.26 (1.17-1.36)[c]	<.001

Abbreviations: ICU, intensive care unit; IQR, interquartile range.
[a]Estimate of effect size after adjustment for differences in acuity score, admission source, admission ICU, time after enrollment of first case in group, and other predictive factors including laboratory values and physiological measurements as detailed in the eSupplement at http://www.jama.com.
[b]Indicates odds ratio (95% confidence interval).
[c]Indicates hazard ratio (95% confidence interval).

Emory eICU Results: Community-Centered Hospital

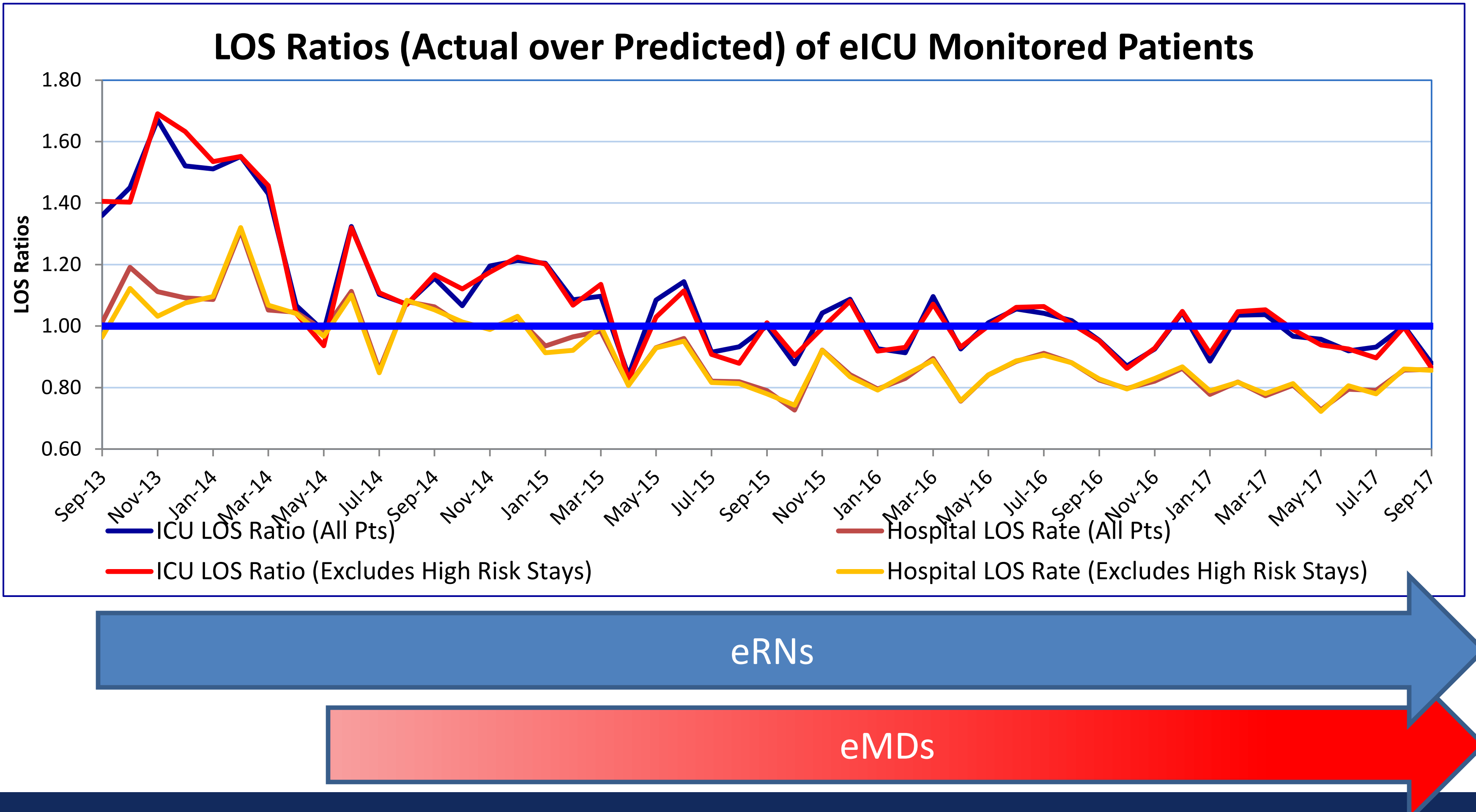


Lives Saved

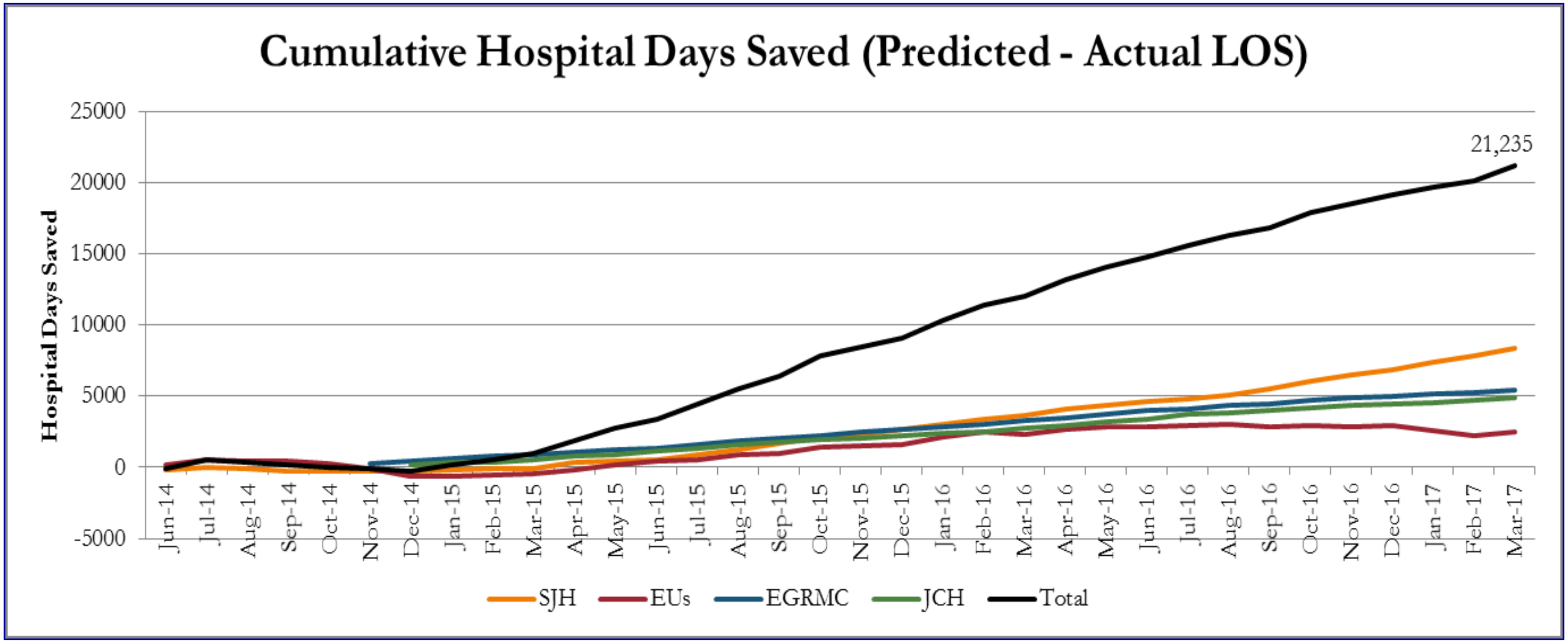


Cumulative Hospital Lives Saved (Predicted - Actual Deaths)
Hospital Lives Saved
1200
1000
800
600
400
200
0
1,041
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
SJH
EUs
EGRMC
JCH
Total

Emory eICU Results: Community-Centered Hospital



Resources Conserved



The JAMA Network

From: **Hospital Mortality, Length of Stay, and Preventable Complications Among Critically Ill Patients Before and After Tele-ICU Reengineering of Critical Care Processes**

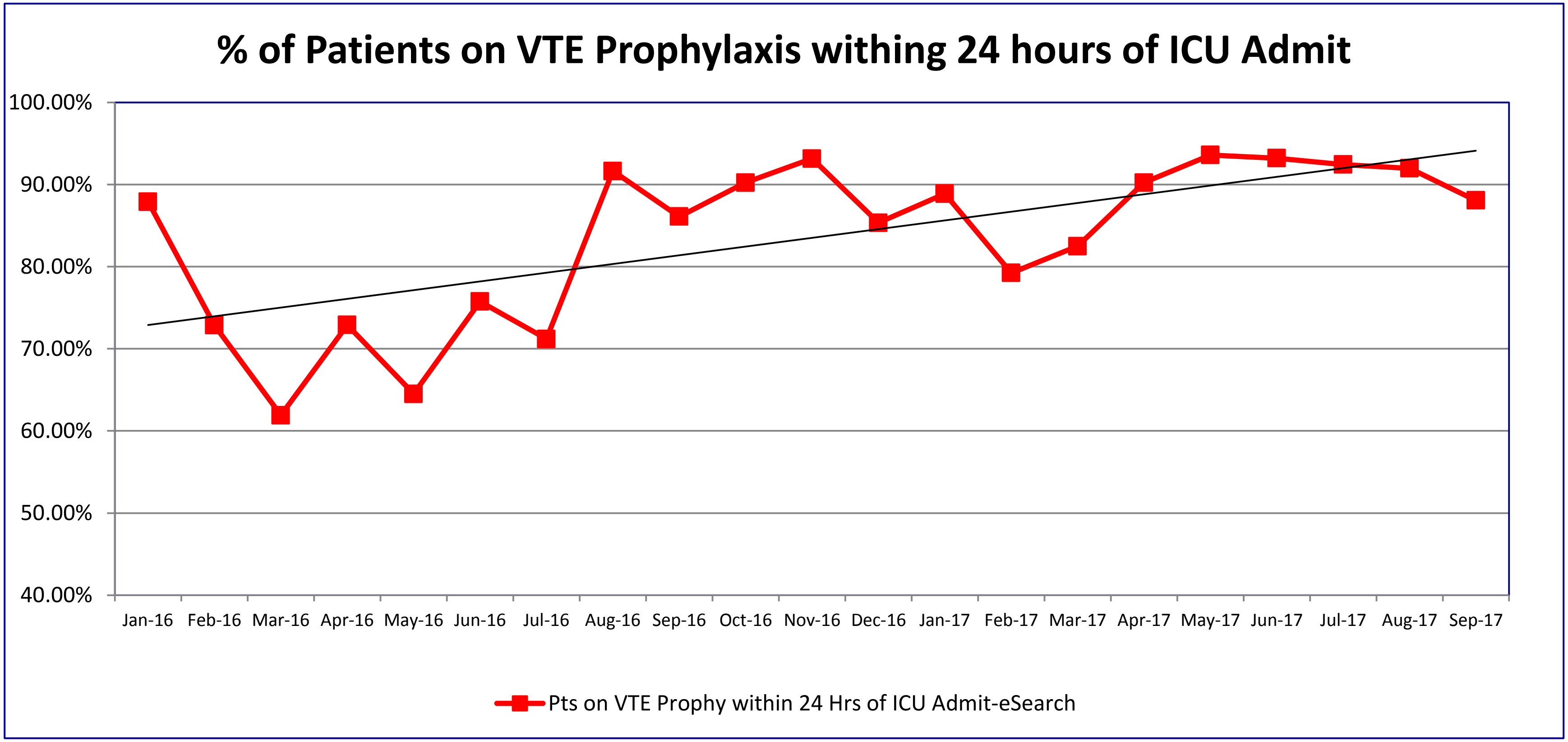
JAMA. 2011;305(21):2175-2183. doi:10.1001/jama.2011.697

Table 4. Association of Tele-ICU Intervention Group With Best Practice and Complication Measures

Clinical Practice Guideline Adherence	No./Total (%) of Patients Eligible[a]		OR (95% CI)	*P* Value
	Preintervention Group	Tele-ICU Group		
Prophylaxis				
Stress ulcer	1253/1505 (83)	4550/4760 (96)	4.57 (3.91-5.77)	<.001
Deep venous thrombosis	1299/1527 (85)	4707/4733 (99.5)	15.4 (11.3-21.1)	<.001
Best practice				
Cardiovascular protection	311/391 (80)	2866/2894 (99)	30.7 (19.3-49.2)	<.001
Prevention of ventilator-associated pneumonia	190/582 (33)	770/1492 (52)	2.20 (1.79-2.70)	<.001
Ventilator-associated pneumonia	76/584 (13)	32/1949 (1.6)	0.15 (0.09-0.23)	<.001
Catheter-related bloodstream infection	19/1529 (1)	29/4761 (0.6)	0.50 (0.27-0.93)	.005
Acute kidney injury	174/1452 (12)	540/4565 (12)	1.00 (0.71-1.69)	.38
After hours care plan review for ICU admissions, No. (%)	705/1529 (46)[b]	2287/4761 (48)[c]		
Interventions for physiological instability	All bedside clinician initiated	483[d] 37 573[e]		

Abbreviations: CI, confidence interval; ICU, intensive care unit; OR, odds ratio.
[a]Unless otherwise indicated.
[b]Off-hours admission reviews not using a workstation.
[c]Off-hours admissions reviews using a workstation.
[d]Initiated by bedside clinician.
[e]Initiated prior to action by bedside clinicians.

VTE Best Practice Compliance



Critical Care Medicine:
February 2016 - Volume 44 - Issue 2 - p 265–274
doi: 10.1097/CCM.0000000000001426
Feature Articles

Economic Evaluation of Telemedicine for Patients in ICUs*

Yoo, Byung-Kwang MD, PhD[1]; Kim, Minchul PhD[1]; Sasaki, Tomoko PhD[2]; Melnikow, Joy MD, MPH[3]; Marcin, James P. MD, MPH[4]

Parameter	Incremental Cost-Effectiveness Ratio < $100,000 (Per Quality-Adjusted Life Year)	Cost Saving[a]
ICU-mortality reduction by tele-ICU (18.5–28.9%)	15.8%	Not feasible even when 100%
Impact of tele-ICU on per-patient per-hospital-stay ICU cost (ratio to pre-tele-ICU cost, excluding tele-ICU operation cost) (0.71–1.14)	98.4% (1.6% reduction)	90.3% (9.7% reduction)
Floor-mortality increase by tele-ICU (12.3–51.8%)	53.4% (increase)	Not feasible even when (-) 100% (i.e., 100% "reduction")
Impact of tele-ICU on per-patient per-hospital-stay floor cost (ratio to conventional floor cost, excluding tele-ICU operation cost) (0.80–1.30)	108.4%	96.7%
Per-patient per-hospital-stay tele-ICU operation cost ($909–$1,057)	$1,560	$422
(1) Per-patient per-hospital-stay tele-ICU equipment-installation (start-up) cost ($200–$348)[b]	$851	Not feasible even when $0
(2) Per-patient per-hospital-stay tele-ICU maintenance and clinical staffing cost ($680–$828)[c]	$1,331	$193
(3) Per-patient per-hospital-stay tele-ICU physician staffing cost ($642–$790)[d]	$1,293	$155
Baseline mortality in pre-tele-ICU (8.91–9.38%)	6.3%	Not feasible even when 100%
Baseline mortality in conventional floor (2.8–3.57%)	5.1%	Not feasible even when 100%

Tele-ICU = telemedicine in the ICU, Pre-tele-ICU = ICU without a telemedicine team.
[a]Cost saving of tele-ICU compared with pre-tele-ICU without a telemedicine team, that is, tele-ICU dominates pre-tele-ICU without a telemedicine team.
[b]Assuming 5-year depreciation (12, 14).
[c]Calculated as per-patient per-hospital-stay tele-ICU operation cost minus (i) per-patient per-hospital-stay tele-ICU equipment-installation (start-up) cost (12, 14).
[d]A part of (ii) per-patient per-hospital-stay tele-ICU maintenance and clinical staffing cost (12, 14).
The lower incremental cost-effectiveness ratio values indicate that tele-ICU is more efficient in an economic sense. All costs in U.S. 2014 dollars.

Critical Care Medicine:
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Feature Articles

Economic Evaluation of Telemedicine for Patients in ICUs*

Yoo, Byung-Kwang MD, PhD[1]; Kim, Minchul PhD[1]; Sasaki, Tomoko PhD[2]; Melnikow, Joy MD, MPH[3]; Marcin, James P. MD, MPH[4]

Measurements and Main Results: The base case cost-effectiveness analysis estimated telemedicine in the ICU to extend 0.011 quality-adjusted life years with an incremental cost of $516 per patient compared with ICU without telemedicine, resulting in an incremental cost-effectiveness ratio of $45,320 per additional quality-adjusted life year (= $516/0.011). The probabilistic cost-effectiveness analysis estimated an incremental cost-effectiveness ratio of $50,265 with a wide 95% CI from a negative value (suggesting cost savings) to $375,870. These probabilistic analyses projected that cost saving is achieved 37% of 1,000 iterations. Cost saving is also feasible if the per-patient per-hospital-stay operational cost and physician cost were less than $422 and less than $155, respectively, based on break-even analyses.

Emory total eICU operational costs are currently $643 per patient.

$422+$155=$577 is break-even even if no 'downstream' cost savings

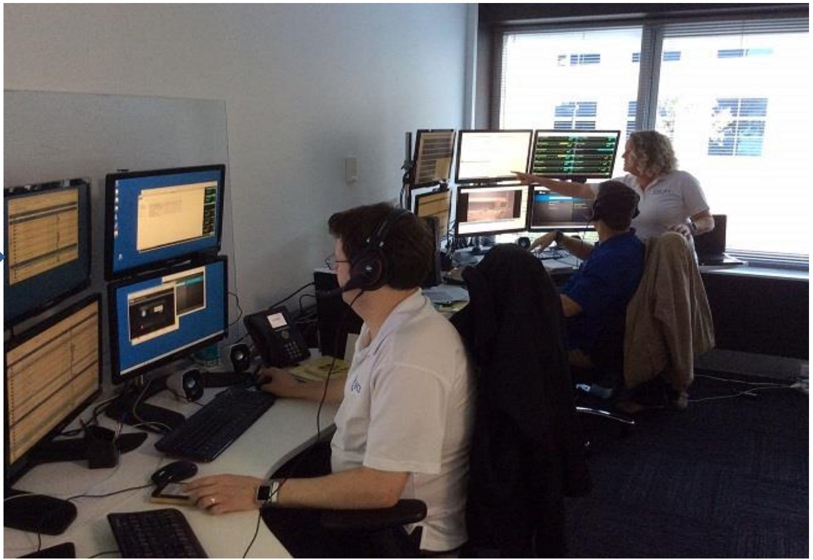
eICU staffing is based on patient ratios. This creates step fixed costs:
if we monitored just 12 additional beds, our eICU costs per patient would drop to approximately $500 (varies depending on occupancy rates).

Emory eICU analysis by Abt

Quantitative findings: Emory eICU compared to Nine other Hospitals

- Decrease of roughly $1,486 in average Medicare spending per episode ($p<0.01$) for a total of 4.6 million over the 15 month period
- Decrease in the rate of 60-day inpatient readmissions of 2.14% ($p<0.10$)
- Decrease in discharges to SNF and LTCHs of 6.9% ($p<0.01$)
- Increase in discharges to home health of 4.9%
- Declining trend in inpatient LOS for the two most recent quarters

Turning Night into Day
July-December 2016



Key Elements of the Study/Trial

- Partner with a University health system in Australia. We chose Macquarie University
- Build a mini clinical operations room (COR) at the partner location
- Relocate Emory board certified intensivists and Emory critical care certified nurses to the partner site
- Have these team members cover the night shift during day time hours in Australia
- Operate simultaneously in the COR in Atlanta with eRNs and have an intensivist on call if needed

Trail Making Test

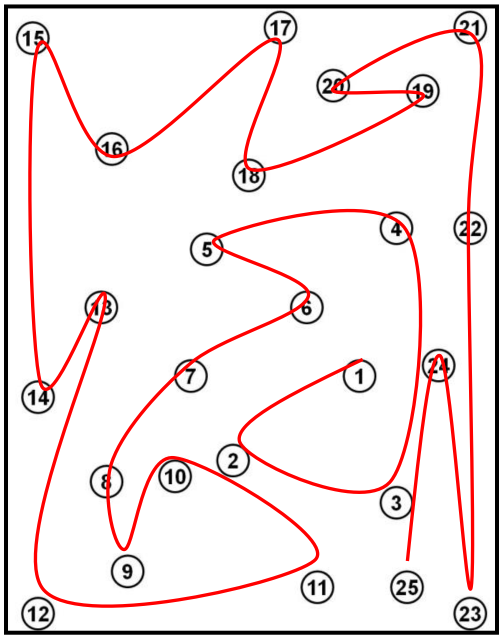
- Validated neuropsychological test
  - visual attention
  - task switching

- Consists of two parts (A and B) in which the subject is instructed to connect a set of 25 dots as quickly as possible while still maintaining accuracy

- Test can provide information about visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning

Timed tests

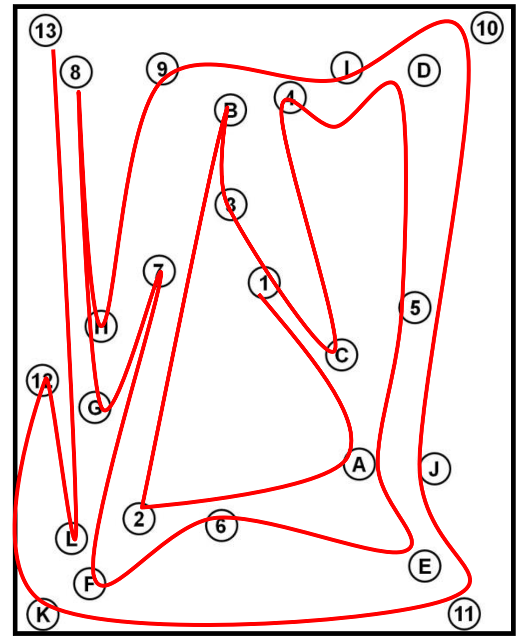
Form A



Connect the dots in ascending numerical order… 1,2,3,4…25…

Errors not allowed must correct as you go

Form B



Connect the dots in ascending and strictly ALTERNATING numerical and alphabetical order… 1,A,2,B, 3, C…13

Subject Data 1:
Nights, Jet Lag, Acclimatized to Days

	Form A -Av	**Form B-Av**	*B-A Av*	
Nights	14.25	**19.9**	*5.65*	Begin Shift
	14.24	**23.78**	*9.54*	End Shift
Jet Lag	13.225	**19.925**	*6.7*	Begin Shift
	14.26	**20.46**	*6.2*	End Shift
Days	12.325	**17.825**	*5.5*	Begin Shift
	12.04	**17.76**	*5.72*	End Shift

Early Outcome Data

Form A Typical completion times: 25-29 seconds

- Emory completion times on average much faster
- Fastest 12.04 end of 12 hours day time in Australia
- Slowest 14.26 after 12 hours during jet lag

Form B Typical completion times: 49-75 seconds

- Emory completion times much faster
- Fastest 17.76 end of 12 hours day time in Australia
- Slowest 23.78 after 12 hours during night shift

On the iPad – Self-Reported Fatigue

iPad 9:50 PM 100%

Mental Fatigue Scale

Below is a scale used to identify your self-perceived level of mental fatigue. Please press the circle next to the description that best matches your current level of mental fatigue and then press "Start Test". This information, as well as your identity, will be kept confidential. However, if you do not wish to share this information, press "Skip to Test" to go directly to the test.

- ○ 1. Fully alert. Wide awake. Extremely peppy
- ○ 2. Very lively. Responsize, but not at peak
- ○ 3. Okay. Somewhat fresh
- ○ 4. A little tired. Less than fresh
- ○ 5. Moderately tired. Let down.
- ○ 6. Extremely tired. Very difficult to concentrate.
- ○ 7. Completely exhausted. Unable to function effectively. Ready to drop.

Start Test

Skip to Test

Source: Samn SW and Perelli LP. Estimating aircraft fatigue: a technique with application to airlift operations. SAM-TR-82-21, Dec 1982

Anecdotal Feedback

"Although I have been a long time night shift worker and believed I have successfully flipped back and forth from nights to days, I found that being on a consistent day schedule means I sleep pretty much the same number of hours every night and wake up before my alarm goes off everyday."

"The most significant aspect for me, was the change from working nights to working days. I felt like I had more time. When working nights, you can either sleep when your get home, or stay up all day and change to a day routine. Either way, your feel tired, and exhausted, especially working 3 or 4 12hour shifts in a row. In Australia, I completed my assigned shifts, went home and slept. The next morning I was able to accomplish whatever I had planned. I was not exhausted and did not lose a day just to make the transition from nights to days."

"Turning Night into Day"

Michael Farquhar: We must recognise the health effects associated with shift working

October 6, 2017

We must support those who work at night

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The 2017 Nobel Prize in Physiology or Medicine has been awarded to Jeffrey Hall, Michael Rosbash, and Michael Young for "discoveries of molecular mechanisms controlling the circadian rhythm."

Their work illuminates the genetic and molecular workings of our body clocks, which allow our physiology to respond to different needs and demands at different times of the day and night.

Increasingly, we are realising how intimately every aspect of our physical and mental health are tied to our circadian rhythms. When our lives are not in synchrony with our body clocks, there are significant consequences.

For many, the most obvious example is when we travel across the world, shifting timezones: we experience jet-lag. Jet-lag makes us feel awake and sleepy at the wrong times, we feel disorientated, sluggish, find it difficult to concentrate, are more likely to become anxious or irritable, have aches, pains, upset stomachs ... we feel out of phase with the world around us. It can take days for our internal clocks to reset and, until they do, we can struggle to function.

Over 3 million people in Britain—more than 1 in 8 of the workforce—regularly work at night, many providing essential, critical services on which Britain's smooth running depends. They are doctors, nurses, police, firefighters, paramedics, transport and maintenance crews, cleaners, call-centre workers, bakers, security guards, factory workers ... all ensuring your life runs like clockwork in the daytime. For them, the experience of working against their body clocks, of feeling jet-lagged, isn't an occasional annoyance due to travel—it's a regular fact of life.

What has been learned

- In some circumstances, eICU consistently saves lives
- In some circumstances, eICU consistently saves costs
- In some circumstances, eICU enhances consistent practice
- eICU can support local teams when numbers and experience of bedside personnel are overwhelmed by complexity, acuity or volume

What is not known

- Where impact of eICU is least/greatest
  - Bedside coverage (physician, APP, nursing, AHP)
  - Patient complexity (low, medium, high risk)
- Influence of local culture on eICU effectiveness
- Influence of eICU on local culture
- Influence of eICU on aggregate quality, safety, access, financial performance

Next steps?