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Strengthening Pediatric Sepsis Response Through Analytics and Culture

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Learning Objectives

- Explain how ghost alert testing and refined criteria can improve EMR-based pediatric sepsis alerts.

- Describe how a foundation of high-reliability science and safety culture amplifies quality improvement methodology.

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Purpose

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Clinical Need:
Pediatric sepsis screening tool
Improve early detection

System Integration:
Integrate alerts and sepsis protocols.

Protocol Framework
Nurse-driven screening
Nurse/Provider clinical judgment
Triage data for parameter inputs
Structured compliance feedback

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Background: Out with the Old Process

Old alerting:

- Low sensitivity
- Poor clinical adoption
- Inadequate staff awareness
- No engagement.

Documentation Gaps:

- Incomplete alert inputs
- Inconsistent triage workflow

Risk Stratification Conflicts:

- High-risk populations
- Separate protocols
- Priority Conflicts

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Approach

- **Existing Alert Parameters**:
  - Capillary refill (Subjective)
  - Neurological assessment
  - Risk factors
  - Vital signs
  - Age specific blood pressure

- **Performance Deficiencies**:
  - Baseline override rates 64-100%
  - Poor inter-rater reliability
  - Sensitivity
  - Specificity
  - Precision/Accuracy

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Statistics Behind EHR Alerting

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Term	Key Question
Sensitivity	If a person is sick, how likely is the test to be positive?
Specificity	If a person is healthy, how likely is the test to be negative?
PPV	If the test is positive, how likely is the person to be sick?
NPV	If the test is negative, how likely is the person to be healthy?
Accuracy	Overall, how often is the test correct?

Approach: Interventions

1. **Redesign Framework**:
   Structured performance improvement
   Clinical champion collaboration

2. **Definition Alignment**:
   Phoenix Criteria Focus
   Redesign Alerting Parameters

3. **Comparative Validation**:
   New alert criteria against previous alert system performance.
   “Ghost" alert methodology for safe system testing.

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*Development and Validation of the Phoenix Criteria for Pediatric Sepsis and Shock: JAMA 2024

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Organ System	Score Range	Criteria / Derivation
Respiratory	0–3 points	Based on PaO_2 or SpO_2, with thresholds spanning from ≥ 400 (0 pts) down to < 100 (3 pts)
Cardiovascular	0–6 points	Composite of number of vasoactive medications (0–2 pts), lactate level (< 5 / 5–10.9 / ≥ 11 mmol/L for 0–2 pts), and age-adjusted MAP thresholds
Coagulation	0–2 points	One point each for abnormalities in platelets, INR, D-dimer, or fibrinogen (max 2 pts)
Neurologic	0–2 points	Based on GCS: ≥ 11 (0 pts), ≤ 10 (1 pt), or bilaterally fixed pupils (2 pts)

Age	MAPs (normal 0 points)
< 1mon	>30
1-11 mons	>38
1-2 years	>43
2-5 years	>44
5-12 years	>48
12-17 years	>51

*Sanchez-Pinto, L. N., Bennett, T. D., DeWitt, P. E., Russell, S., Rebull, M. N., Martin, B., Akech, S., Albers, D. J., Alpern, E. R., Balamuth, F., Bembea, M., Chisti, M. J., Evans, I., Horvat, C. M., Jaramillo-Bustamante, J. C., Kissoon, N., Menon, K., Scott, H. F., Weiss, S. L., … Wynn, J. L. (2024). *Development and Validation of the Phoenix Criteria for Pediatric Sepsis and Septic Shock*. **JAMA, 331**(8), 675–686. https://doi.org/10.1001/jama.2024.0196

New Alert Criteria

1. Less than 18 years old. AND ONE OF THE FOLLOWING (2 – 6)
2. Hypotension: Mean Arterial Pressure (mmHg)

0-1 month	<30
1-11 months	<38
1- < 5 years	<44
5-17 years	<51

3. *High-Risk AND GCS < 10
4. High-Risk AND 1 Abnormal **Vital Sign
5. GCS < 10 AND 1 Abnormal Vital Sign
6. Two Abnormal Vital Signs

*Febrile Neutropenia
Sickle Cell Disease
Active Cancer

**Abnormal Vitals

1. Saturation ≤ 92% (any Oxygen)
2. Temperature ≥ 101 °F
3. Heart Rate
   a) 0 – less than 5 years: ≥ 150
   b) 5 years to 17 years: ≥ 120

Results – Analysis of Old and Proposed Alerts

- Analysis via retrospective chart abstraction:
  - Old vs proposed alert criteria comparison
- Identical patient population tested both alerts:
  - improve criteria with the proposed (new) alert

		Old	Proposed
ED Arrivals 8/20 – 9/14:	*3401 pts*	290 pts (8.5%)	330 pts (9.7%)
		10/610 pts with both alerts (1.6%)	
Daily ED Arrivals Average:	*131 pts*	12 pts (9.2%)	13 pts (9.9%)
2023 Final Coded Sepsis Pts:	*68 pts*	34 pts (50%)	54 pts (79%)

Statistics With Improved EHR Alerting

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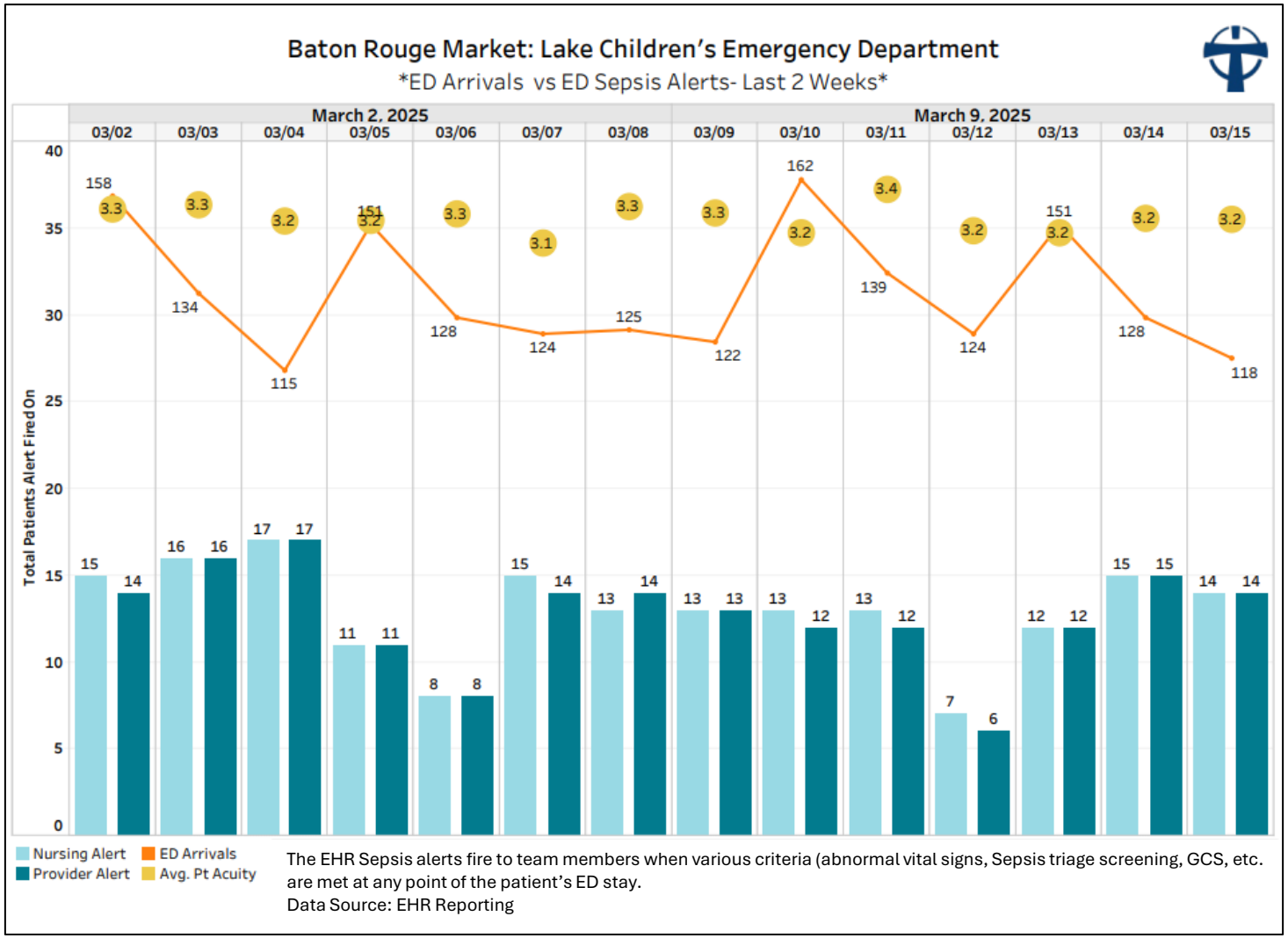
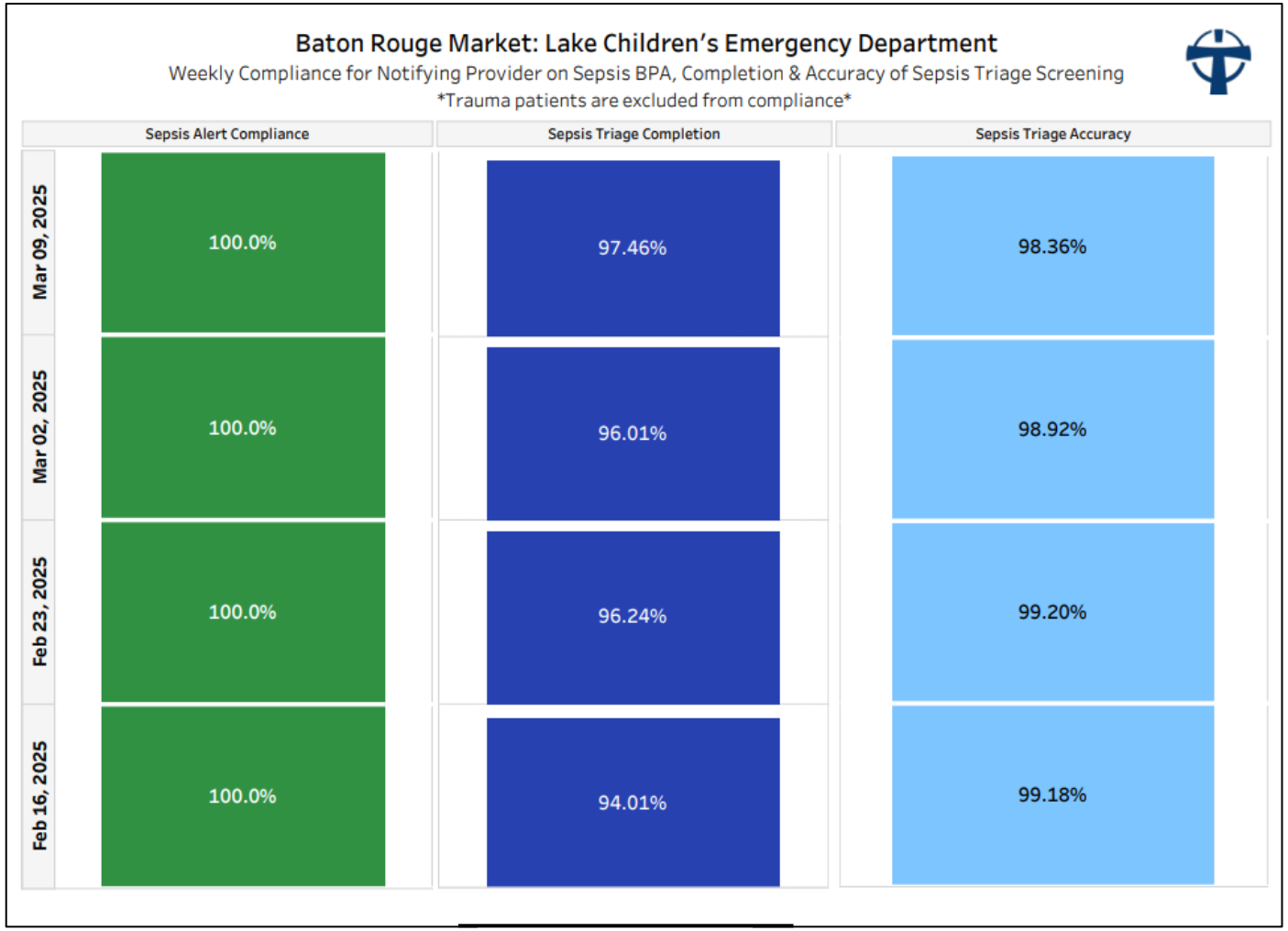
Term	Key Question	New Alert: Prevalence 0.13%
Sensitivity	If a person is sick, how likely is the test to be positive?	87.10%
Specificity	If a person is healthy, how likely is the test to be negative?	91.08%
PPV	If the test is positive, how likely is the person to be sick?	1.25%
NPV	If the test is negative, how likely is the person to be healthy?	99.98
Accuracy	Overall, how often is the test correct?	91.07%

Continued Monitoring



The EHR Sepsis alerts fire to team members when various criteria (abnormal vital signs, Sepsis triage screening, GCS, etc. are met at any point of the patient's ED stay.
Data Source: EHR Reporting

Continued Monitoring



Data Source: OLOL Children's EHR

KEY DRIVER DIAGRAM

PROBLEM STATEMENT

Sepsis carries a significant mortality, mortality and financial burden for the pediatric population.

SMART GOAL

The SMART aim was to decrease pediatric sepsis related mortality in Kentucky Children's Hospital (KCH) from a baseline mean mortality index of 1.3 to 0.91 over a 5-year period

KEY DRIVERS	INTERVENTIONS
Foundation of Culture of Safety throughout KCH	# Train all KCH faculty and staff on SPS Culture of Safety
	# Create and implement a sepsis screening tool
Early recognition of signs and symptoms of sepsis in the pediatric patient	# Create and implement a process for multidisciplinary sepsis huddles when a patient screens positive for sepsis
	# Create a sepsis huddle option when paging out RRT via 3-5200
Multidisciplinary evaluation of patients with concern for sepsis	# Creation of dedicated Rapid Response RN for preventative rounding
	# Create and implement EPIC sepsis BPA that will automatically page out sepsis huddle notification
Utilize evidence-based management of pediatric sepsis	# Create and implement an evidence based pediatric sepsis algorithm and order set
	# Educate staff on pediatric sepsis and sepsis process through multimodal learning
Communicate effectively with all team members during huddle	# Create a multidisciplinary sim curriculum about communication during huddles/RRTs
	# Utilize VR training during sepsis simulations
Real time identification and review of missed sepsis cases and delayed sepsis treatment	# Hold regular multidisciplinary debrief of missed or delayed sepsis cases

Complete	In-Progress	Not Started

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Changing the Culture

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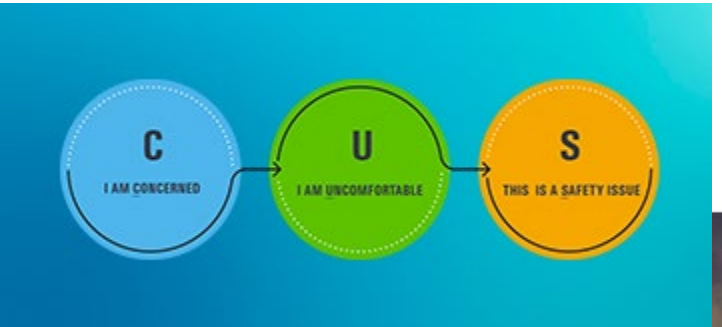

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Introductions

All team members will introduce themselves and their role on the team.

SBAR

Provider who initiated RRT will give SBAR (see back of sheet for SBAR example) .

Evaluation

Identified team members will evaluate the patient and the provider will tell the family that the team will discuss the plan outside the room before returning to update them.

Discussion & Watcher Form

Plan discussed **outside** the room. All team members have the opportunity to speak and express concerns. Watcher form completed together as team.

Family Update & RRT Note

Provider and RN update the family, and the provider completes RRT event note (.KCHRRTCodeNote)

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WATCHER: Action Response Plan

DATE: ____/____/____

Place Pt Sticker here

Last updated: Date /Time

__/__/____ _____.
__/__/____ _____.
__/__/____ _____.

CONCERN : _____.

(Please provide reason primary concern for activating RRT)

Identify RISKS

WHAT ARE THE SYMPTOMS THAT CONCERN YOU?

- ☐ Changes in Breathing Pattern _____
- ☐ Seizures _____
- ☐ Not acting like self _____
- ☐ Unexplained High Heart Rate _____
- ☐ _____
- ☐ _____

Identify RISKS

Shared mental Model & Situational Awareness Huddle

Mitigation Plan for Symptoms

- ☐ Increase vital signs frequency: _____
  Repeat vitals within_____ _____
- ☐ Increase RT assessments: _____
- ☐ Labs: _____

Appropriate level of care? Is assignment/Staffing appropriate?

Planned reassessment time: _____

By WHO: _____

WHEN TO CALL TEAM AGAIN

Next RRT CRITERIA

- HR: ☐ _____.
- RR: ☐ _____.
- BP/(MAP) ☐ _____.
- SpO2:
  - Cap refill:
  - Pulses:
- Respiratory Support: FIO2 max:
- Neurologic Concerns: ☐ _____.

RAPID MD:	DCN:
Patients RN:	PICU TL:

What are your concerns?

What is plan?

When should another rapid response be called?

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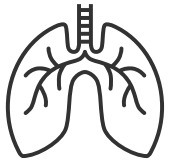
Pediatric Sepsis Model Variables

Solid organ transplant, high risk med tech, immunosuppression

Temperature

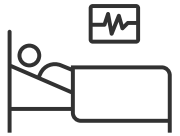
Heart rate, capillary refill

Systolic BP, Diastolic BP, MAP

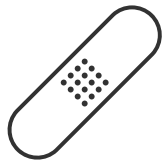


Respiratory rate

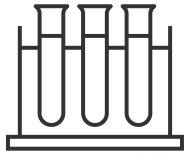
Active LDA



Admitted less than 12 hours*, level of consciousness



Skin assessment



Labs-ALT, Bands

Pediatric Sepsis Workflow

Score >30

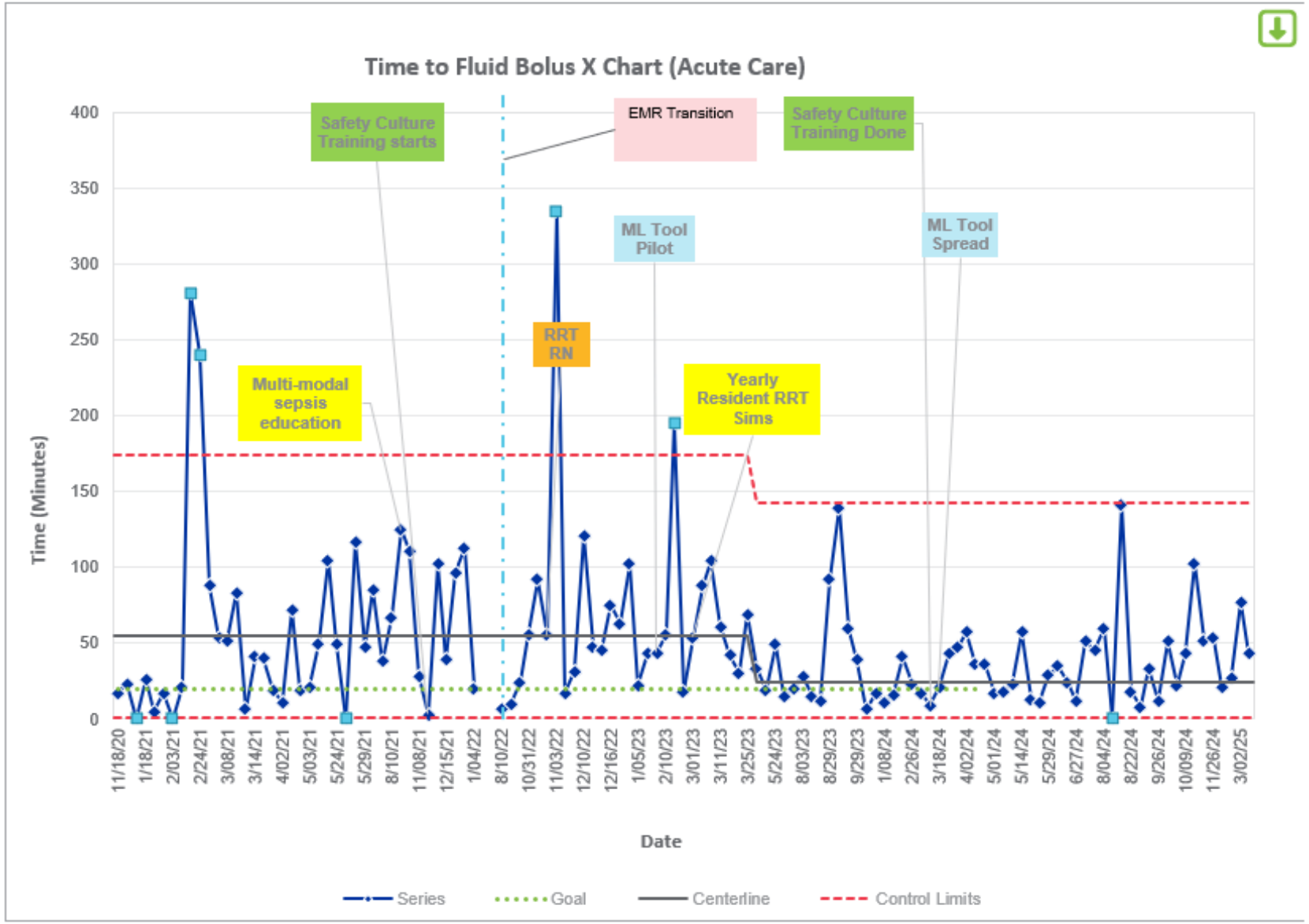
RN & FCP→ push notification
Goal: assess patient and determine need for interventions

*PICU excludes this score
Rapid RN rounds

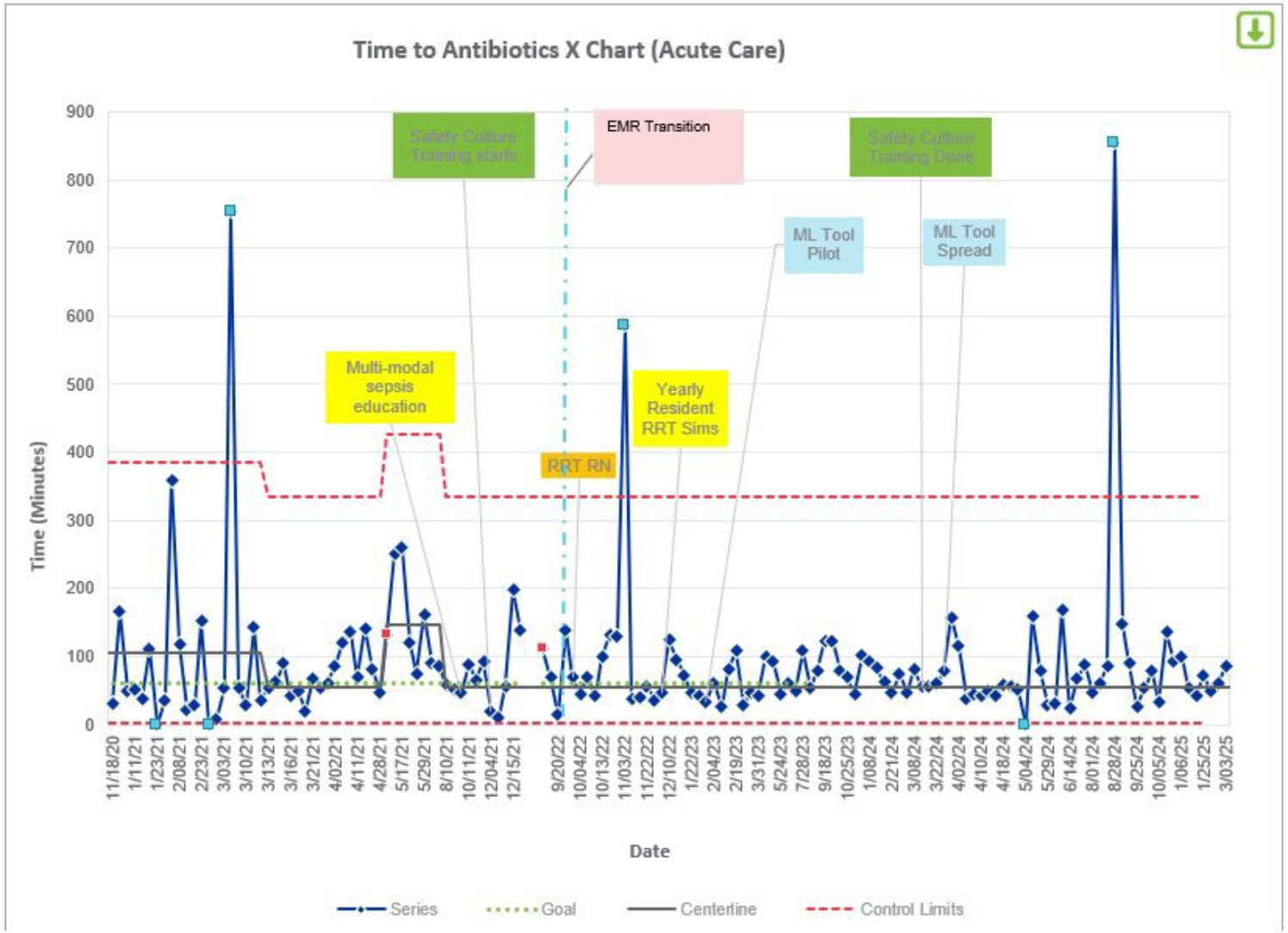
Score >45

RN, FCP, unit TL, and DCN → alert to activate sepsis huddle

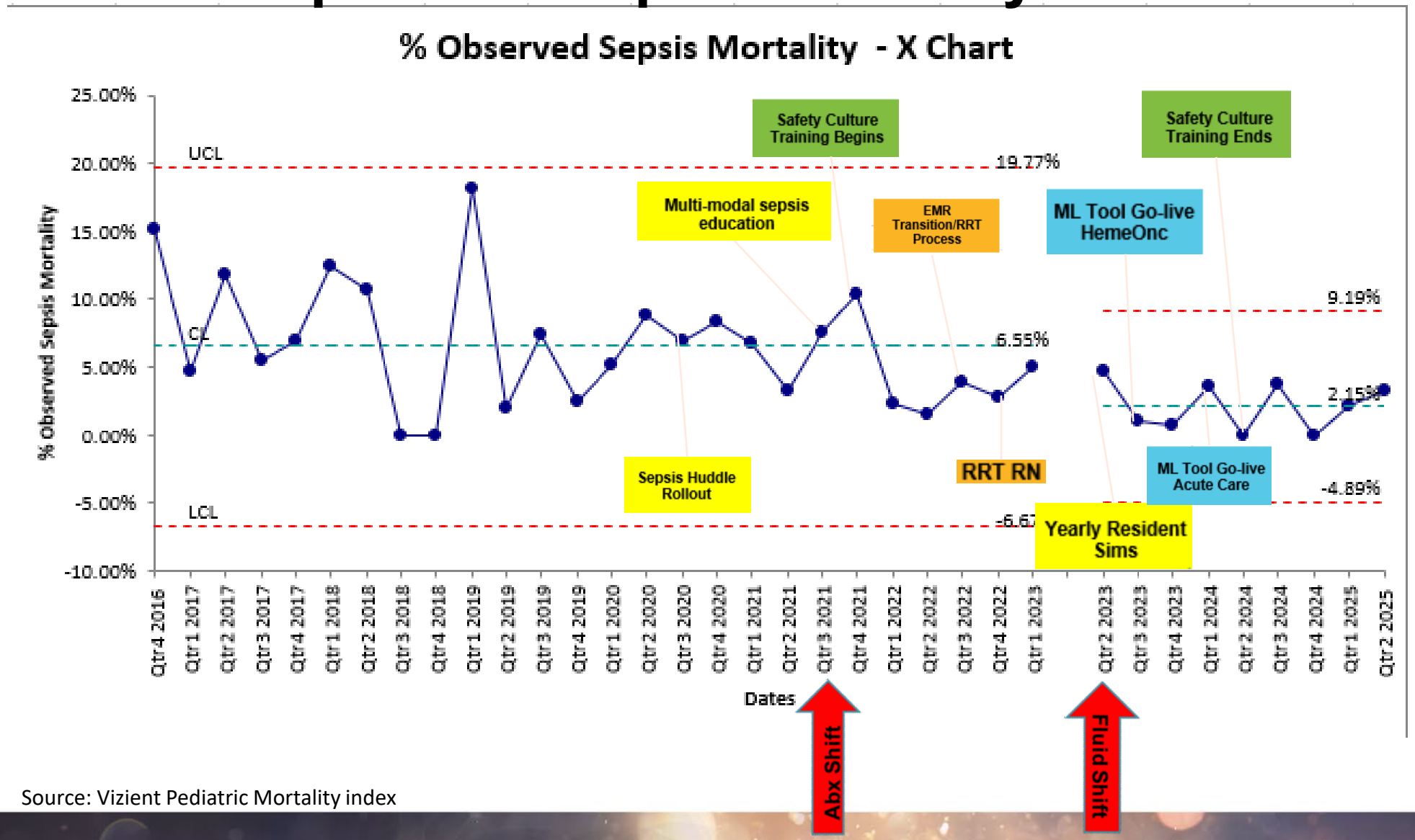
Time to Fluid Bolus X-Chart



Time to Antibiotic X-Chart



Pediatric sepsis in-hospital mortality



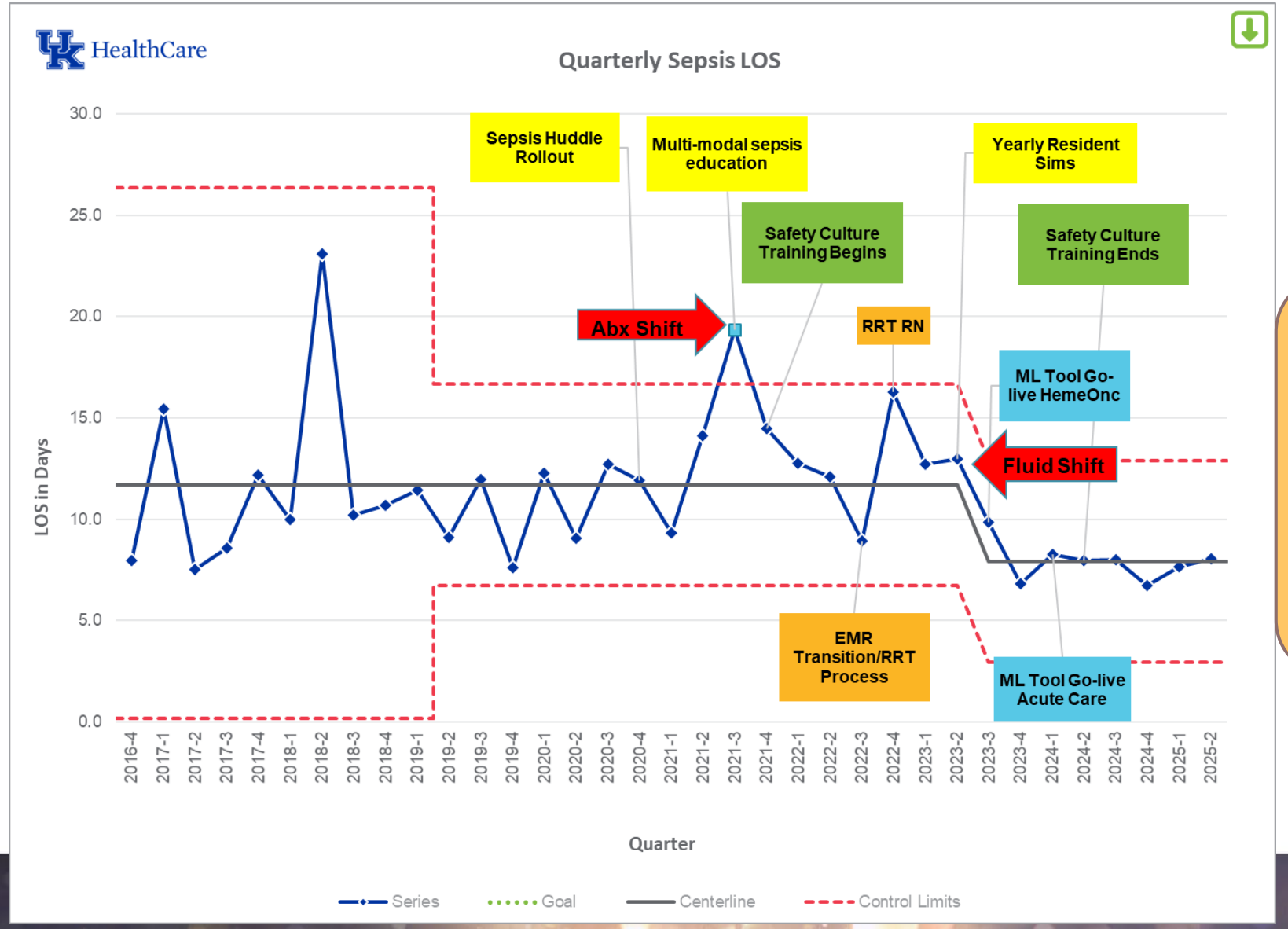
6.6%→2.2%

IPSO Recommendations

- Need additional Sepsis Attribution Confirmation
- Adjust to 30-Day Mortality

Source: Vizient Pediatric Mortality index

Pediatric sepsis Length of Stay-Days



11.7→7.9 Days

Closest Correlation

- Improved Fluid Bolus
- Predictive Analytics Tool

Source: Vizient Length of Stay Index

Lessons Learned

- **Alert Logic Education**
  - What does the alert mean?
  - How does the alert function?
  - What are the inputs?

- **Logic Integrity**
  - EMR tools are built by humans
    - Errors
    - Unintended consequences.
  - Validation is essential
  - Objective: Signal >>>Noise

- **Strong Safety Culture**
  - Promotes high reliability
  - Embedding safety behaviors into workflows improves consistency and outcomes

- **Quality Improvement**
  - Understanding current system processes is critical for meaningful change.
  - Multidisciplinary buy-in drives adoption and sustainability.
  - Messaging positive impact of process is critical

Key Takeaways

Performance Trade-offs / Improvements

- 0.13 - 0.15% in ED prevalence
- Balance predictive alert test characteristics
- Ghost alert methodology – non-disruptive

Culture is Key

- High reliability tactics can drive change
- Go to the Gemba

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Questions?

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