

## Tele ICU Now and the Future

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# Disclosures

## *Funding – Current and Past*

Research support from Deltex, LIDCO, Fresenius & B Braun, Merck for RCTS in colorectal & liver surgery within ERAS protocols

Loan equipment from LIDCO, Deltex, Niccomo, Cheetah, APC cardiovascular

Advisory Board: Edwards Lifesciences, Baxter, Merck, Deltex, Trevena, Phillips

RfPB Grant NIHR UK (TERSC Study)

## *Positions Held – Present and Past*

ERAS Society Executive Committee & ERAS Guidelines Committee

President ERAS USA

Chair ERAS Society Education Committee

UK National Clinical Advisor for Enhanced Recovery

UK National Lead in ERAS for Upper GI Surgery

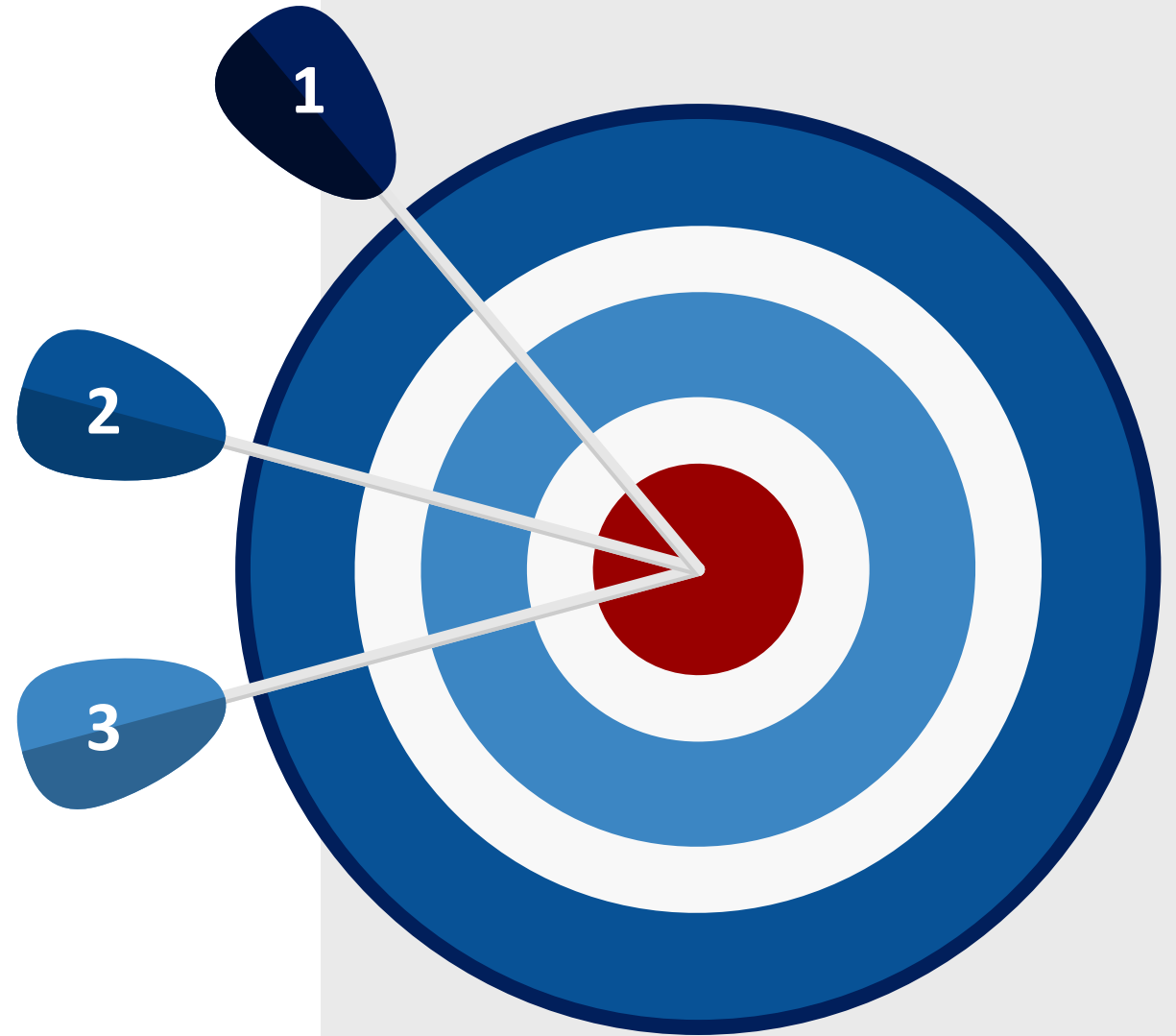
UK Resuscitation Council ALS & ILS Editorial Board

European Resuscitation Council ALS & ILS Editorial Board

WHO Lifebox Committee

# Learning Objectives

- 1 Describe where we are with TeleICU and its functionality
- 2 Summarize how a tele-ICU platform creates high reliability (and hence safety) across a health system
- 3 Discuss the Future application of TeleICU to optimize care for all patients across a Health System



# Penn Medicine FY22 Facts & Figures



Penn Medicine – University of Pennsylvania Health System

Type: Academic | Location: Philadelphia, PA (Greater Philadelphia Region)

6 HOSPITALS	3,600 LICENSED BEDS	6,243 PHYSICIANS
6,991,218 OUTPATIENT VISITS	413,721 ED VISITS	135,122 ADULT ADMISSIONS

11.1 Billion Annual Operating Revenue



# What is PENN E-LERT®?

- PENN E-LERT is Penn Medicine's Virtual Remote Monitoring Tele-ICU Program that helps support bedside providers and aims to improve quality and consistency of critical care delivery.
- We are able to effectively monitor patients remotely, **24/7, 365 days a year**, via a state-of-the-art audio/video platform and an EPIC Integrated alert monitoring system.



# PENN E-LERT STAFFING

One (1) eMD:  
Overnight [1/300]

One (1) eAPP:  
24/7 [1/300]

Four (4) eRNs:  
24/7 [1/70]

One (1) eRT:  
24/7 [1/300]

One (1) Telehealth  
Coordinator:  
24/7 [1/300]

## PENN E-LERT LOCATIONS



CCH



HUP



LGH



PAH



PPMC



PRINCETON



RITTENHOUSE

*PENN E-LERT is one of the largest telemedicine ICU programs in the nation with more than 450 connected cameras as fixed & mobile devices across the enterprise.*



COVID-19 has accelerated technology adoption



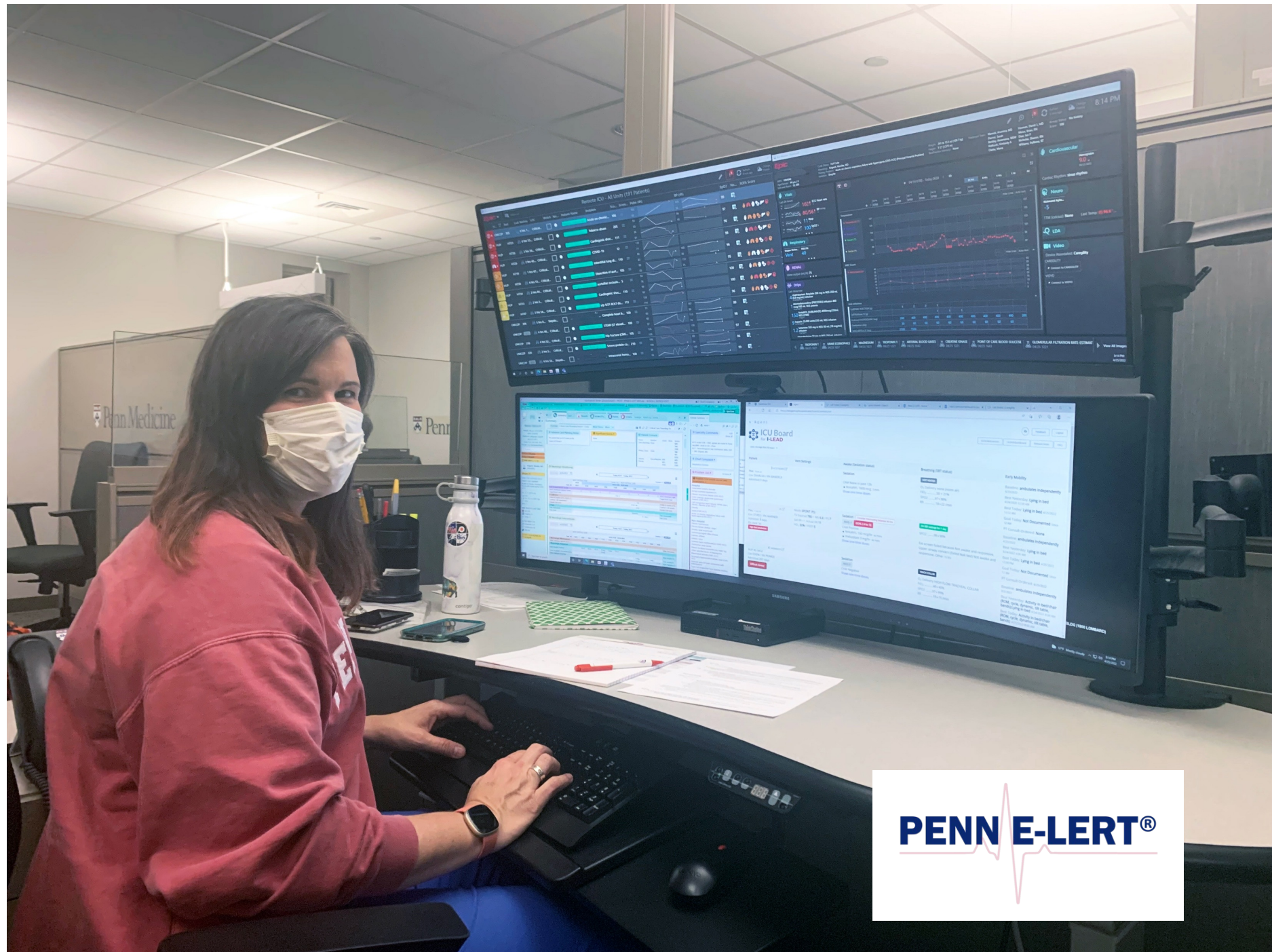


# Opportunity During COVID-19

In 2020 Penn Medicine's Center for Connected Care Department partnered with EPIC to create a customized, first-in-class, EPIC integrated, alert monitoring system for its TeleICU program, PENN E-LERT®.







# Fixed Cameras Allow Situational Awareness

- High Resolution
- High Power Zoom
- 2 way vision – providers can see each other
- 2 way audio
- Ability to call other providers or participants in on their mobile device for consults
- All on the call have visual and audio situational awareness





**Penn LiveLink** enables multiple Penn clinicians to access a secure audio-video clinical platform via your smart device. LiveLink uses WebRTC technology and opens in your smart device's web browser, meaning you not need to download an application to utilize the service. Here's how it works:



## 01 Initiating LiveLink:

- Requesting clinician presses PENN E-LERT® button, located at the footwall of the patient's room or on a mobile cart in patient's room.
- Alternatively, requesting clinician can call PENN E-LERT at (215) 893-7310 and provide the patient level details.
- Requesting clinician provides PENN E-LERT their phone number or email address to receive link.

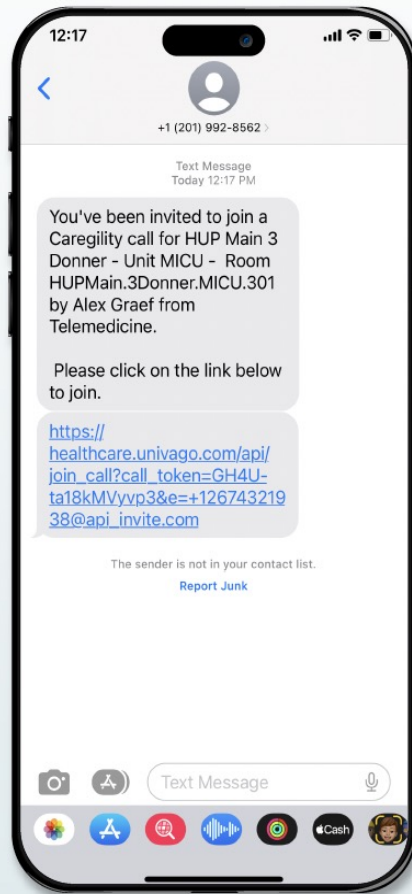
## 02 Receiving LiveLink:

- Requesting clinician receives text message or email that includes:
  - Hospital
  - Unit
  - Room Endpoint
  - Penn E-LERT Clinician Name
  - Link

## 03 Opening LiveLink:

- Requesting clinician clicks on link to join the patient room virtually.
- When prompted, requesting clinician must allow access to use their device's microphone and camera.
- Requesting clinician is now in the patient room virtually.
- PENN E-LERT clinician must remain in the patient room virtually, however can minimize themselves if clinically appropriate.

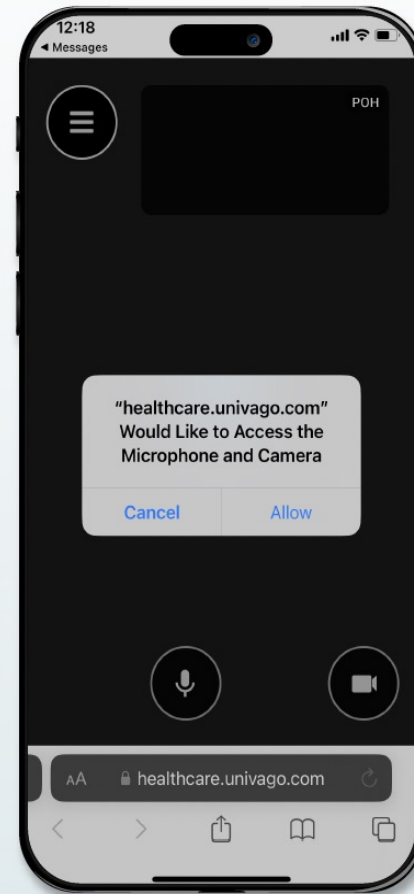
Immediate 2-way situational Awareness with camera and audio anywhere in the world



Patient  
Room  
Details

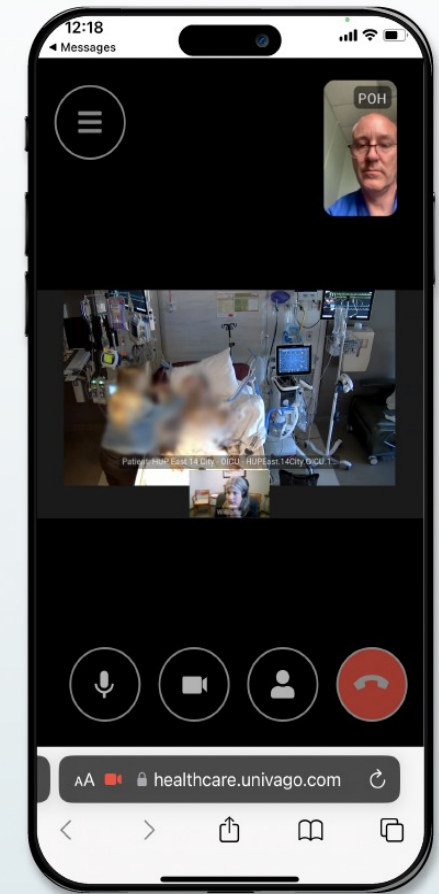
Link

**Figure 1.** Initial text with room details and link to virtual patient room



Microphone  
and Camera  
Access Prompt

**Figure 2.** Prompt for microphone and camera access; Select "Allow"



Your  
Self  
View

Patient  
Room

Your  
Audio &  
Video  
Controls

**Figure 3.** Requesting clinician view in patient room virtually

## Disclaimers:

- » LiveLink is only available on units with PENN E-LERT service.
- » LiveLink invitation expires 30 minutes after the link is sent to a mobile device.
- » PENN E-LERT controls the camera's pan, tilt and zoom features.

# PENN E-LERT As A Reactive Service

TELEMEDICINE ICU – IMPROVING QUALITY & OUTCOMES



**80% of Opportunity**  
**Evenings, Nights, Weekends**  
**Lower Bedside Staffing Ratios**

## Immediate Threat to Life

- Cardiac Dysrhythmia
- Hemodynamic Changes
- Respiratory Issues
- Ventilator Issues
- Neurological Deterioration

## Trending Threat to Life

- Hemodynamic Changes
- Respiratory Issues
- Ventilator Issues
- Sepsis Alerts
- Electrolyte Disturbance
- ARDS Alerts

e-Consult Connectivity  
Procedure Support  
Documentation Support

Immediate Bedside Support – Video & Voice  
Clinical Decision Support  
Resource Activation and Escalation

Post Event - Ongoing Monitoring & Support  
Freeing up Bedside Providers

Video Review for Downstream  
QI & Education (select units)

# PENN E-LERT As A Proactive Service

TELEMEDICINE ICU – IMPROVING QUALITY & OUTCOMES



**Continuous Opportunity**  
**Reducing Mortality**  
**Reducing Secondary Complications**

## Respiratory Bundles

- Spontaneous Breathing trials
- Sedation Holds – Awakening trials
- Hyperoxia Nudges
- Vent Orders Matching Actual Vent Setting
- Extubation Check List
- Less Time on Ventilator
- Reduced Reintubations
- Best Practice Compliance

## Proactive Patient Rounding

- Active Rounding
- Improved Vigilance
- Efficient Use of Bedside Providers
- Improved Patient Care

## System Wide Quality Improvement

- Improved Quality & Clinical Outcomes
- Reduced Variability in Care – High Reliability
- Higher Health System Value

## Sepsis Detection & Compliance

- Earlier Detection – 24/7
- Best Practice Compliance
- Reduced Mortality
- Reduced Organ Dysfunction

## ICU Bundle Compliance

- GI Prophylaxis
- VTE Prophylaxis
- Best Practice Compliance
- Reduced Complications

## Post Cardiac Arrest Targeted Temperature Management

- TTM Algorithm Compliance
- Improved Neurological Outcomes

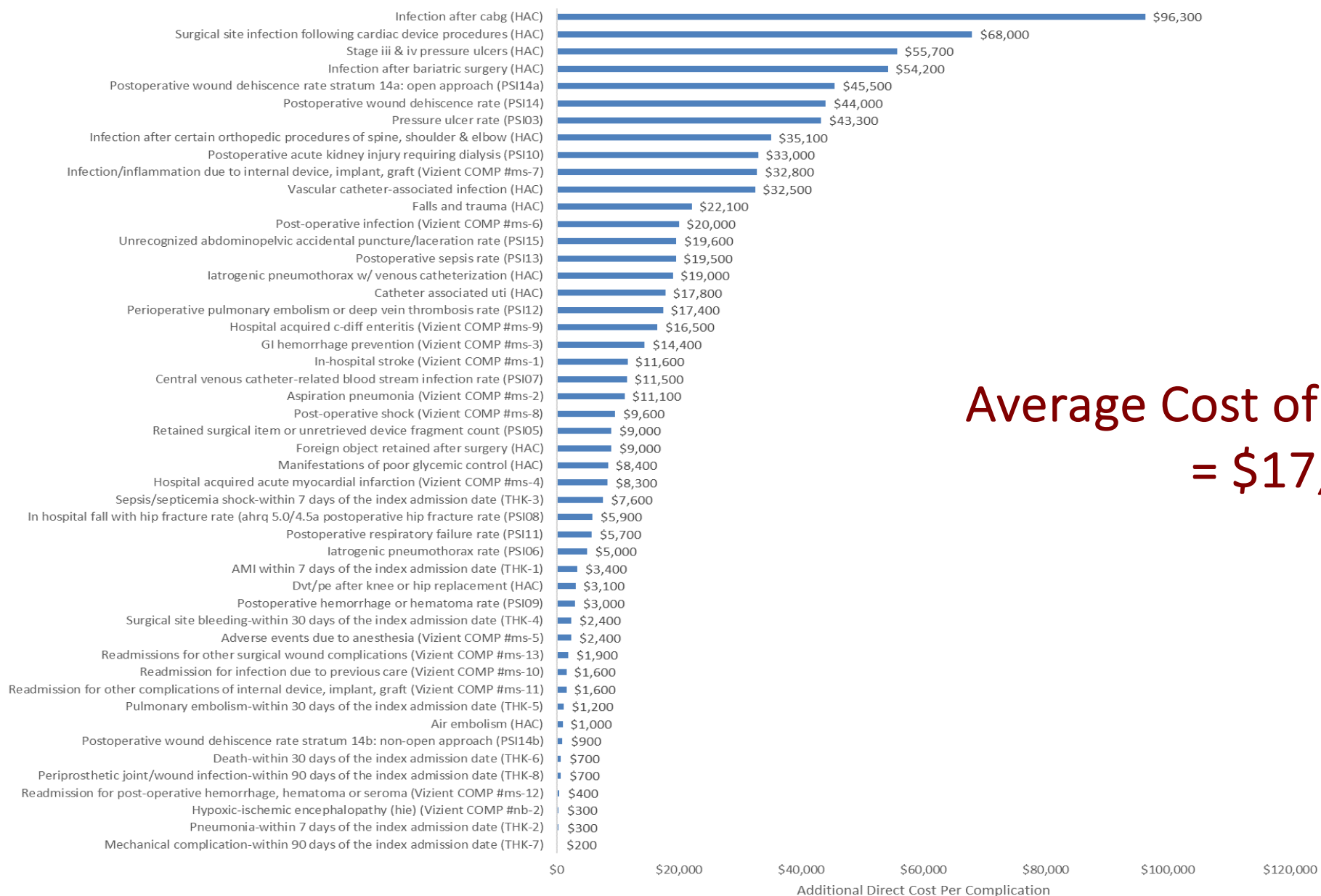


# Main Causes of Serious Untoward Events in Health Care

- 01 Failure to follow procedure or best practice
- 02 Failure to recognize a problem
- 03 Failure to escalate appropriately
- 04 Lack of governance in all of the above
- 05 Lack of 'SAFE' environment where providers feel empowered to reach out for support



# Additional direct cost per complication





# High Reliability in Healthcare – a long way left to go.....

**BMJ** Journals

ORIGINAL RESEARCH

## Striving for high reliability in healthcare: a qualitative study of the implementation of a hospital safety programme

Leahora Rotteau <sup>1</sup>, Joanne Goldman <sup>1,2,3</sup>, Kaveh G. Shojania <sup>1,2,4</sup>, Timothy J. Vogus,<sup>5</sup> Marlys Christianson,<sup>6</sup> G. Ross Baker,<sup>7</sup> Paula Rowland,<sup>3,8</sup> Maitreya Coffey<sup>9,10,11</sup>

**BMJ**

Rotteau L, et al. *BMJ Qual Saf* 2022;**31**:867–877. doi:10.1136/bmjqs-2021-013938

 The Health Foundation

**BMJ** Journals

EDITORIAL

## High reliability organising in healthcare: still a long way left to go

Christopher G Myers <sup>1,2,3</sup>, Kathleen M Sutcliffe<sup>1,2,3,4,5</sup>

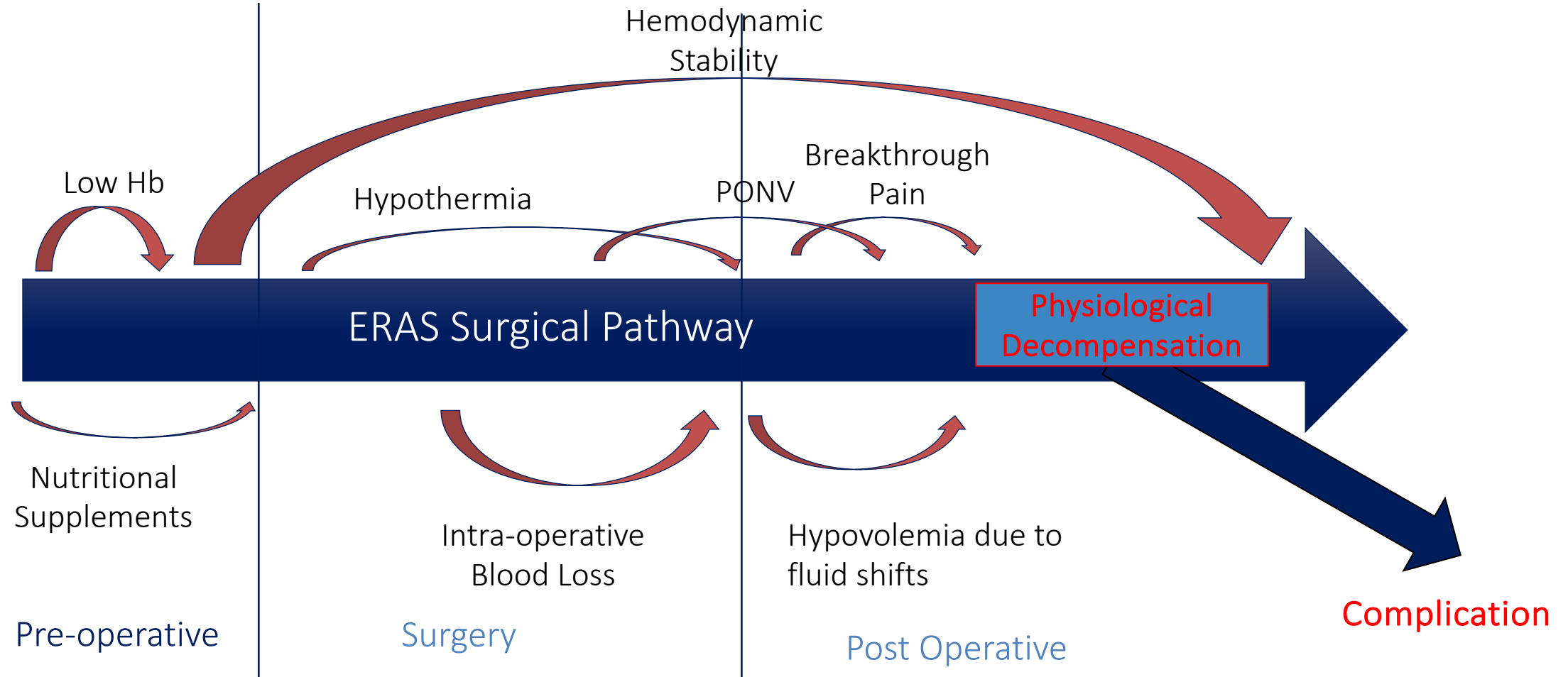
**BMJ**

Rotteau L, et al. *BMJ Qual Saf* 2022;**31**:867–877. doi:10.1136/bmjqs-2021-013938

 The Health Foundation



# Early Detection of Derangement of Physiological and Laboratory Values Enables earlier intervention



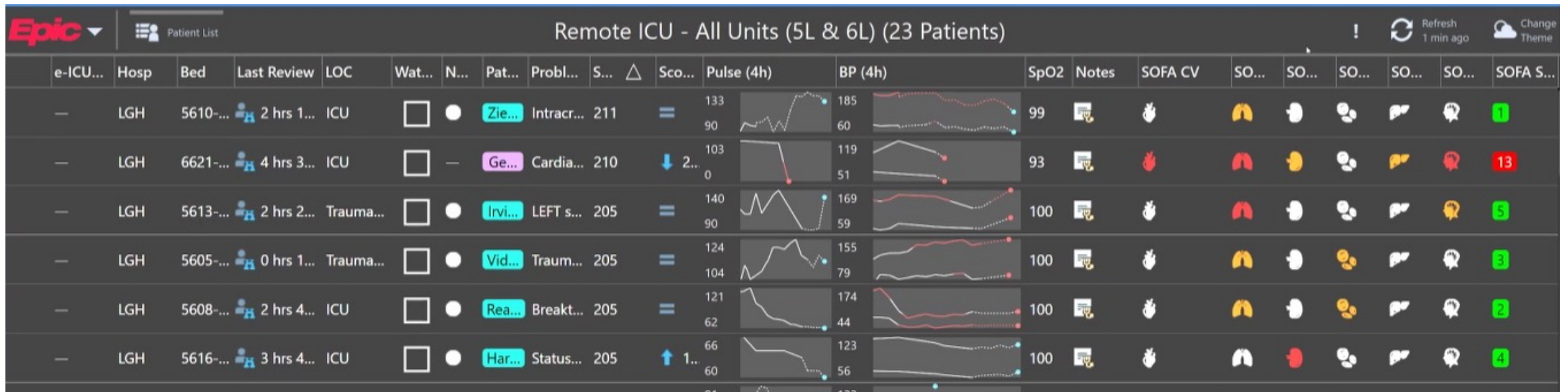
# Clinical Deterioration Index / SOFA Score Delta

## Robust Remote Clinical Surveillance

## PennChart – validated and unvalidated data fields – query every two minutes

80+ clinical variables = weighted deterioration index score

- ▶ Tier 1 Clinical Deterioration
  - ▶ Tier 2 Scheduled Review
  - ▶ Tier 3 Missing Measures
  - ▶ Tier 4 Physiological Indicators
- ▶ Visual Alerts
  - ▶ 07:00 SOFA Calculation
  - ▶ 18:00 SOFA Calculation



# What is a BPA Alert?

- **BPA** stands for **B**est **P**ractice **A**dvisory.
- Best Practice Advisory (BPA) alerts are electronic pop-up alerts that are received by our E-LERT clinicians [based on information in a patient's Electronic Medical Record (EMR)] that influence clinical actions and guide clinical processes.



# Custom BPAs to Reduce Unnecessary Variation in Real Time

ALERT NAME
ABP MAP <= 50 ALERT
AKI ALERT
ASYSTOLE ALERT
ELEVATED HR ALERT
EXTUBATION ORDER ALERT
HEMOGLOBIN ALERT - <= 6
HEMOGLOBIN ALERT - DROP BY 3
HIGH PEEP ALERT
HIGH RISK EXTUBATION SCREEN ALERT
HIGH SYSTOLIC ABP ALERT
HIGH SYSTOLIC NIBP ALERT
INCREASED FIO2 ALERT
INCREASED PEAK PRESSURE ALERT
LACTATE ALERT
LOW HR ALERT
LOW SYSTOLIC ABP ALERT
LOW SYSTOLIC NIBP ALERT
LOW TIDAL VOLUME ALERT
LOW UNSTABLE HR ALERT
MISSING VENTILATOR ORDER ALERT
NIBP MAP ALERT
NON-VENT HIGH FIO2 ALERT
PCO2 ALERT
PH (ABG) ALERT
POTASSIUM ALERT
SODIUM ALERT
SPO2 ALERT
TTM - TARGET TEMP ALERT

- ▶ PennChart – Tele-ICU module
- ▶ Best in class EPIC technology – presented, published, now widely preferred
- ▶ Twenty-eight (28) BPA alerts
- ▶ Millions of calculations per day of which an estimated 800 BPAs managed per day – one every 6 minutes
- ▶ Adjustable parameters at the patient level
- ▶ Two step clinical validation process – artifact, actionable, non-actionable
- ▶ Our PI enhancements are ongoing



# Alert Validation

- We incorporated Alert Validation within EPIC to better tailor our alerts to our patient population and reduce alarm fatigue.
- Alerts were evaluated every 2 weeks based on volume and user satisfaction. Adjustments were made and some alerts were suppressed that did not drive clinical outcomes for the patients.
- After the 1<sup>st</sup> set of iterations, there was about a **39% decrease** in the volume of alerts.

Top 10 Alerts Firing By Volume

	5/18/21 to 6/01/21		6/15/21 to 6/29/21
Alert Name:	# Times Alert Fired:	Logic Behind Alert ( <b>RED</b> Text Indicates Changed Logic):	# Times Alert Fired:
SPO2 ALERT	4417	SpO2 < 88 % for last 5 minutes ( <b>mean</b> )	3428
HIGH SYSTOLIC ABP ALERT	3105	ABP Systolic > 180 for last 10 minutes	1573
ABP MAP <=50 ALERT	2149	ABP MAP <= 50 ( <b>mean</b> ) for last 5 minutes	843
SYSTOLIC ABP ALERT	2084	ABP Systolic < 85 AND MAP < 60 for last 5 minutes ( <b>mean</b> )	1317
PCO2 ALERT	1131	PCO2 is <=25 or >= 55	631
SYSTOLIC NIBP ALERT	878	NIBP Systolic < 85 AND MAP < 60	707
GLUCOSE ALERT	640	Glucose is <=45 or >=400 ( <b>suppress</b> )	N/A
NIBP MAP ALERT	533	NIBP MAP <= 50 in the last 1 minute	446
ELEVATED HR ALERT	415	HR >= 150 for last 5 minutes ( <b>mean</b> )	336
AKI ALERT	352	rise in 0.3 or doubling of creat and Urine < 100mls/4 hours average ( <b>Suppress for patients on dialysis or CCRT</b> )	279
<b>Totals:</b>	15704	N/A	9560

Alert Volume  
Reduction

39%



# Seamless Integration of Video and Live Waveforms into EMR

Application Server uphsepipe06 - PROD - PENN E-LERT VIRTUAL - KRIST 3 : Hospital ADT

Encounters Hospital Chart Patient Lookup Bed Board My Reports Telephone Call Print Log Out

Chart ... Remot... Results ...

Remote Monitoring

REMOTE MONITORING

Launch Video

Mark as Reviewed

End Elerl Notifica...

BestPractice

Device Select

Progress Notes

Pt Specific Alert

End Patient Alert...

Search

SpO2 Abnormal

Allergies: No Known Allergies

ADMITTED: 10/31/2022 (1 D)

Patient Class: Inpatient

R temporal ICH

Ht: 5' 8" (172.7 cm)

Last Wt: 200 lb (90.7 kg)

BMI: 30.41 kg/m<sup>2</sup> !

NO ORDERS TO ACKNOWLEDGE

NEW RESULTS, LAST 36H

ACTIVE MEDS (21)

Scheduled (2)

Continuous (2)

PRN (17)

One-Step

CrCl/SCr: 100.9 mL/min, 0.8 mg/dL

Launch Video Camera (Caregility)

Connect

Mark as Reviewed

Mark Patient as Reviewed

Filed on 11/1/22 at 0519 by

End Elerl Notification

End Elerl

BestPractice Advisories

No advisories to address.

Device Select

Name	Type	Ass...
H1009NEURON	UPHS IP NEURON 0009 (VENT/BIP)	At
HUPEast.10City.NICU...	UPHS IP CAREGILI 0009 DEVICE	
HUP10CITY1009BEDM...	UPHS IP BEDSIDE MONITOR	

Progress Notes

Create Note in NoteWriter

Notes Activity

Create Note

COV Telemed add on 1

COV phone visit 2

COV video visit 3

Incomplete Progress Notes (last 24 hours)

Author Serv... Auth... Cosign File Time

Index

- Orders
- Plan of Care
- Req Doc
- Active Lines
- Allergies
- Tx Team
- Admit Info
- Meds
- Nurse Drive
- Heparin
- Monitoring
- Inpatient
- Sedation
- Monitoring
- Chemotherapy
- Checklist
- Current Meds
- I/O & Results
- Tasks
- Problem List
- History
- Blood Admin
- Vitals/Hemodynamics
- MAR Audit
- Bowel Management
- Info
- Anticoagulation
- Monitoring
- Glucose and Insulin
- Monitoring
- Penn E-lerl
- Alerts

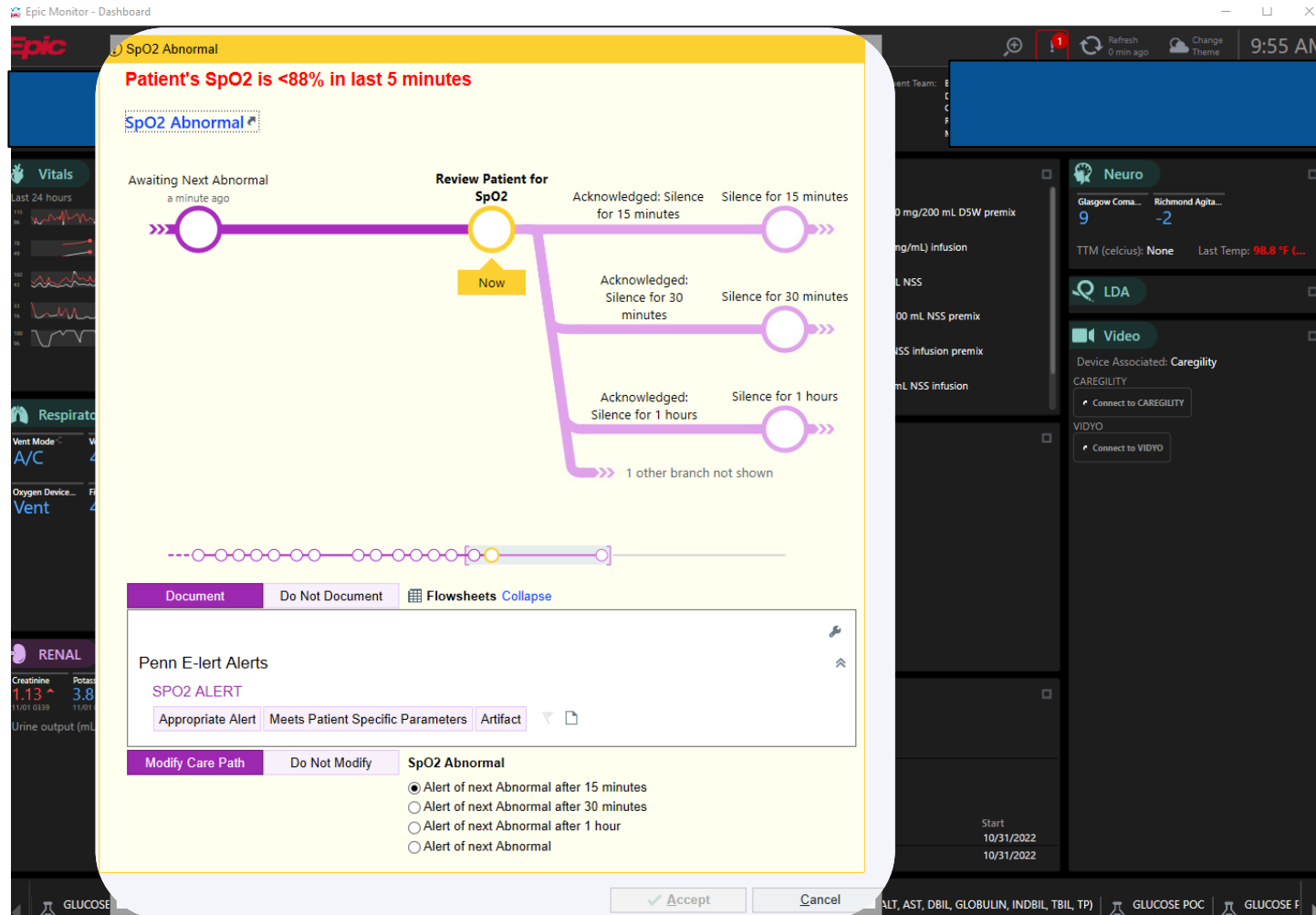
Video Feed: Patient PPMAC-PAC3-HVICU-PPMD-PAC3-HVICU/3011

Camera platform launched within EMR

Live Waveforms launched from within EMR



# Governance in Managing Alarms and Escalation



Health System needs Governance to address deterioration / abnormal values

Logic to:  
Acknowledge  
Delay / park  
Action  
Appropriate action  
Escalation

The EMR is ideal for this and records who is actioning and what is being actioned

# Governance in Alert Validation Process

## BPA ALERT FIRES FROM PATIENT ASSIGNMENT LIST

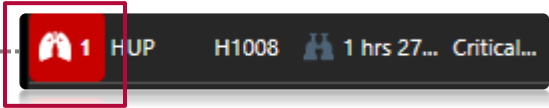
Team Member clicks on alert to open patient in PennChart (EPIC). Alert is noted on patient's storyboard.

## TEAM MEMBER CLICKS ON ALERT FROM STORYBOARD

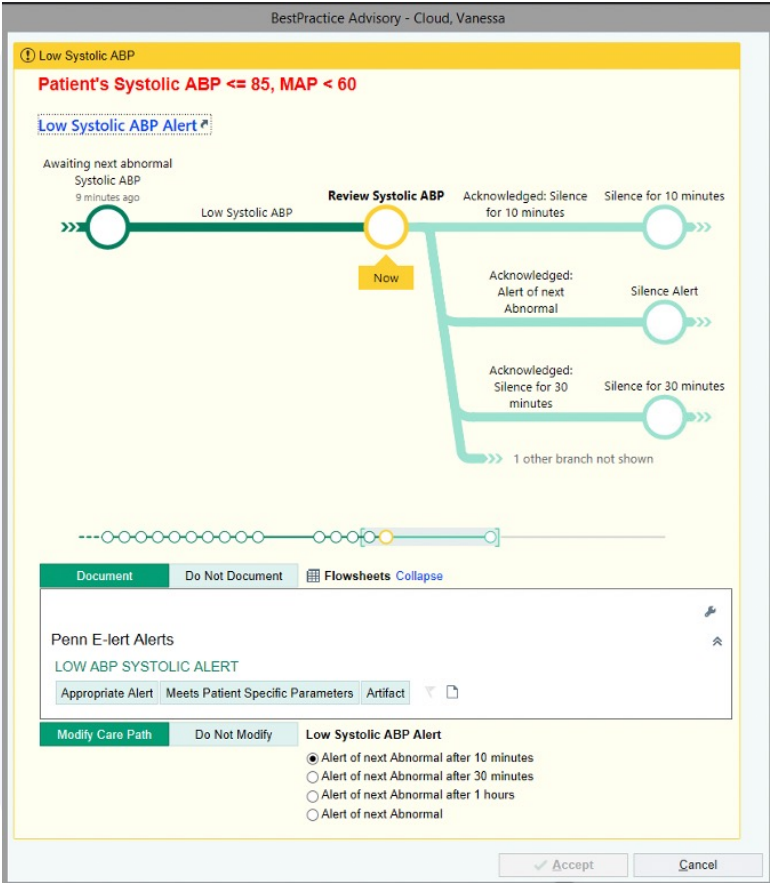
Decision tree is brought up to validate alert and Team Member selects one of the following validations: Appropriate, Meets Patient Specific Parameters or Artifact.

## TEAM MEMBER SELECTS VALIDATION, A TIME INTERVAL AND HITS "ACCEPT" TO CLEAR ALERT

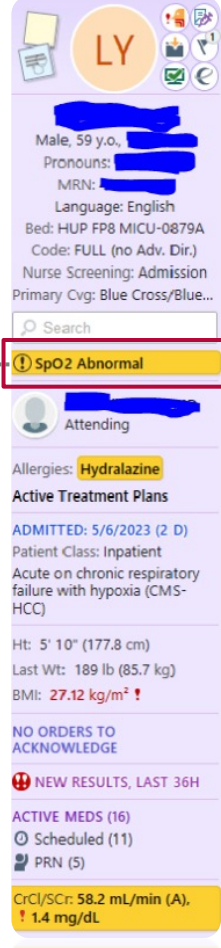
1.



2.



3.



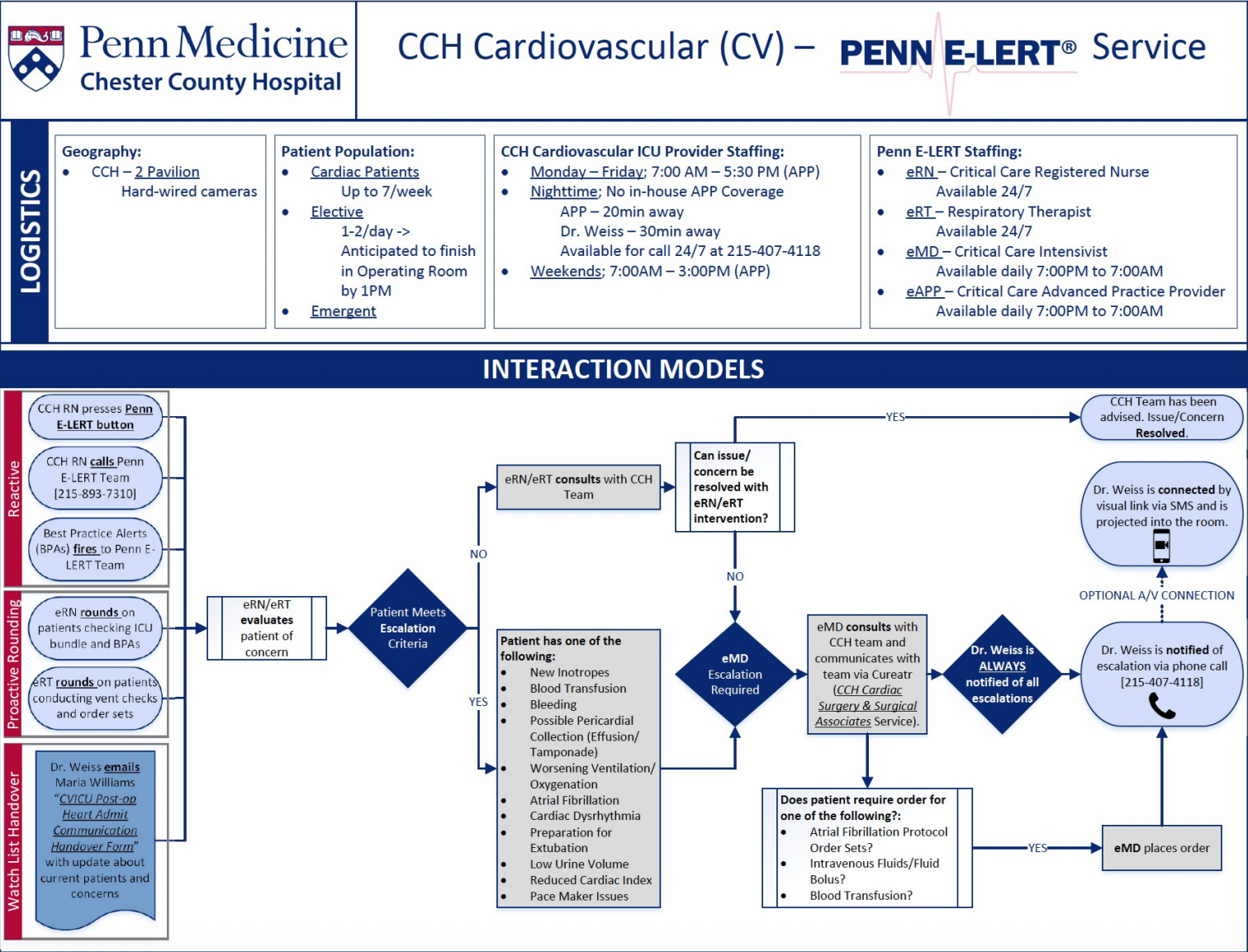
# Governance in Escalation to Providers

Logistics

Proactive

Reactive

Watch List





Penn Medicine

# EPIC Integrated Tele-ICU Platform

## Illustration of Functionality using our eRT Service



# Creation of an eRT (eRespiratory Therapy) Service

The NEW ENGLAND  
JOURNAL of MEDICINE

IN DEPTH

## Deployment of Tele-ICU Respiratory Therapy and the Creation of an eRT Service Line

Krzysztof Laudanski, MD, PhD, MA, FCCM, MHC, Michael Scott, MBChB, FRCP, FRCA, FFICM,  
Ann Marie Hufferberger, DBA, RN, NEA-BC, Justin Wain, C. William Hanson III, MD  
Vol. 3 No. 6 | June 2022  
DOI: 10.1056/CAT.21.0239



➤ *“The eRT Service detected unfavorable practice patterns in ARDS treatment and intervened before the ARDS algorithmic trigger was activated; this demonstrates that proactive chart review focused on targeted, high-value intervention can result in improved outcomes over a solution using algorithms and system design to respond to it.”*

Table 1. Facilities Covered by the eRT Service Line\*

Hospital	Number of Beds	Number of eRT Interventions	ICU Description
Hospital 1	24	159	Medical ICU
Hospital 2	14	35	General ICU
Hospital 3	6	28	Long-term acute care
Hospital 4	22	2,889	Neuro ICU
	16	4,368	Surgical ICU
	36	5,586	Heart and vascular ICU
	12	1,578	Cardiac ICU
	24	5,574	Medical ICU
Hospital 5	24	214	General ICU
Hospital 6	16	269	Surgical and cardiac and neuro ICU
	13	581	Medical ICU
Hospital 7	16	1,773	Medical ICU
	24	2,013	Heart and vascular and cardiac ICU
	24	1,649	Trauma and surgical ICU
	24	1,548	Neuro ICU

\*Significant diversity in ICU profile and size is seen across hospitals, underscoring the ability of the telemedicine respiratory therapist (eRT) service line to adapt to various settings and to take into account the needs and culture of the particular unit. We found that over time, ICU diversity was reflected in the mix of services provided. Source: The authors

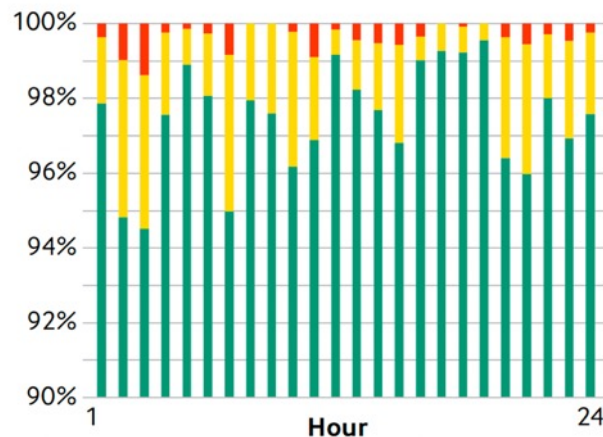
NEJM

Catalyst

Innovations in Care Delivery

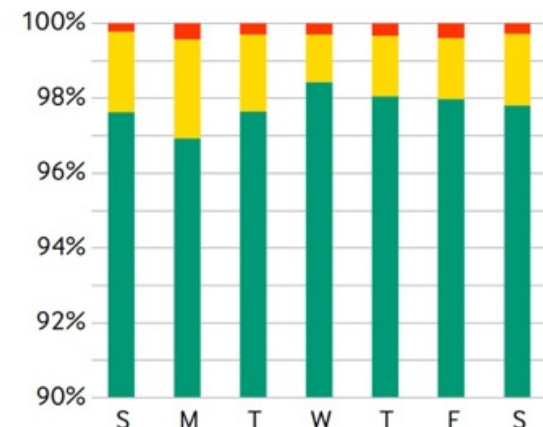
C – Responses Per 24 Hours

Interactions: Routine Urgent Emergent



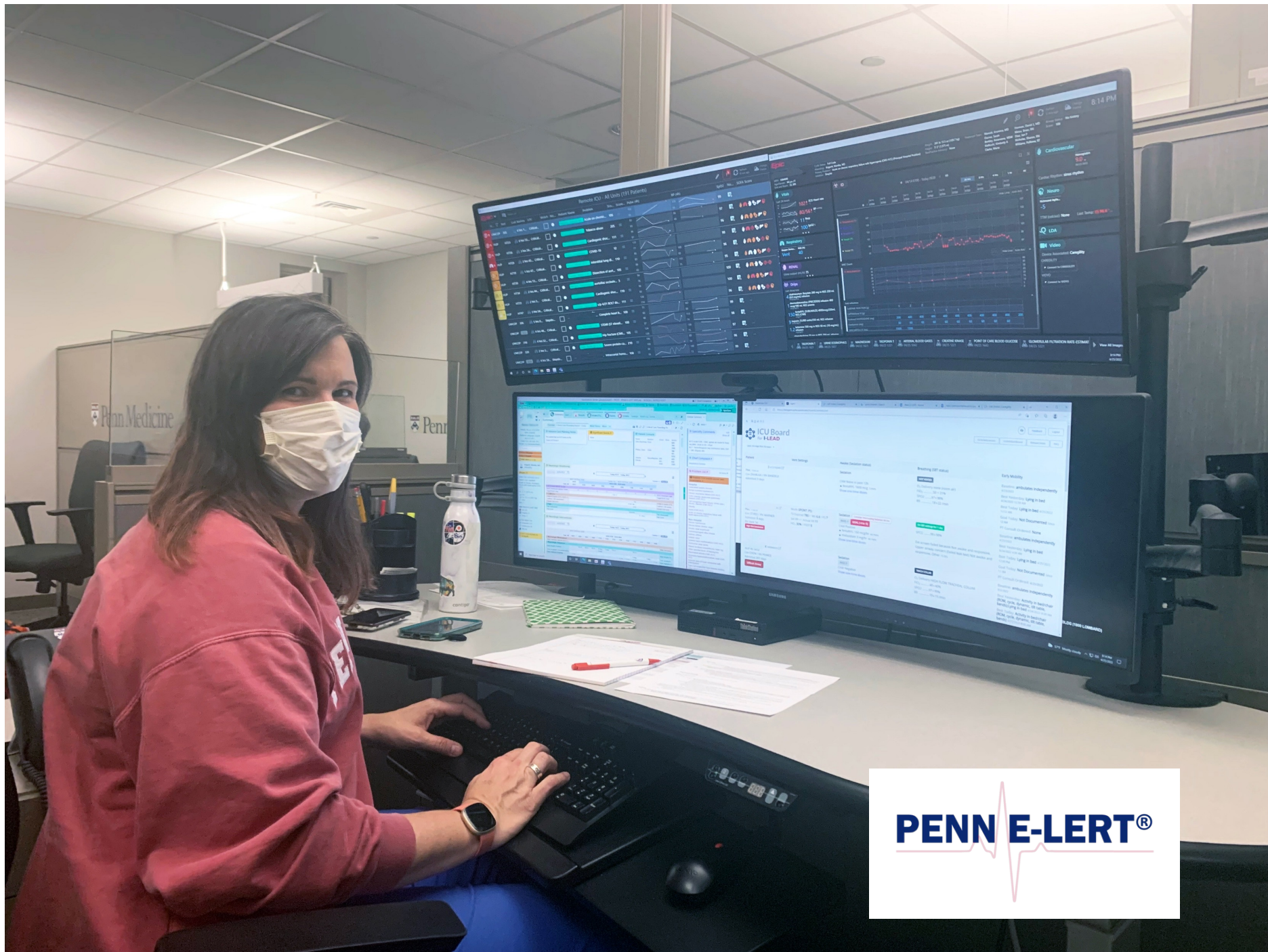
D – Percent Routine, Urgent and Emergent Per Day

Interventions: Routine Urgent Emergent



eRT data collection period was 42 days





# Best Practice

## PROACTIVE

Compliance With Best Practice

- ICU Bundle
- Sepsis Bundle
- Low Volume Protective Lung Ventilation
- Trending abnormal physiological values

## REACTIVE

Immediate Detection of Physiological Changes

- Bedside support for nurse and provider
- 2 Way Audio/Visual
- Advice and Intervention
- Activation of Teams and Protocols

## PREDICTIVE

The Future

- Predictive physiological deterioration interventions before harm occurs.

# PENN E-LERT Workstation Screens

- PENN E-LERT's workstation monitoring pages consist of three (3) main EPIC screens:

UNIT LEVEL DATA

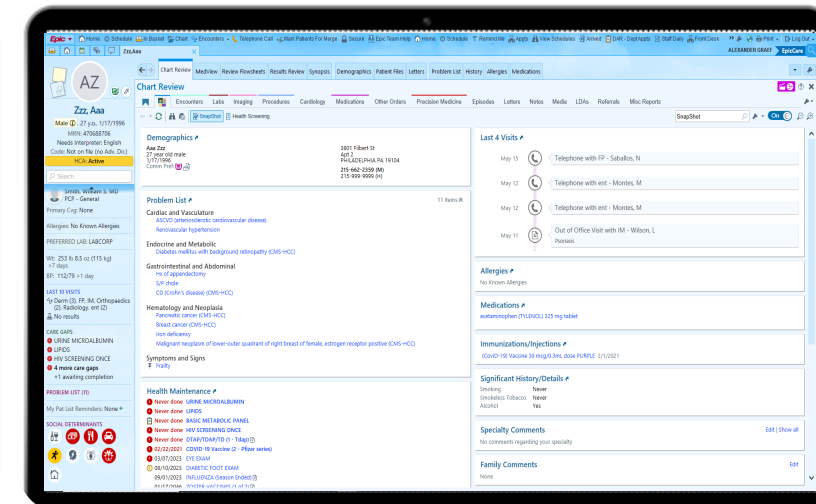
LIVE PATIENT LEVEL DATA

PATIENT LEVEL  
INTERACTION

BPA Alert Screen/Patient  
Assignment List Screen

Widget/Dashboard Screen

PennChart/Patient's Chart  
in EPIC Screen





## BPA Alert Screen/Patient Assignment List Screen

Some of the information found on the Best Practice Advisory (BPA) Alert Screen/Patient Assignment List include:

- Patient Name
- Patient Location
- Patient Problem(s)
- Patient Acuity Score
- Date/Time of Last RN Review
- Pulse Trends
- Blood Pressure Trends
- SPO2 Value
- Notes
- SOFA Pictures of Affected Systems

Hosp	B. △	Last Review	LOC	Wa...	N...	Patient Name	Problem	Sc...	Scor...	Pulse (4h)	BP (4h)	SpO2	N...	SOFA Score
HUP	302	0 hrs 21...	Critical...	<input type="checkbox"/>	●	[REDACTED]	COVID-19	110	=	87 83		100		[SOFA Icons]
HUP	303	0 hrs 18...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Acute hypoxemic...	112	↑ 100	131 87		92		[SOFA Icons]
HUP	304	0 hrs 19...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Acute hypoxemic...	105	=	99 90		94		[SOFA Icons]
HUP	305	0 hrs 21...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Acute respiratory...	111	=	92 85		91		[SOFA Icons]
HUP	306	0 hrs 18...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Moderate protein...	105	=	121 82	150 51	98		[SOFA Icons]
HUP	307	0 hrs 1...	Critical...	<input type="checkbox"/>	●	[REDACTED]	COVID-19	311	=	112 85		92		[SOFA Icons]
HUP	308	0 hrs 19...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Acute respiratory...	211	=	108 97		95		[SOFA Icons]
HUP	0960	1 hrs 29...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Seizure (CMS-HCC)	212	=	76 63	115 52	100		[SOFA Icons]
HUP	0961	5 hrs 35...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Sepsis (CMS-HCC)	210	↑ 100	136 134		96		[SOFA Icons]
HUP	0962	0 hrs 7...	Critical...	<input type="checkbox"/>	●	[REDACTED]	Acute renal failur...	105	=	176 129 79	149 72	95		[SOFA Icons]



















## BPA Alert Screen/ Assignment List Screen

### With Alerts












#### Best Practice Advisory (BPA) Alerts:

- Alerts are color coded based on severity: Red, Orange, Yellow.
- The most recent or severe alert will appear at top of screen.
- The icon in the alert designates what system is affected or the type of alert.

**Epic** Patient List Remote ICU - RN Assignment A (53 Patients) 3 Refresh 0 min ago Change Theme

	Hosp	Bed	Last R...	LOC	Watch	No...	Patient Name	Problem	Sco...	Score...	Pulse (4h)	BP (4h)	SpO2	Note	SOFA Score
	PPMC	5006	4 hrs 22...	Critical...	<input type="checkbox"/>			Stroke due to intr...	105*	=	88 84	159 81	94		
	PPMC	3019	0 hrs 10...	Critical...	<input type="checkbox"/>			Drug-induced my...	100*	=	99 84	144 86	95		
	HUP	H1069	0 hrs 13...	Critical...	<input type="checkbox"/>			Acute on Chronic...	210*	↑ 5	90 80		92		
	PPMC	5012	6 hrs 16...	Critical...	<input type="checkbox"/>			Closed nondispla...	107*	=	111 103	124 79	98		
	PPMC	3005	6 hrs 12...	Critical...	<input type="checkbox"/>			5/3: CABG x3 (LL...	205*	↑ 100	111 91	142 60	97		

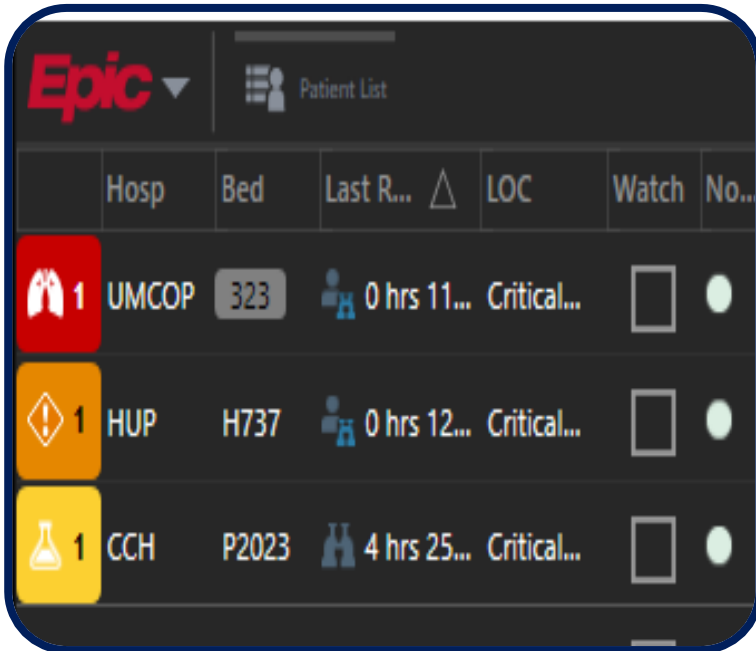
**Epic** Patient List Remote ICU - RN Assignment A (53 Patients) 3 Refresh 0 min ago Change Theme

	Hosp	Bed	Last R...	LOC	Watch	No...	Patient Name	Problem	Sco...	Score...	Pulse (4h)	BP (4h)	SpO2	Note	SOFA Score
	HUP	H1069	0 hrs 15...	Critical...	<input type="checkbox"/>			Acute on Chronic...	210*	↑ 5	90 80		92		
	PPMC	5006	4 hrs 24...	Critical...	<input type="checkbox"/>			Stroke due to intr...	105*	=	88 84	159 81	94		
	PPMC	5012	6 hrs 18...	Critical...	<input type="checkbox"/>			Closed nondispla...	107*	=	111 103	124 79	98		






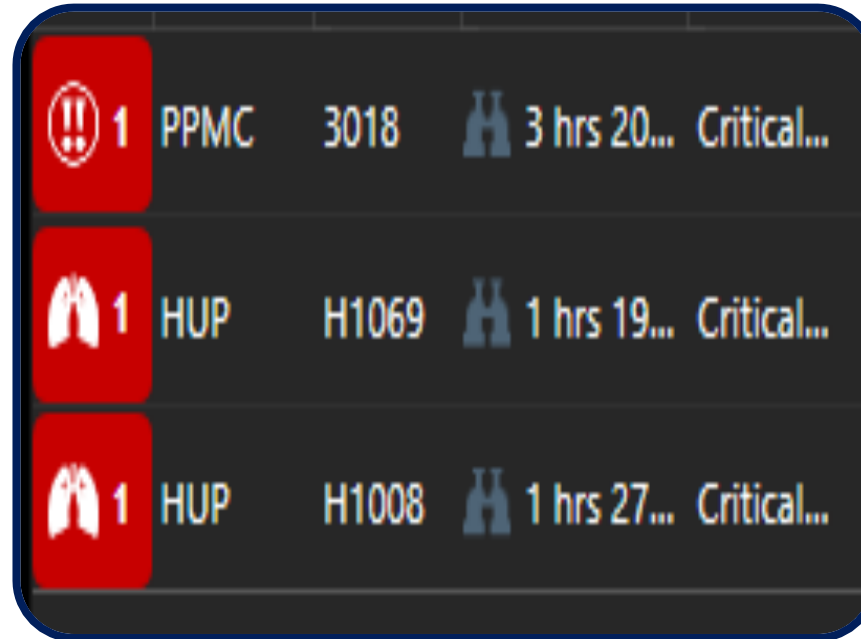
## Best Practice Advisory (BPA) Alert Screen

## With Quality Improvement and Safety Alerts






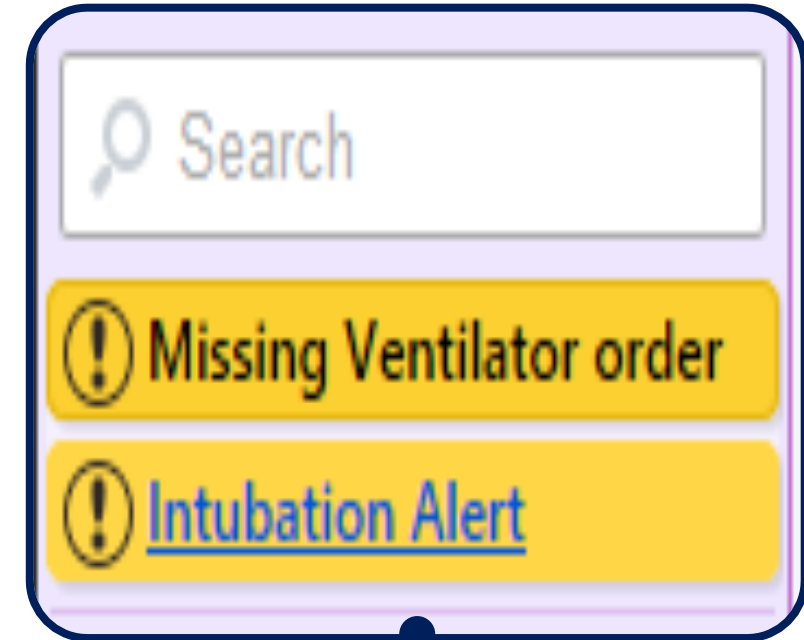
A screenshot of the Epic Patient List interface. The header shows the Epic logo and a 'Patient List' tab. Below the header is a table with columns: Hosp, Bed, Last R..., LOC, Watch, and No... The table contains three rows of patient data, each with a colored icon in the first column: a red lung icon for UMCOP, an orange diamond icon for HUP, and a yellow flask icon for CCH. Each row also shows a bed number, a time-to-event indicator (e.g., '0 hrs 11...'), and a status (e.g., 'Critical...').

	Hosp	Bed	Last R...	LOC	Watch	No...
	UMCOP	323	0 hrs 11...	Critical...	<input type="checkbox"/>	<input checked="" type="radio"/>
	HUP	H737	0 hrs 12...	Critical...	<input type="checkbox"/>	<input checked="" type="radio"/>
	CCH	P2023	4 hrs 25...	Critical...	<input type="checkbox"/>	<input checked="" type="radio"/>




A zoomed-in screenshot of the patient list table, showing three rows of data. Each row starts with a red square icon containing a white exclamation mark and the number '1'. The data includes patient names (PPMC, HUP, HUP), bed numbers (3018, H1069, H1008), and time-to-event indicators (3 hrs 20..., 1 hrs 19..., 1 hrs 27...). The status for all three patients is 'Critical...'. The table also includes columns for 'Hosp' and 'Bed'.


	PPMC	3018	3 hrs 20...	Critical...
	HUP	H1069	1 hrs 19...	Critical...
	HUP	H1008	1 hrs 27...	Critical...



A screenshot of an alerts panel. At the top is a search bar with the text 'Search'. Below the search bar are two yellow alert boxes. The first alert box contains a red exclamation mark icon and the text 'Missing Ventilator order'. The second alert box contains a red exclamation mark icon and the text 'Intubation Alert'.

Search

 Missing Ventilator order

 Intubation Alert

Additional eRT Quality Improvement  
and Safety Alerts Not Shown in  
Screenshot:

- Extubation Alert
- High FIO2
- PEEP>12
- High Pressure
- Low Tidal Volume
- Missing Risk Screen/Plan
- PH/Co2

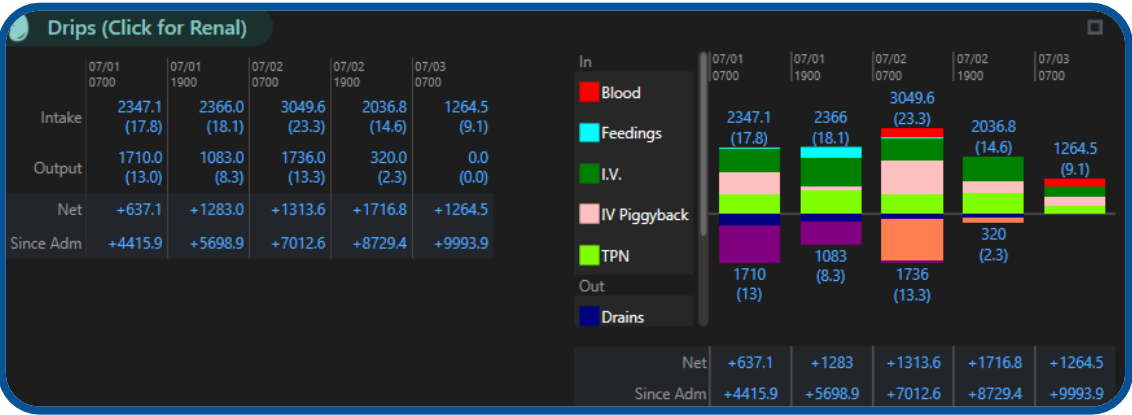
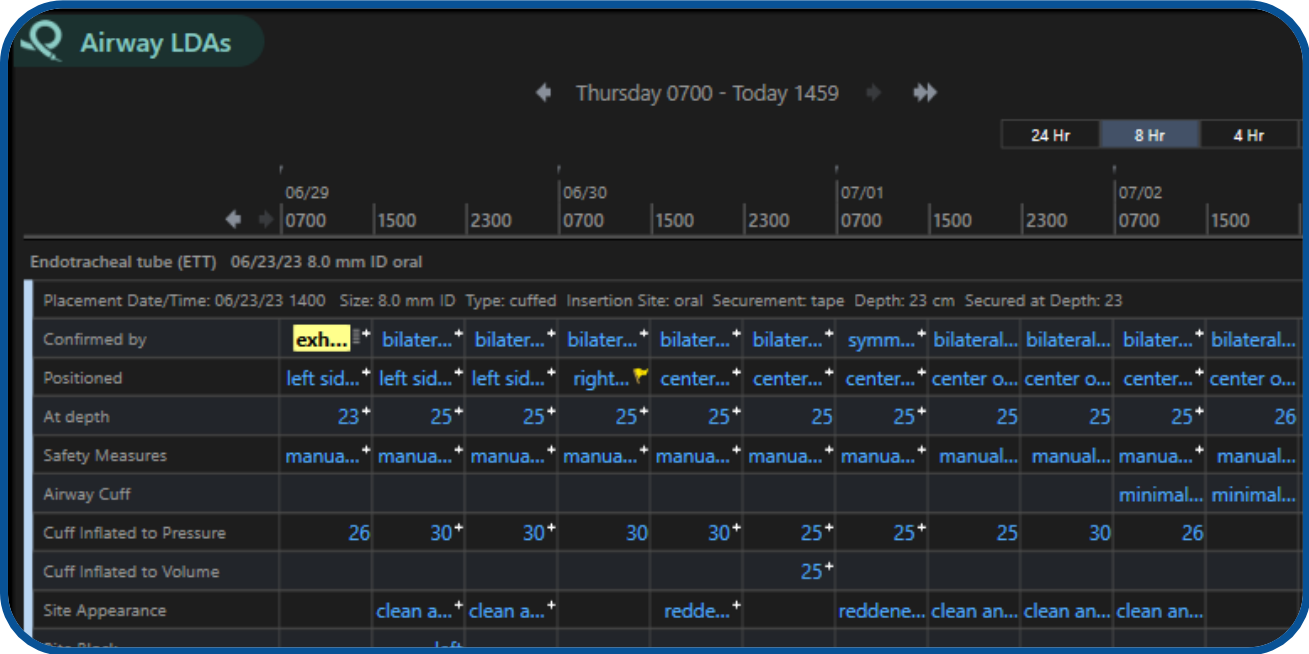
## Widget/Dashboard Screen

- Some items that can be found on the Widget/Dashboard Screen include:
  - Information at a single glance for each system.
  - Live Waveforms.
  - Live Camera Feed.
- Displayed widgets are customizable within EPIC Monitor at the user level.
- If you click on one of the widget boxes, the view will expand with additional details on that specific system.



# Widget/Dashboard Screen

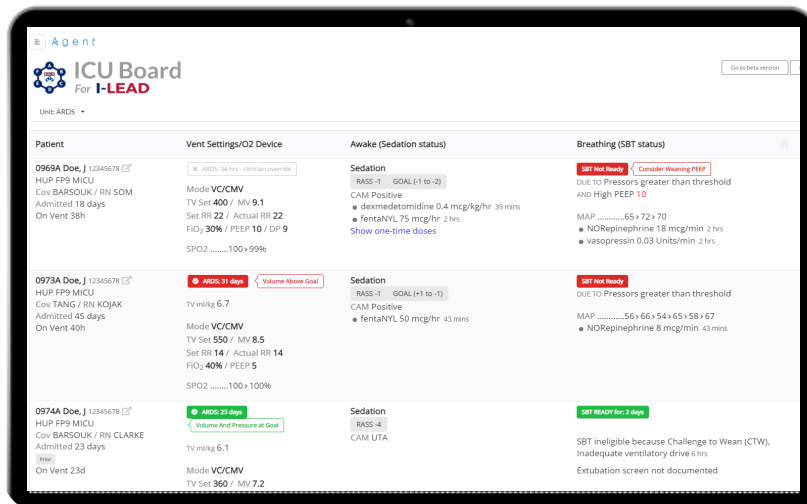
# With Expanded Views of Airway LDAs, Drips and Vent Settings Widgets



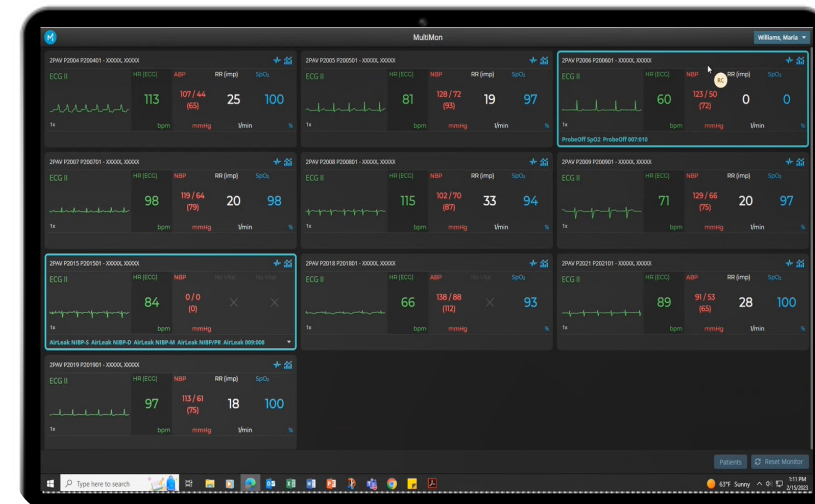
# Additional EPIC Integrated Applications

- In addition to the three (3) main EPIC screens, the PENN E-LERT team also utilizes the internal Agent ICU Board and Sickbay Monitor applications. These applications communicate with EPIC and provide the PENN E-LERT team with valuable information to improve patient quality and safety.

## ICU Board



## Sickbay Monitor



## ICU Board

- The ICU Board application pulls pertinent information from EPIC to alert the eRT of the following quality and safety improvement opportunities:
  - ARDS/LPV Intervention
  - SBT

Agent

**ICU Board**  
For I-LEAD

Unit: ARDS ▾

Go to beta version

Patient	Vent Settings/O2 Device	Awake (Sedation status)	Breathing (SBT status)
<b>0969A Doe, J</b> 12345678 HUP FP9 MICU Cov BARSOUK / RN SOM Admitted 18 days On Vent 38h	✕ ARDS: 34 hrs - clinician override  Mode <b>VC/CMV</b> TV Set <b>400</b> / MV <b>9.1</b> Set RR <b>22</b> / Actual RR <b>22</b> FiO <sub>2</sub> <b>30%</b> / PEEP <b>10</b> / DP <b>9</b>  SPO2 .....100 > 99%	<b>Sedation</b> RASS -1 GOAL (-1 to -2) CAM Positive ● dexmedetomidine 0.4 mcg/kg/hr 39 mins ● fentaNYL 75 mcg/hr 2 hrs <a href="#">Show one-time doses</a>	<b>SBT Not Ready</b> <a href="#">Consider Weaning PEEP</a> DUE TO Pressors greater than threshold AND High PEEP <b>10</b>  MAP .....65 > 72 > 70 ● NORepinephrine 18 mcg/min 2 hrs ● vasopressin 0.03 Units/min 2 hrs
<b>0973A Doe, J</b> 12345678 HUP FP9 MICU Cov TANG / RN KOJAK Admitted 45 days On Vent 40h	✓ ARDS: 31 days <a href="#">Volume Above Goal</a>  TV ml/kg 6.7  Mode <b>VC/CMV</b> TV Set <b>550</b> / MV <b>8.5</b> Set RR <b>14</b> / Actual RR <b>14</b> FiO <sub>2</sub> <b>40%</b> / PEEP <b>5</b>  SPO2 .....100 > 100%	<b>Sedation</b> RASS -1 GOAL (+1 to -1) CAM Positive ● fentaNYL 50 mcg/hr 43 mins	<b>SBT Not Ready</b> DUE TO Pressors greater than threshold  MAP .....56 > 66 > 54 > 65 > 58 > 67 ● NORepinephrine 8 mcg/min 43 mins
<b>0974A Doe, J</b> 12345678 HUP FP9 MICU Cov BARSOUK / RN CLARKE Admitted 23 days On Vent 23d Prior	✓ ARDS: 23 days <a href="#">Volume And Pressure at Goal</a>  TV ml/kg 6.1  Mode <b>VC/CMV</b> TV Set <b>360</b> / MV <b>7.2</b>	<b>Sedation</b> RASS -4 CAM UTA	<b>SBT READY for: 2 days</b>  SBT ineligible because Challenge to Wean (CTW), Inadequate ventilatory drive 6 hrs Extubation screen not documented



## Sickbay Monitor

- In communication with the EPIC dashboard, the Sickbay Monitor application displays live waveform information and **alerts the eRT of a change in patient respiratory status.**
- The PENN E-LERT team can access the Sickbay Monitor application via a web browser or within EPIC Monitor via a widget.

### Sickbay Monitor in Web Browser



### Sickbay Monitor in EPIC Monitor as a Widget



# Sickbay platform distributing waveforms for an ICU

Dashboard:

Silent Alarms

Configurable Display / waveforms

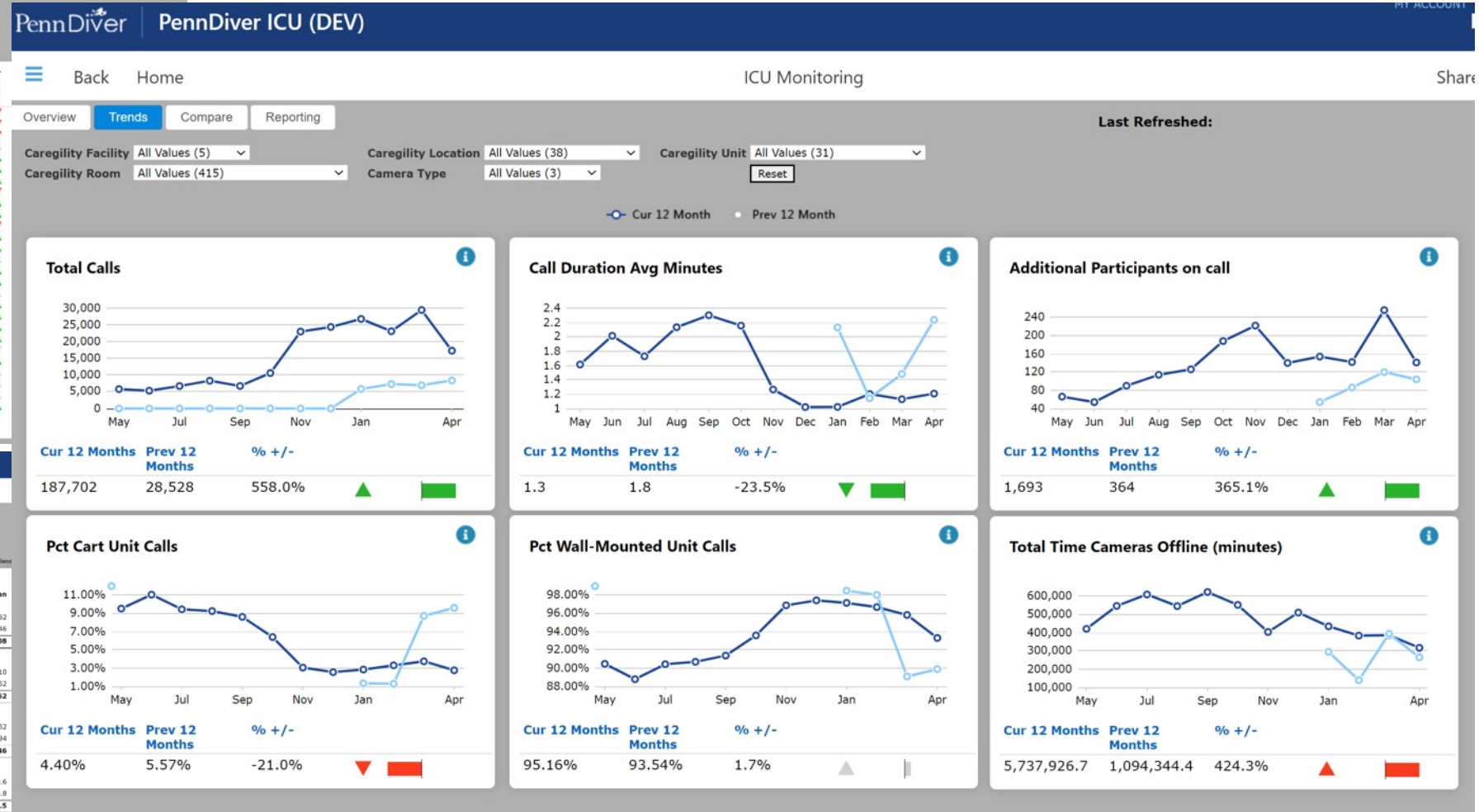
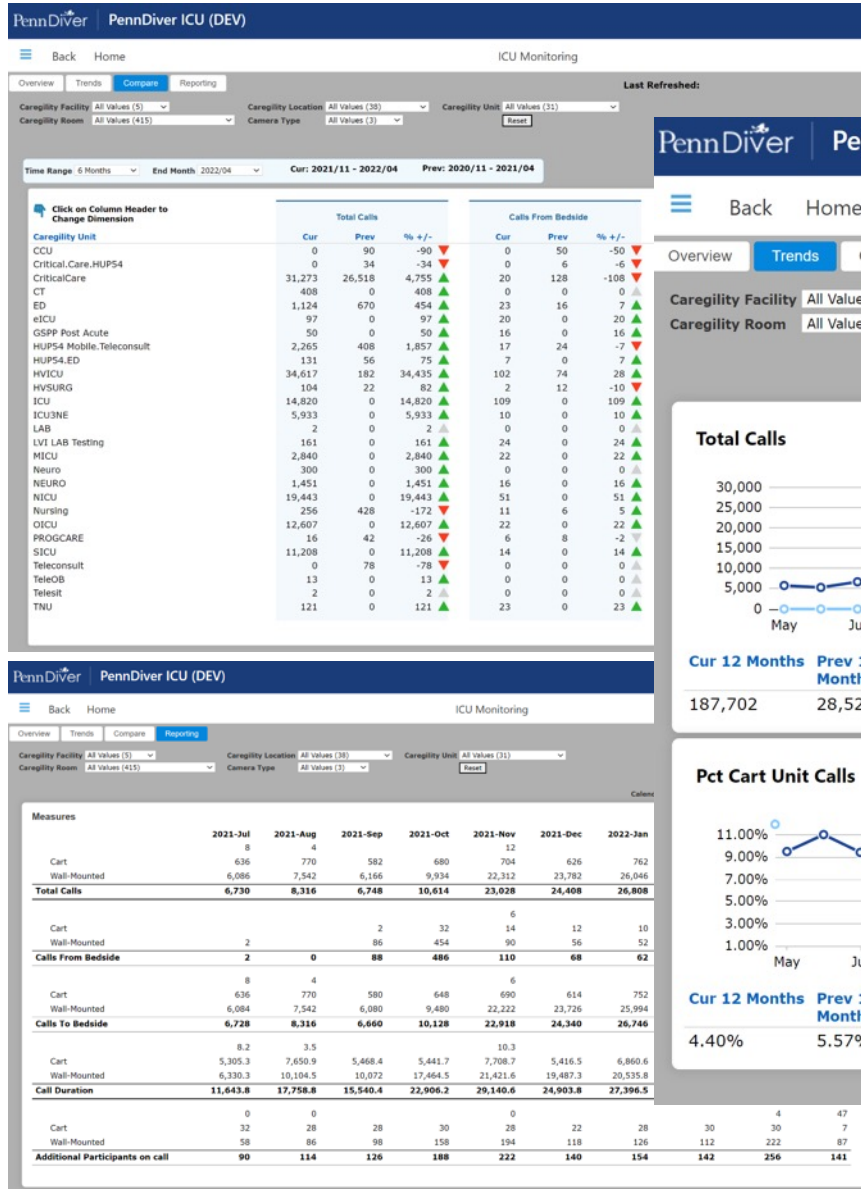
Color coded alarms

Choose routing of alarms:

local / central



# Metrics – Mapping Reliability



Everyone has access to their own data!

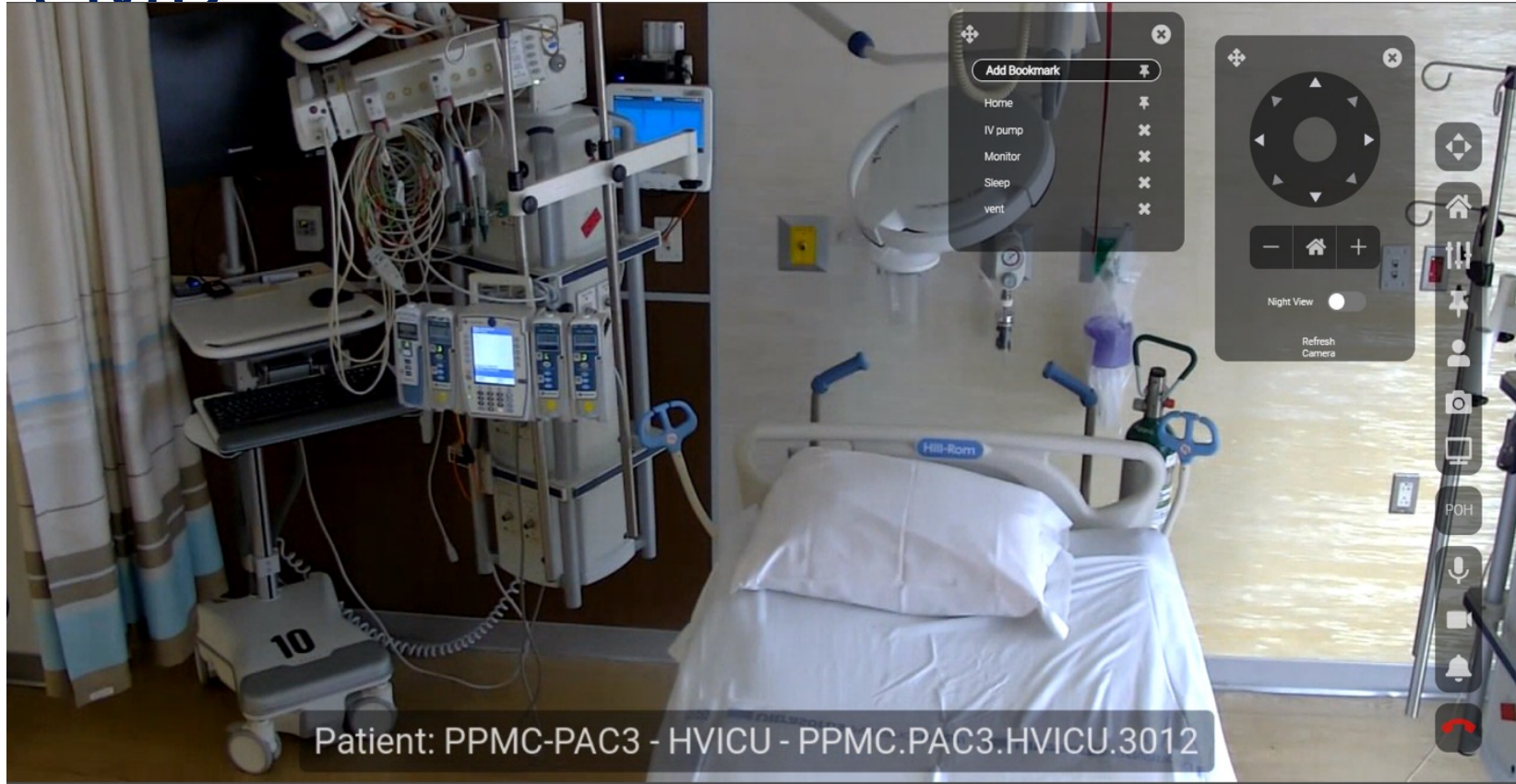




**Penn Medicine**  
Hospital of the University of Pennsylvania

# **Future State - Can you Control an ICU Remotely?**

# Gift of Life Center is staffed remotely by eAPP & eMD



6 beds

Admission, orders sets, changes in orders if physiological change

Remote ventilator changes

# Summary





# Platform

Integrated EMR with  
Live Physiological  
Waveforms, Smart  
Alarms and Bedside  
Camera Platform

Live Monitoring  
Waveforms

Cloud  
AI Smart Alarm  
Algorithms

Health System  
Monitoring

Ensures All patients Treated the Same  
No Weakest Link = High Reliability  
Proactive & Reactive Detection  
Earlier Intervention = Better Outcomes  
Quality & Efficiency

Electronic Medical Record / Physiological Data

Bedside  
Monitor

Wearable  
Monitor

Bedside  
Provider

Patient

eRN / eRT  
eMD / eAPP

Identification  
Validation  
Escalation  
Bedside Support

Validation / Further Information  
Intervention

Attending  
Provider

High Level Decision Making

Visual Situational Awareness if  
not bedside

# Main Causes of Serious Untoward Events in Health Care

- 01 Failure to follow procedure or best practice
- 02 Failure to recognize a problem
- 03 Failure to escalate appropriately
- 04 Lack of governance in all of the above
- 05 Lack of 'SAFE' environment where providers feel empowered to reach out for support



# Building the Tele ICU Platform into the EMR ensures we address these Issues

01

Best practice is set and followed

02

Early Recognition of a patient with a problem – trending values and live waveforms

03

Governance in escalation both clinically and bedside provider

04

Governance in all of the above

05

A 'SAFE' environment where providers feel empowered to reach out for support

80%

of opportunity  
during nights  
and weekends





# The Future is Already Here in Tele ICU

Fully integrated functional platform with visual dashboards and intuitive, time saving interface

Proactive Best Practice compliance and governance is now available across a Health System

Smart Alarms are here - Best Practice Advisory's / Alarms can be configured outside of the bedside monitor

Connectivity and 3<sup>rd</sup> party software is now enabling the integration of live physiological data and waveforms in real-time into the Electronic Medical Record

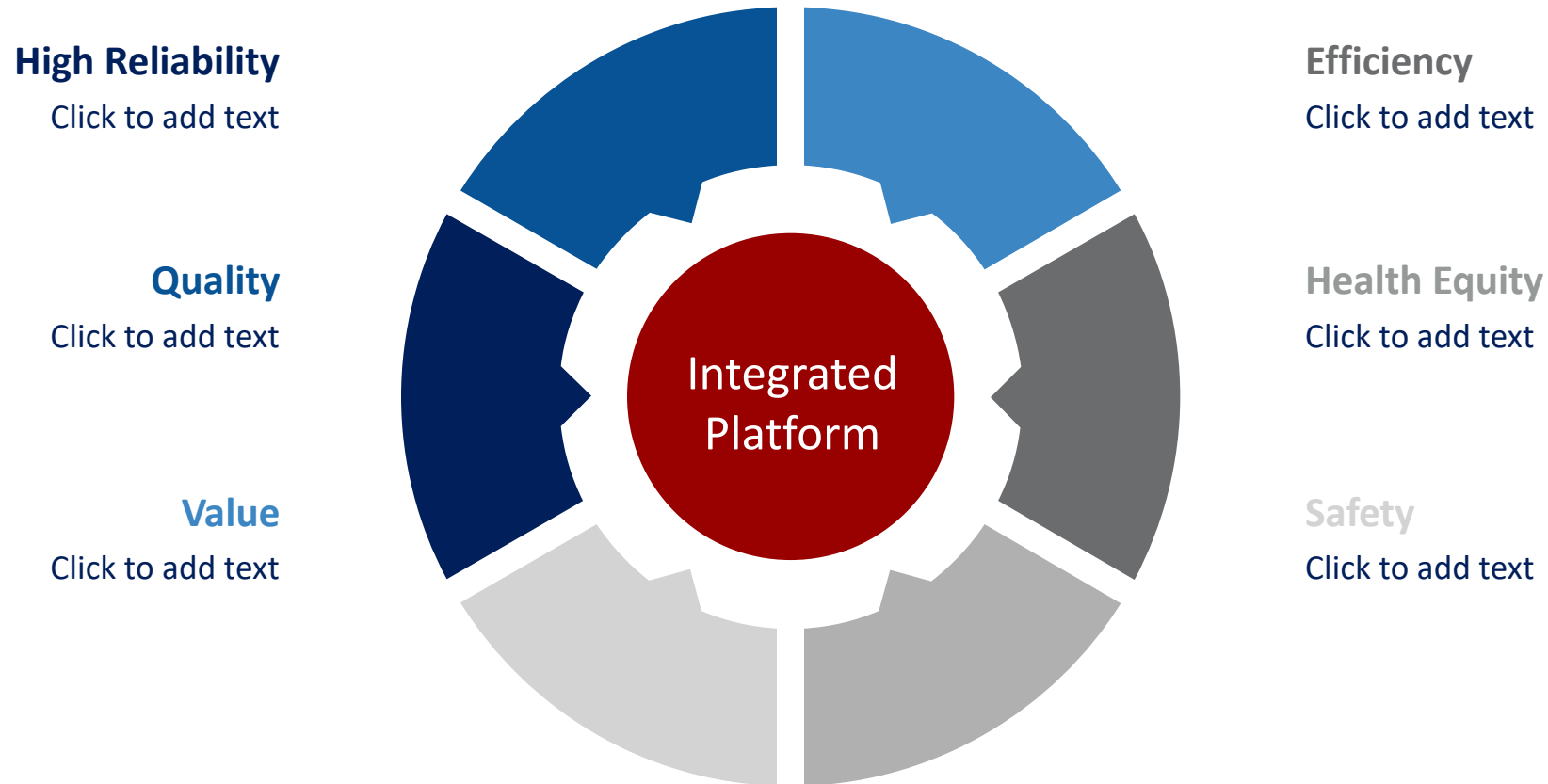
Earlier detection of Trends is possible, augmented by physiological waveforms

Live waveforms being linked to EMR means AI can be used— AKI prevention, hypotension prevention

Remote interaction can be almost instantaneous allowing situational awareness and high level decision making

Platform can be utilized across the Health System – implications for resource allocation and bedside provider support

# The Integrated Platform Drives Health System:



# Thank You!



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