Leveraging Electronic Health Record Data to Optimize Patient Safety and Quality of Care

Chris Horvat, MD MHA

Improving Patients Safety and Quality in Latvia

Riga Stradins University

June 7, 2018

Leveraging Electronic Health Record Data to Optimize Patient Safety and Quality of Care

Chris Horvat, MD MHA

Assistant Professor, Pediatric Critical Care Medicine

Director, Health Informatics for Clinical Effectiveness

Children's Hospital of Pittsburgh of UPMC

University of Pittsburgh

CRITICAL CARE MEDICINE

Conflict of Interest Disclosures

Children's Hospital of Pittsburgh Young Investigator Award

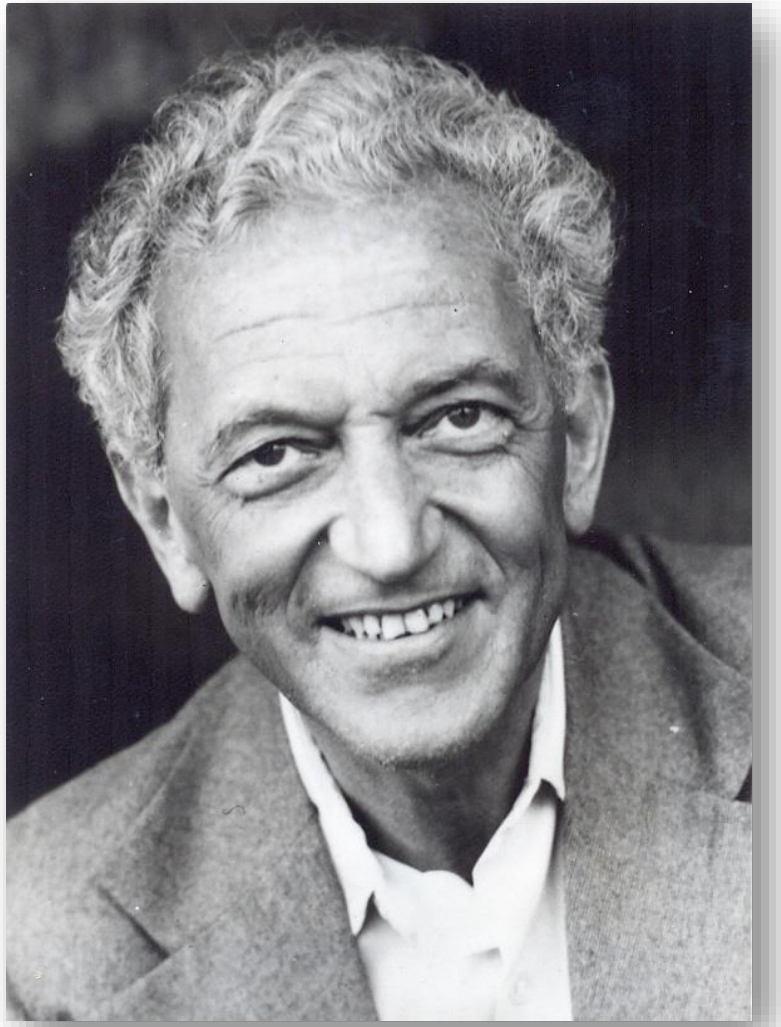
Children's Hospital of Pittsburgh of UPMC

UNIVERSITY OF PITTSBURGH

CRITICAL CARE MEDICINE

Our 5 Best Practices

1) **Build an accessible data infrastructure**: Making best use of the EHR
2) **Standardizing without protocolizing:** Guidelines not recipes
3) **Back to the bedside:** Use tech to increase patient contact
4) **Continuously re-evaluate performance:** Drive performance with dashboards
5) **Acknowledge uncertainty:** Modern, probabilistic decision-making



Dr. Peter Safar

Rules for Navigating Life

Rule No. 1

"If anything can go wrong, fix it!"

Rule No. 8

"If it is worth doing, it is worth doing right now."

W. Edwards Deming

"Lack of knowledge… that is the problem."

"It is not enough to do your best, you must know what to do, and then do your best."

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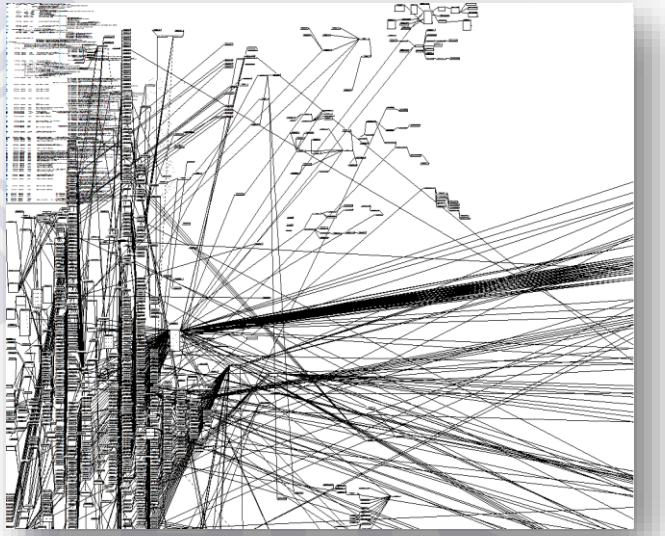
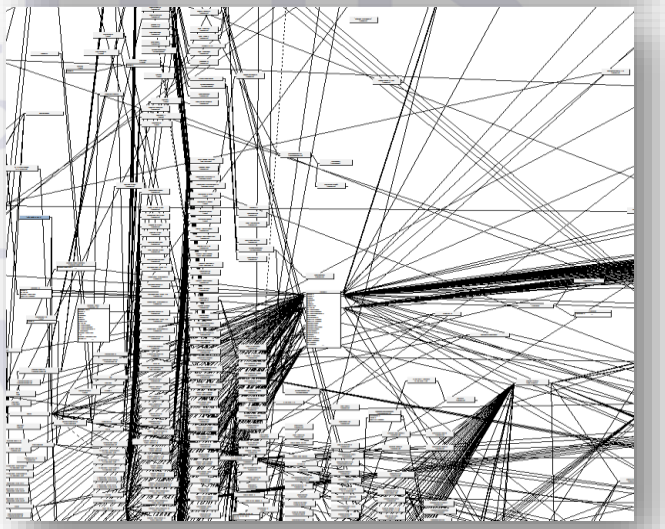
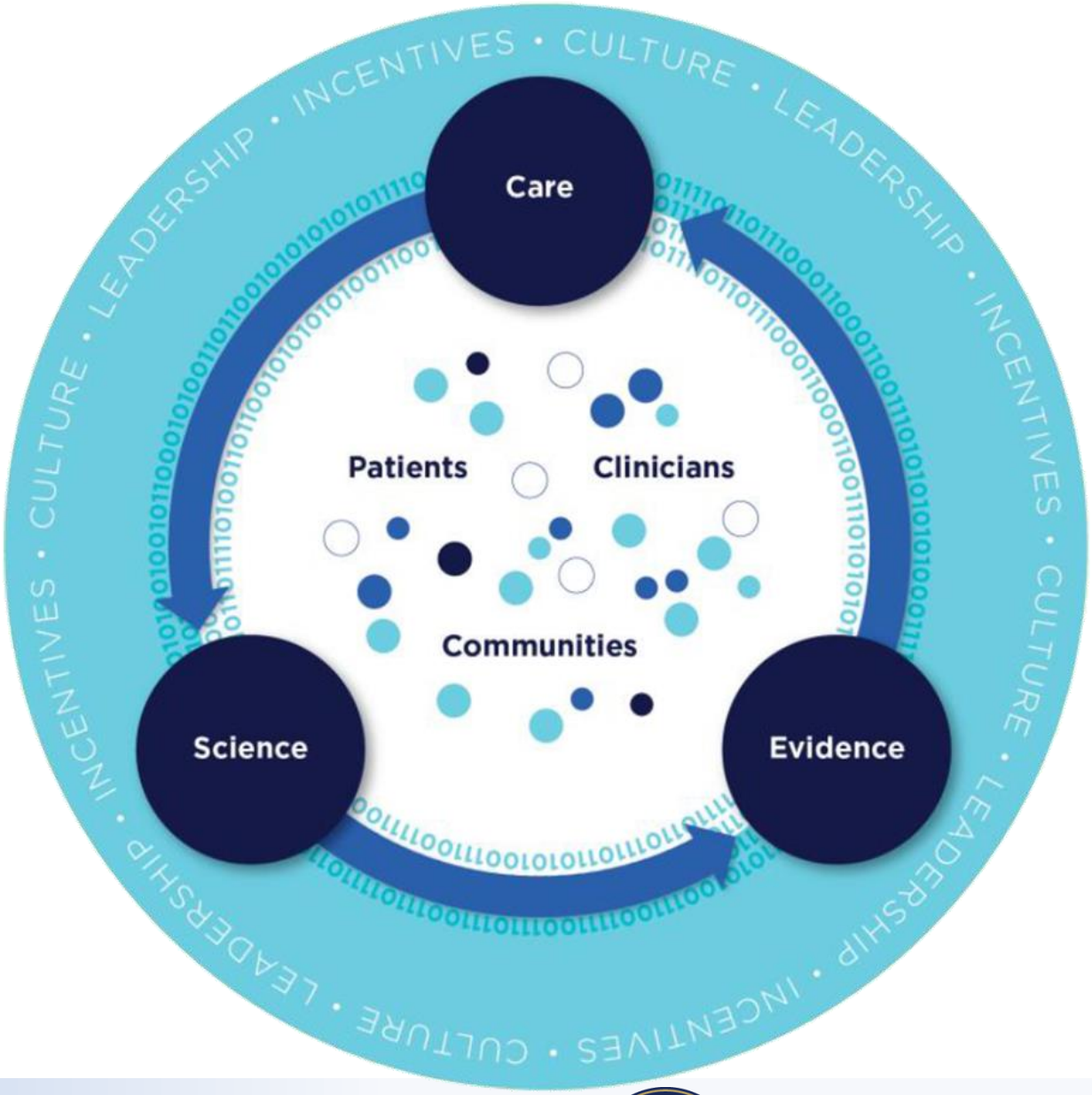
Historic and Modern Health Data Collection

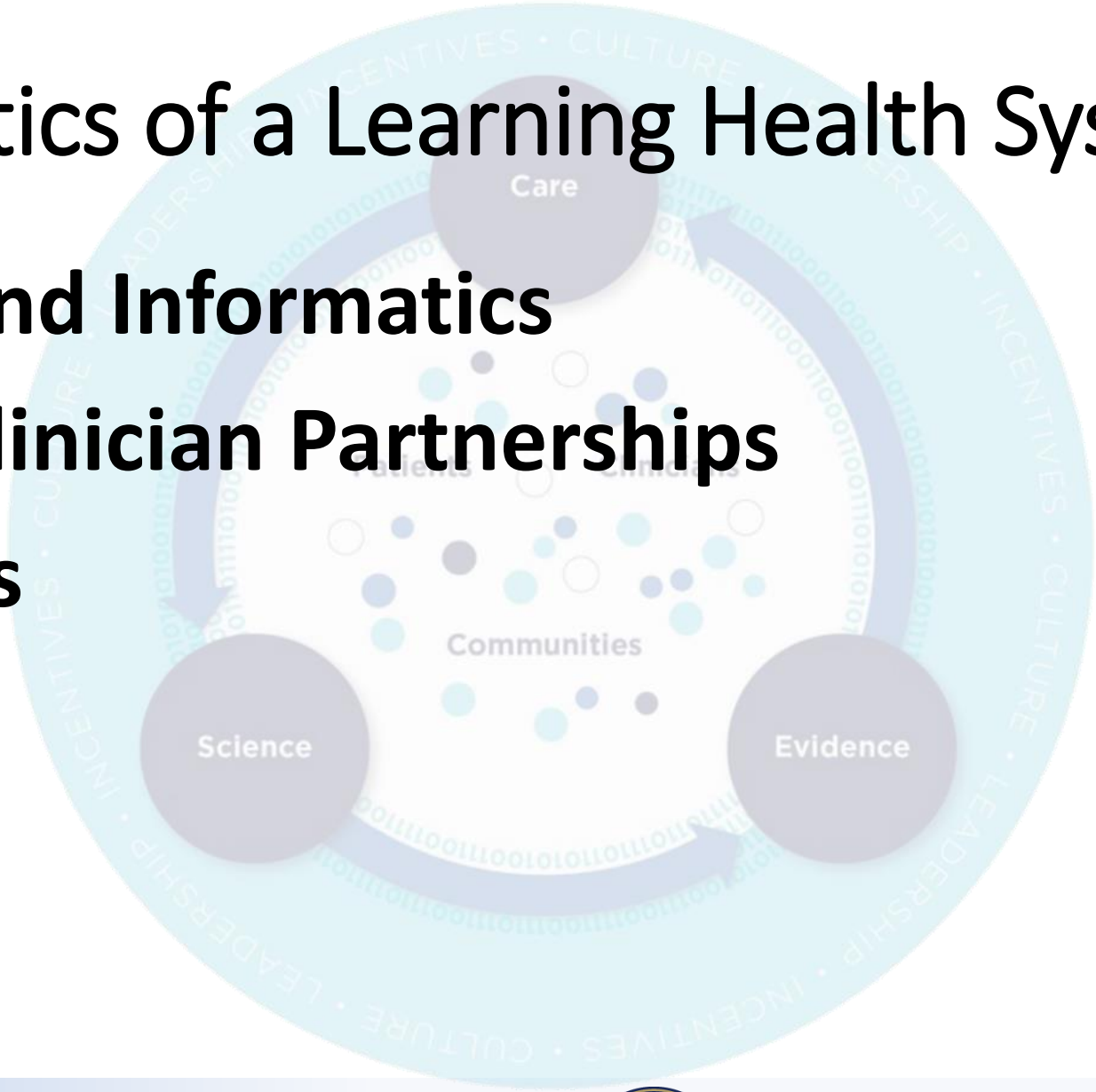
JP Allen, Yale University Press



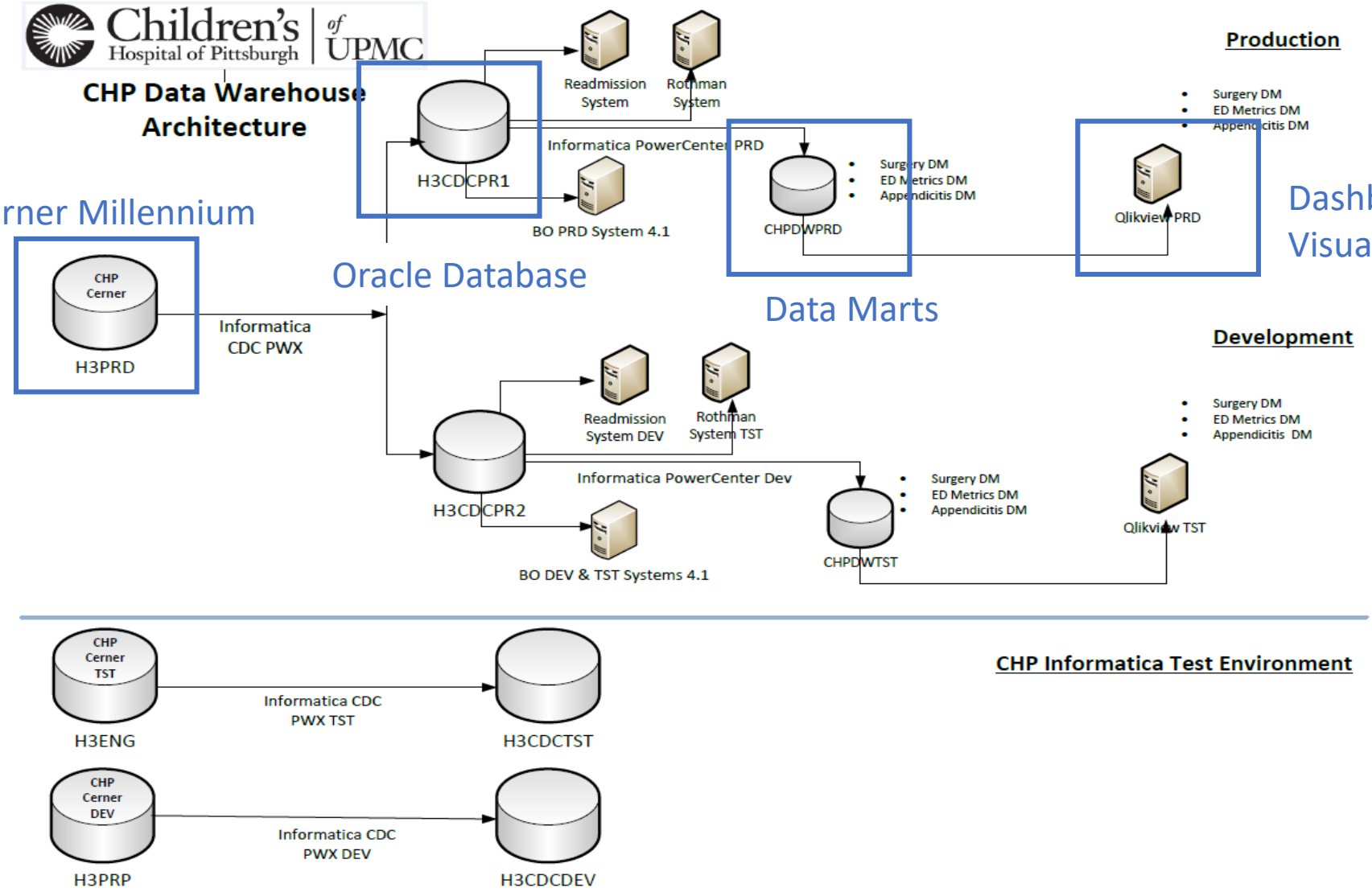



INCENTIVES • CULTURE • LEADERSHIP • INCENTIVES • CULTURE • LEADERSHIP • INCENTIVES • CULTURE • LEADERSHIP • INCENTIVES • CULTURE • LEADERSHIP
Care
Patients
Clinicians
Communities
Science
Evidence

Characteristics of a Learning Health System



- **Science and Informatics**
- **Patient-Clinician Partnerships**
- **Incentives**
- **Culture**


Children's Hospital of Pittsburgh of UPMC
CHP Data Warehouse Architecture
Cerner Millennium
Oracle Database
Data Marts
Dashboard Visualization
Production
Development
CHP Informatica Test Environment
CHP Cerner
H3PRD
Informatica CDC PWX
H3CDCPR1
Readmission System
Rothman System
BO PRD System 4.1
Informatica PowerCenter PRD
CHPDWPRD
Surgery DM
ED Metrics DM
Appendicitis DM
Qlikview PRD
H3CDCPR2
Readmission System DEV
Rothman System TST
BO DEV & TST Systems 4.1
Informatica PowerCenter Dev
CHPDWTST
Qlikview TST
CHP Cerner TST
H3ENG
Informatica CDC PWX TST
H3CDCTST
CHP Cerner DEV
H3PRP
Informatica CDC PWX DEV
H3CDCDEV

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☐ THE PROCRUSTEAN BED: THE DANGER IN THE PROLIFERATION OF PROTOCOLS

The Journal of Emergency Medicine, Vol. 52, No. 2, pp. e53–e54, 2017

0736-4679/$ - see front matter

Paul Janson, MD
April Vavra, RN, ADN
Lawrence General Hospital
Lawrence, Massachusetts

CRITICAL CARE PERSPECTIVE

Standardized Intensive Care

Protocol Misalignment and Impact Misattribution

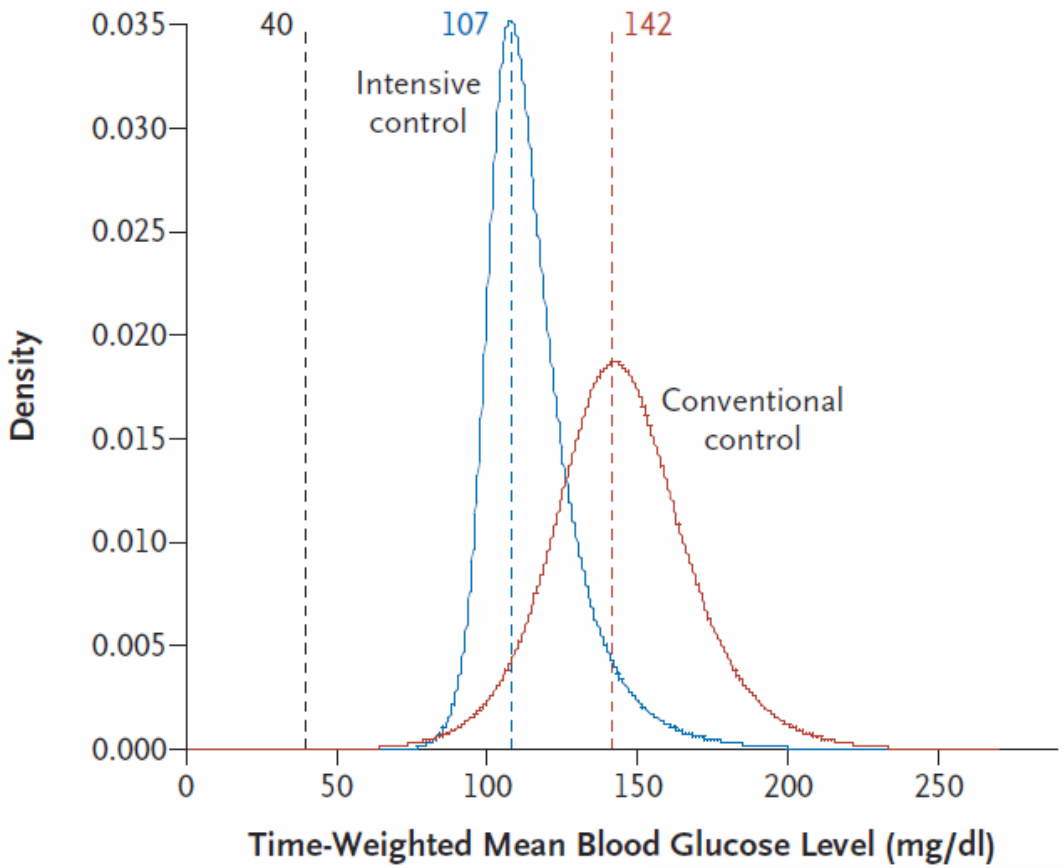
Brian P. Kavanagh[1,2] and Michael Nurok[3]

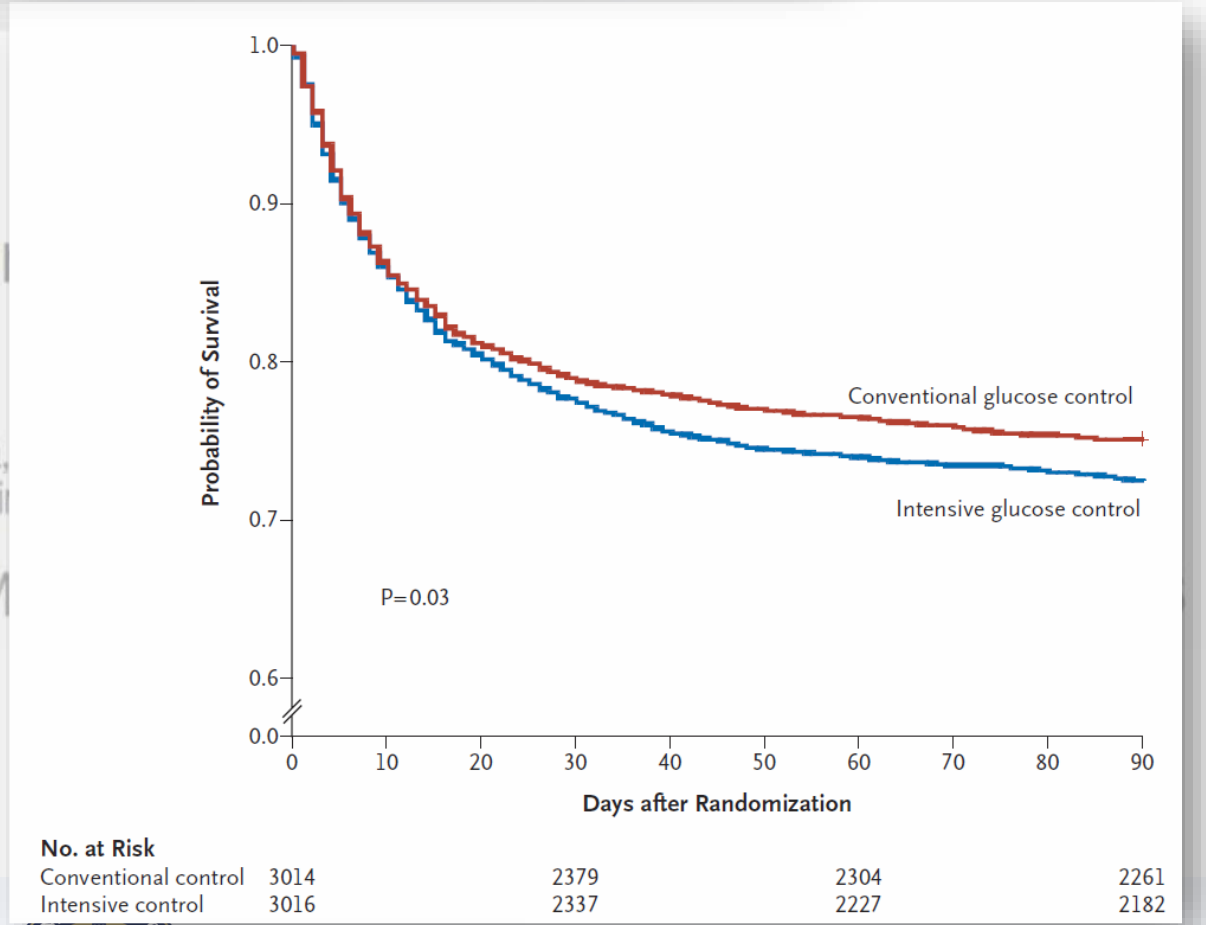
[1]Department of Critical Care Medicine and [2]Department of Anesthesia, Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada; and [3]Cardiac Surgery Intensive Care Unit, Cedars-Sinai Heart Institute, Los Angeles, California

American Journal of Respiratory and Critical Care Medicine Volume 193 Number 1 | January 1 2016

Intensive versus Conventional Glucose Control in Critically Ill Patients

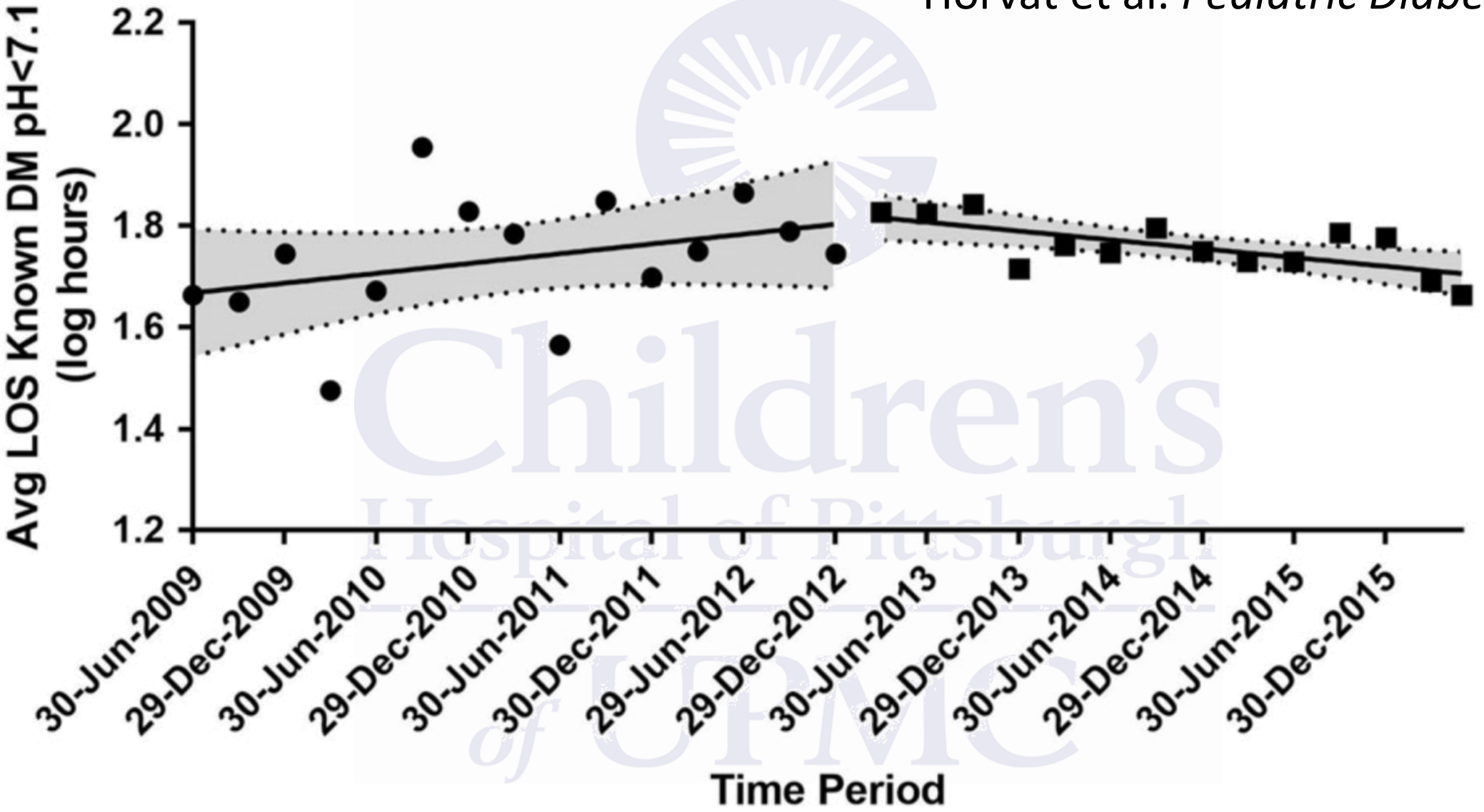
The NICE-SUGAR Study Investigators*





N ENGL J MED 360;13 NEJM.ORG MARCH 26, 2009

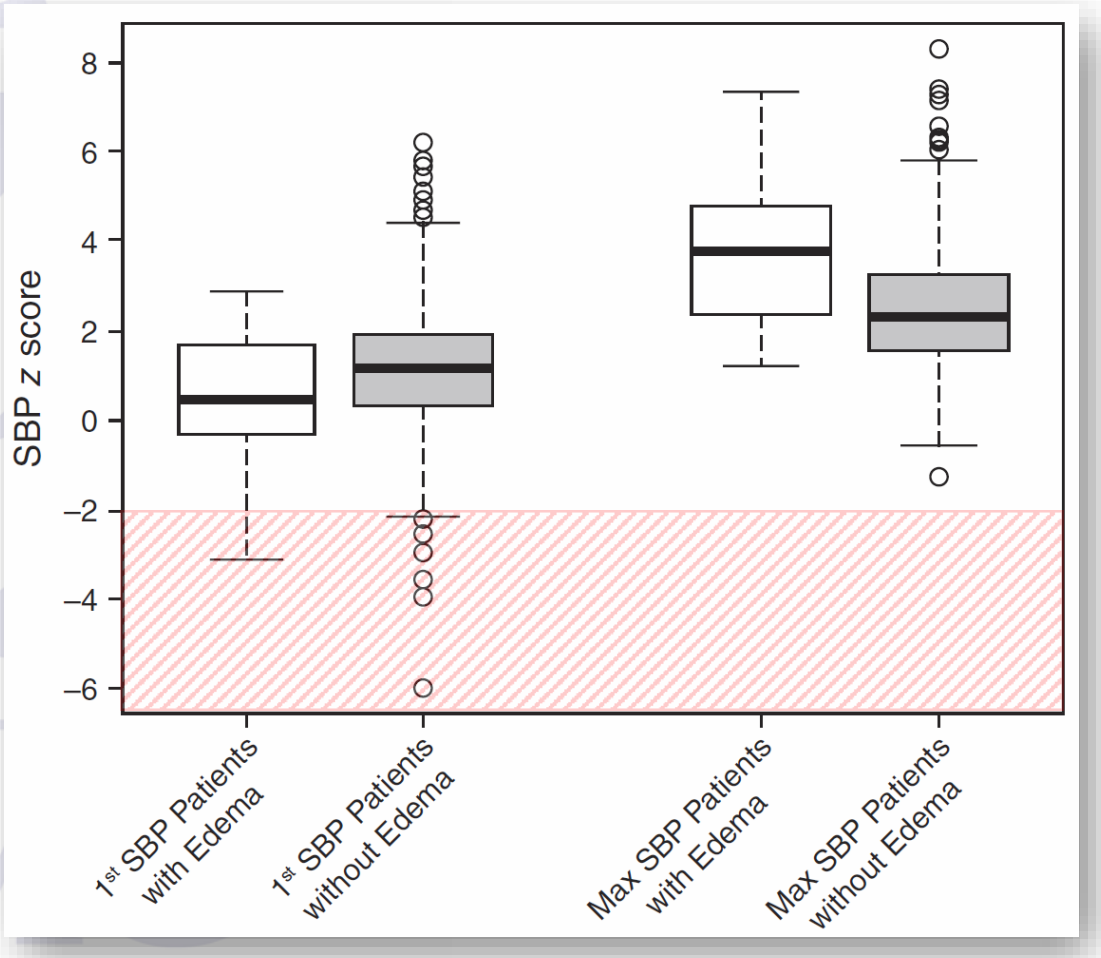
Horvat et al. *Pediatric Diabetes* 2018



Horvat et al. *Pediatric Diabetes* 2018

Uncontrolled DM (including new onset T1D) and DKA ED
Clinical Effectiveness Guideline

IV Therapy
(To be given only if patient dehydrated)
- Hour 1: Isotonic saline (NSS) 10 mL/kg
- Hour 2: Continue NSS for patients with severe dehydration 10 mL/kg



Mortality = 0.08%

W. Edwards Deming

"If you can't describe what you are doing as a process, you don't know what you're doing."

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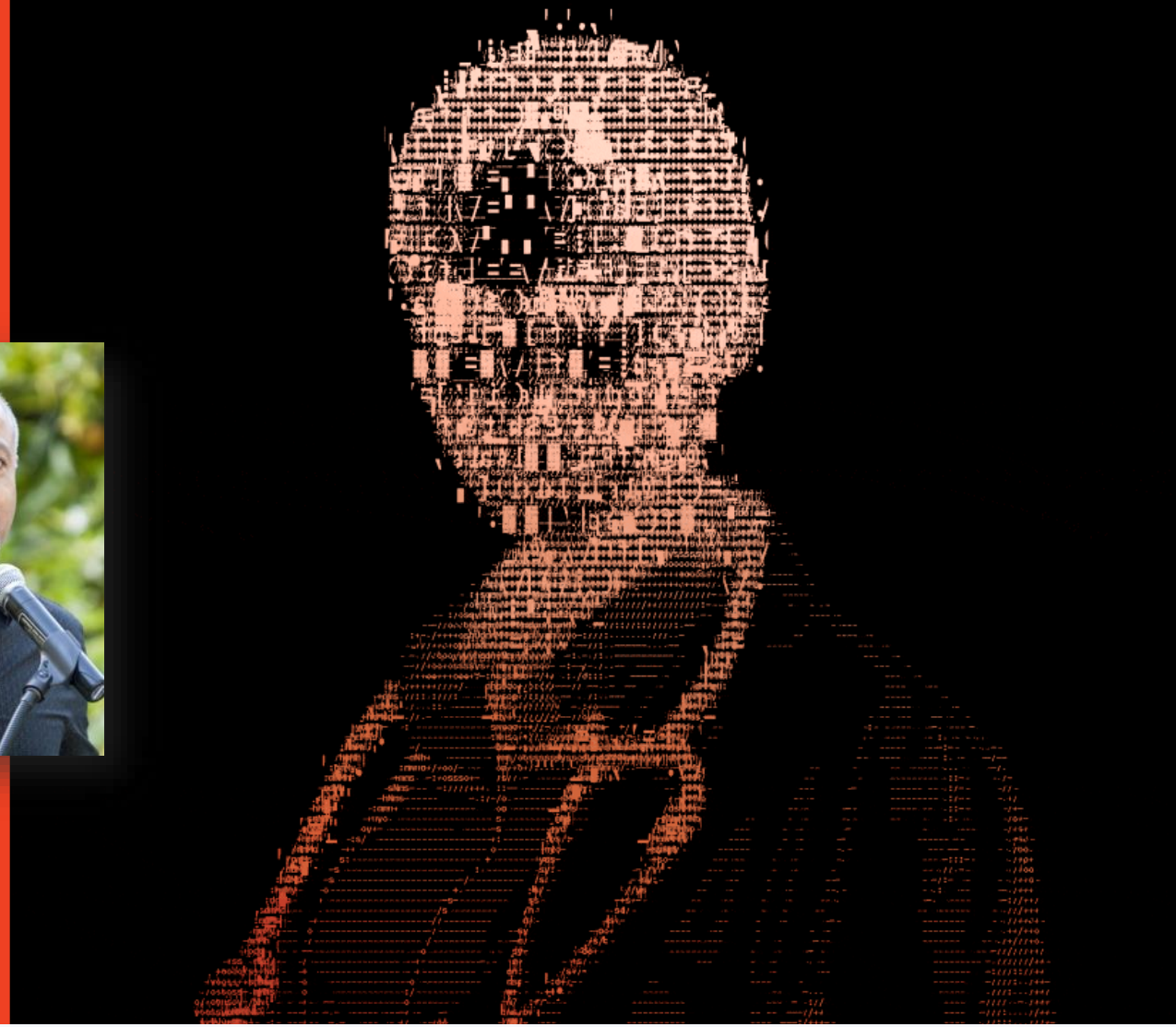
HOW TECH CAN TURN DOCTORS INTO CLERICAL WORKERS

THE THREAT THAT ELECTRONIC HEALTH RECORDS AND MACHINE LEARNING POSE TO PHYSICIANS' CLINICAL JUDGMENT — AND THEIR WELL-BEING.

BY ABRAHAM VERGHESE
ILLUSTRATION BY ERIK CARTER

MAY 16, 2018



CLINICAL RESEARCH STUDY

THE AMERICAN JOURNAL of MEDICINE®

Inadequacies of Physical Examination as a Cause of Medical Errors and Adverse Events: A Collection of Vignettes

Abraham Verghese, MD,[a] Blake Charlton, MD,[b] Jerome P. Kassirer, MD,[c] Meghan Ramsey, MD,[a] John P.A. Ioannidis, MD, DSc[d]

[a]The Program in Bedside Medicine and [d]Stanford Prevention Research Center, Stanford University School of Medicine, Stanford, Calif; [b]Department of Internal Medicine, University of California, San Francisco; [c]Department of Internal Medicine, Tufts University School of Medicine, Boston, Mass.

 • The American Journal of Medicine (2015) 128, 1322-1324

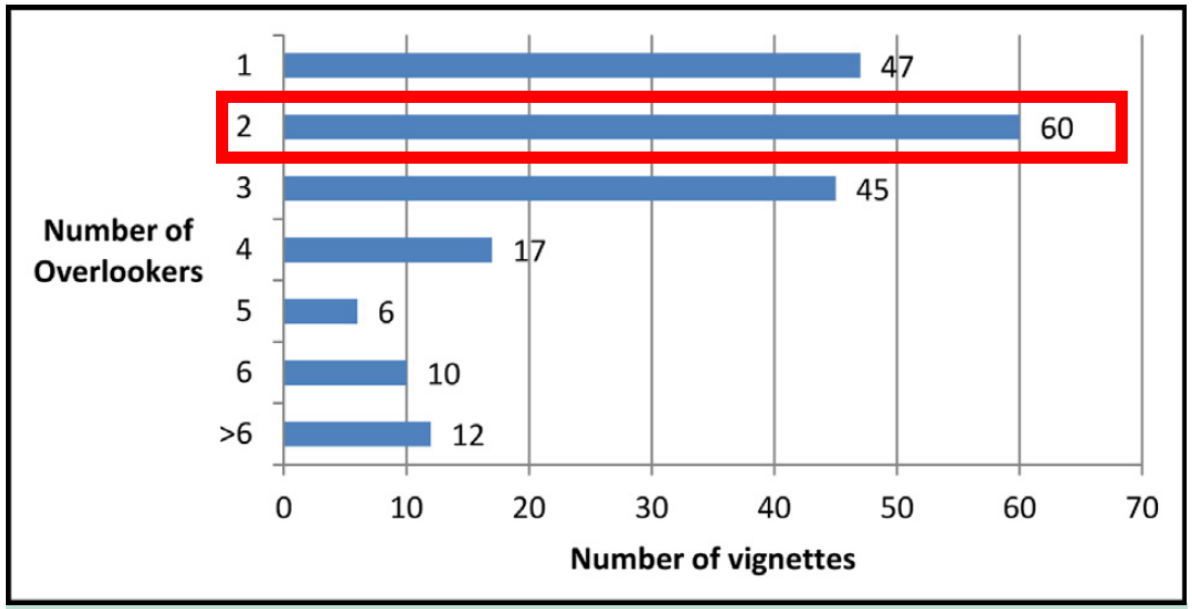


Figure 1 Distribution of number of overlookers for 208 oversights in physical exam.

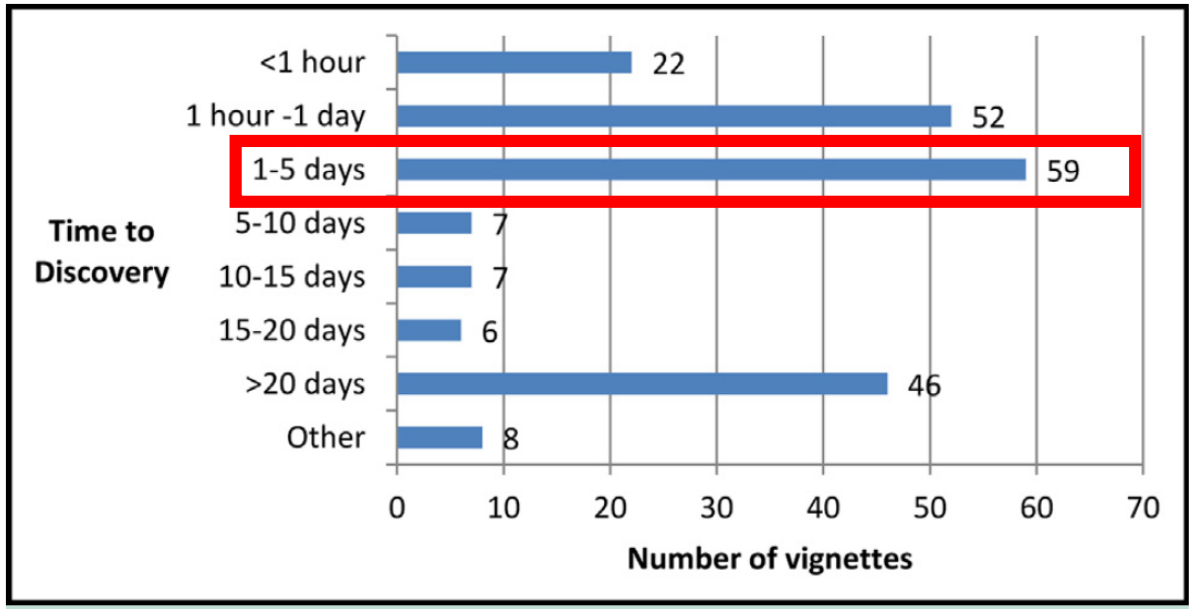
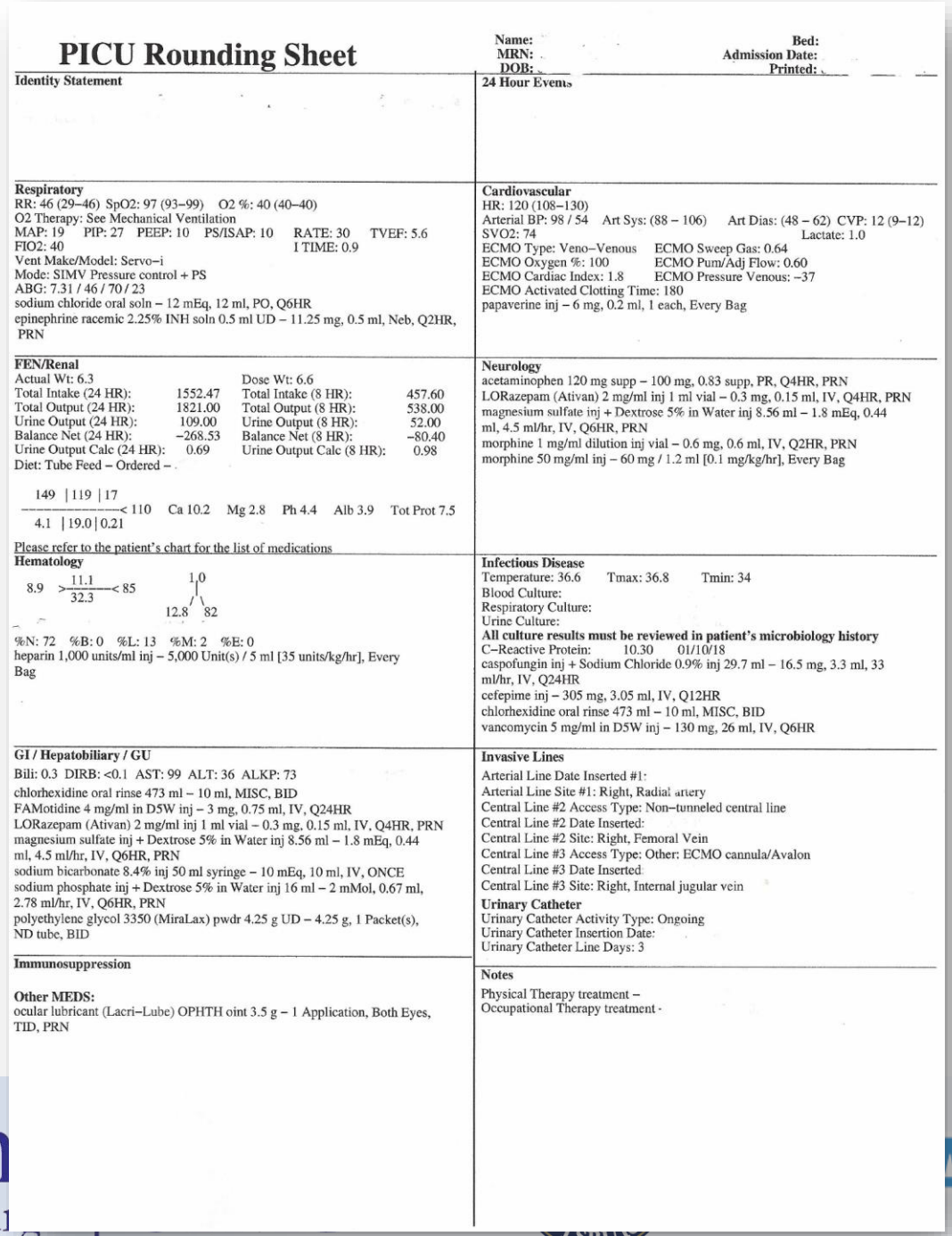


Figure 2 Distribution of time to discovery for 208 oversights in physical exam.

Summary of vitals and current support systems

Snapshot of patient's current status



PICU Rounding Sheet

Name: Bed:
MRN: Admission Date:
DOB: Printed:

Identity Statement

24 Hour Events

Respiratory
RR: 46 (29–46) SpO2: 97 (93–99) O2 %: 40 (40–40)
O2 Therapy: See Mechanical Ventilation
MAP: 19 PIP: 27 PEEP: 10 PS/ISAP: 10 RATE: 30 TVEF: 5.6
FIO2: 40 I TIME: 0.9
Vent Make/Model: Servo–i
Mode: SIMV Pressure control + PS
ABG: 7.31 / 46 / 70 / 23
sodium chloride oral soln – 12 mEq, 12 ml, PO, Q6HR
epinephrine racemic 2.25% INH soln 0.5 ml UD – 11.25 mg, 0.5 ml, Neb, Q2HR, PRN

Cardiovascular
HR: 120 (108–130)
Arterial BP: 98 / 54 Art Sys: (88 – 106) Art Dias: (48 – 62) CVP: 12 (9–12)
SVO2: 74 Lactate: 1.0
ECMO Type: Veno–Venous ECMO Sweep Gas: 0.64
ECMO Oxygen %: 100 ECMO Pum/Adj Flow: 0.60
ECMO Cardiac Index: 1.8 ECMO Pressure Venous: –37
ECMO Activated Clotting Time: 180
papaverine inj – 6 mg, 0.2 ml, 1 each, Every Bag

FEN/Renal
Actual Wt: 6.3 Dose Wt: 6.6

Total Intake (24 HR):	1552.47	Total Intake (8 HR):	457.60
Total Output (24 HR):	1821.00	Total Output (8 HR):	538.00
Urine Output (24 HR):	109.00	Urine Output (8 HR):	52.00
Balance Net (24 HR):	–268.53	Balance Net (8 HR):	–80.40
Urine Output Calc (24 HR):	0.69	Urine Output Calc (8 HR):	0.98

Diet: Tube Feed – Ordered –

149 | 119 | 17
———————< 110 Ca 10.2 Mg 2.8 Ph 4.4 Alb 3.9 Tot Prot 7.5
4.1 | 19.0 | 0.21

Please refer to the patient's chart for the list of medications

Neurology
acetaminophen 120 mg supp – 100 mg, 0.83 supp, PR, Q4HR, PRN
LORazepam (Ativan) 2 mg/ml inj 1 ml vial – 0.3 mg, 0.15 ml, IV, Q4HR, PRN
magnesium sulfate inj + Dextrose 5% in Water inj 8.56 ml – 1.8 mEq, 0.44 ml, 4.5 ml/hr, IV, Q6HR, PRN
morphine 1 mg/ml dilution inj vial – 0.6 mg, 0.6 ml, IV, Q2HR, PRN
morphine 50 mg/ml inj – 60 mg / 1.2 ml [0.1 mg/kg/hr], Every Bag

Hematology
8.9 > 11.1 / 32.3 < 85
10
12.8 / \ 82
%N: 72 %B: 0 %L: 13 %M: 2 %E: 0
heparin 1,000 units/ml inj – 5,000 Unit(s) / 5 ml [35 units/kg/hr], Every Bag

Infectious Disease
Temperature: 36.6 Tmax: 36.8 Tmin: 34
Blood Culture:
Respiratory Culture:
Urine Culture:
All culture results must be reviewed in patient's microbiology history
C–Reactive Protein: 10.30 01/10/18
caspofungin inj + Sodium Chloride 0.9% inj 29.7 ml – 16.5 mg, 3.3 ml, 33 ml/hr, IV, Q24HR
cefepime inj – 305 mg, 3.05 ml, IV, Q12HR
chlorhexidine oral rinse 473 ml – 10 ml, MISC, BID
vancomycin 5 mg/ml in D5W inj – 130 mg, 26 ml, IV, Q6HR

GI / Hepatobiliary / GU
Bili: 0.3 DIRB: <0.1 AST: 99 ALT: 36 ALKP: 73
chlorhexidine oral rinse 473 ml – 10 ml, MISC, BID
FAMotidine 4 mg/ml in D5W inj – 3 mg, 0.75 ml, IV, Q24HR
LORazepam (Ativan) 2 mg/ml inj 1 ml vial – 0.3 mg, 0.15 ml, IV, Q4HR, PRN
magnesium sulfate inj + Dextrose 5% in Water inj 8.56 ml – 1.8 mEq, 0.44 ml, 4.5 ml/hr, IV, Q6HR, PRN
sodium bicarbonate 8.4% inj 50 ml syringe – 10 mEq, 10 ml, IV, ONCE
sodium phosphate inj + Dextrose 5% in Water inj 16 ml – 2 mMol, 0.67 ml, 2.78 ml/hr, IV, Q6HR, PRN
polyethylene glycol 3350 (MiraLax) pwdr 4.25 g UD – 4.25 g, 1 Packet(s), ND tube, BID

Invasive Lines
Arterial Line Date Inserted #1:
Arterial Line Site #1: Right, Radial artery
Central Line #2 Access Type: Non–tunneled central line
Central Line #2 Date Inserted:
Central Line #2 Site: Right, Femoral Vein
Central Line #3 Access Type: Other: ECMO cannula/Avalon
Central Line #3 Date Inserted:
Central Line #3 Site: Right, Internal jugular vein

Urinary Catheter
Urinary Catheter Activity Type: Ongoing
Urinary Catheter Insertion Date:
Urinary Catheter Line Days: 3

Immunosuppression

Other MEDS:
ocular lubricant (Lacri–Lube) OPHTH oint 3.5 g – 1 Application, Both Eyes, TID, PRN

Notes
Physical Therapy treatment –
Occupational Therapy treatment -

Medications organized for clinician's brain

Automated tracking of important quality markers (CVL days)

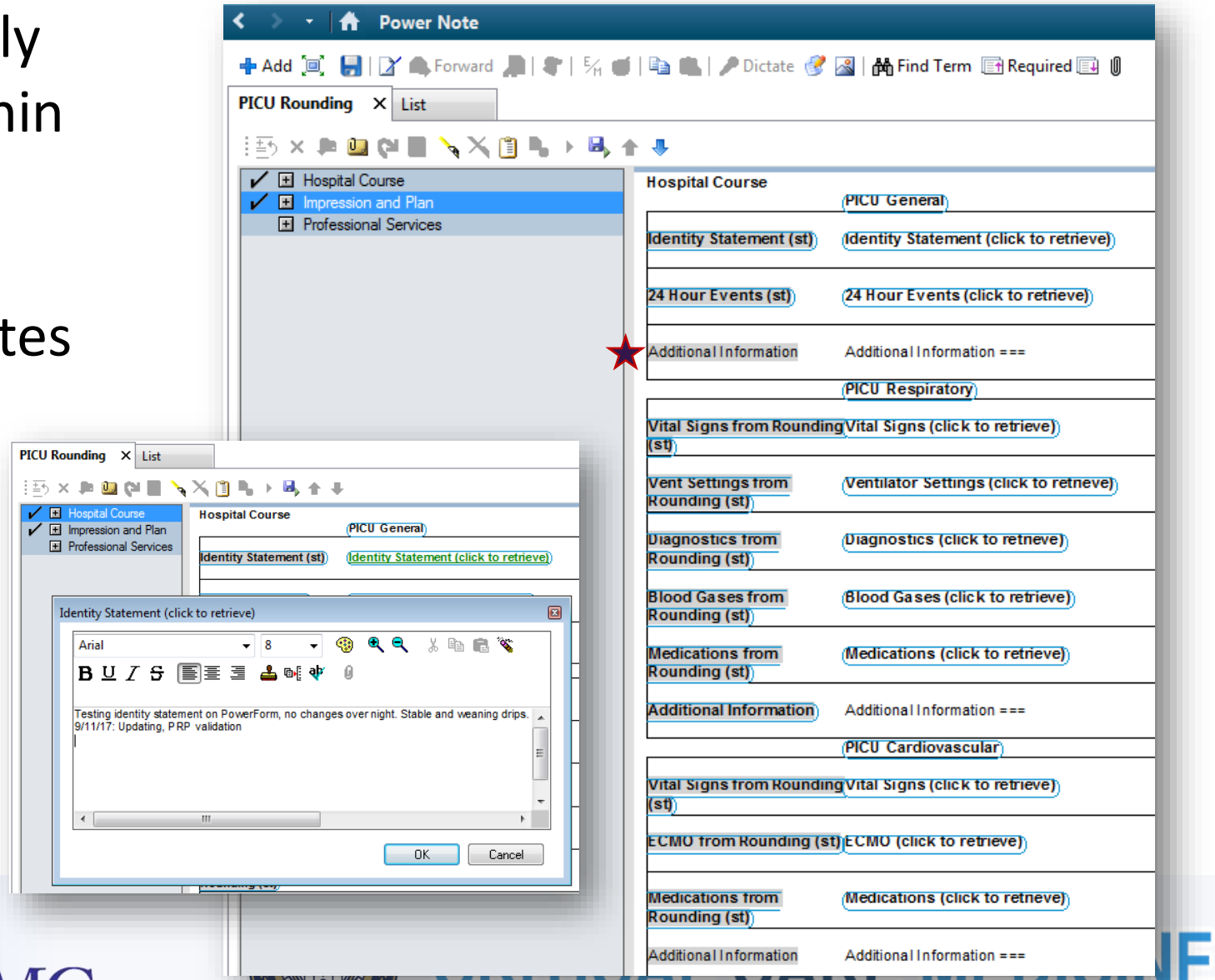
Children's Hospital of Pittsburgh

AL CARE MEDICINE

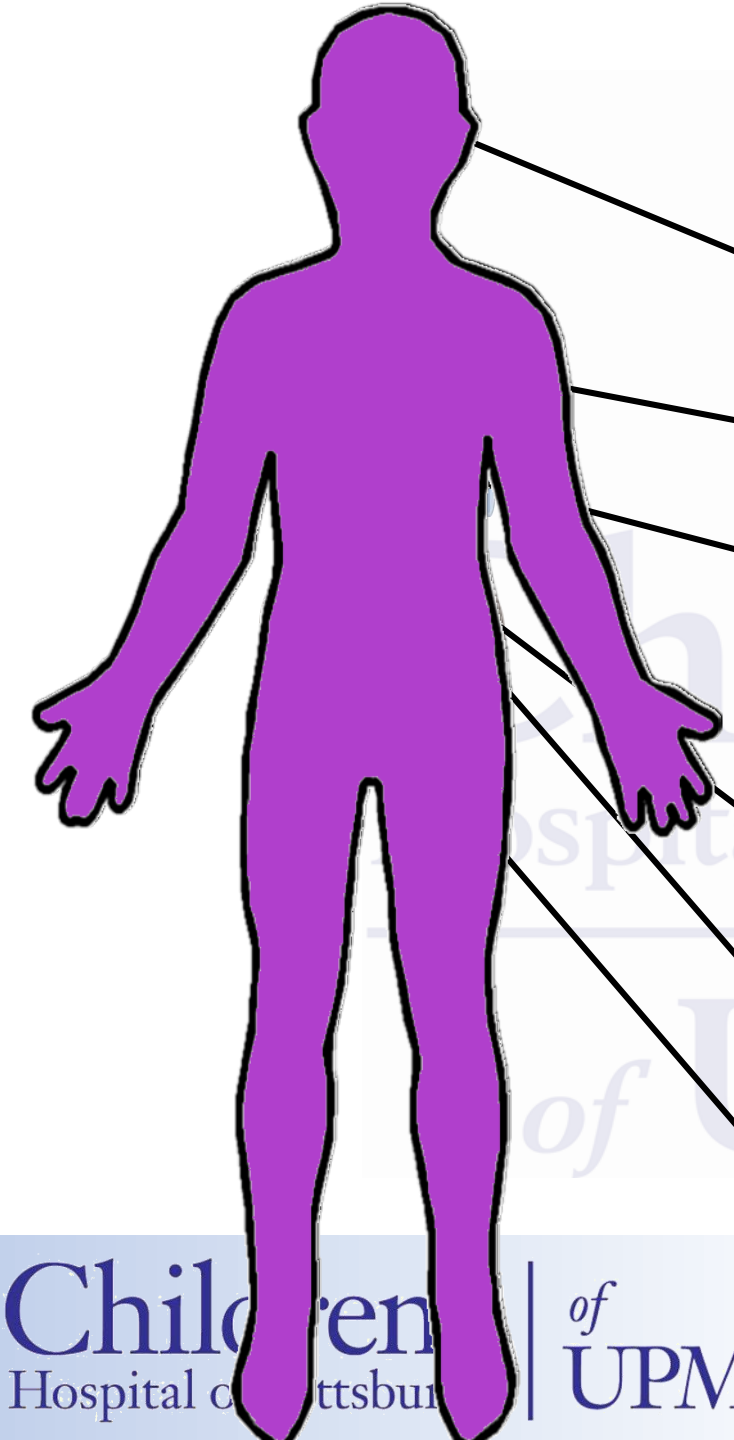
Back to the Bedside

- Summary data is automatically generated and organized within the Electronic Record

- 90-100% of daily progress notes can be completed on rounds



Invasive Strategies and a High Risk Environment



- Continuous intracranial pressure monitor
- External ventricular drain

- Extracorporeal oxygenation
- Ventricular assist devices

- Endotracheal mechanical ventilation
- Pleural drainage
- Diagnostic and therapeutic bronchoscopy

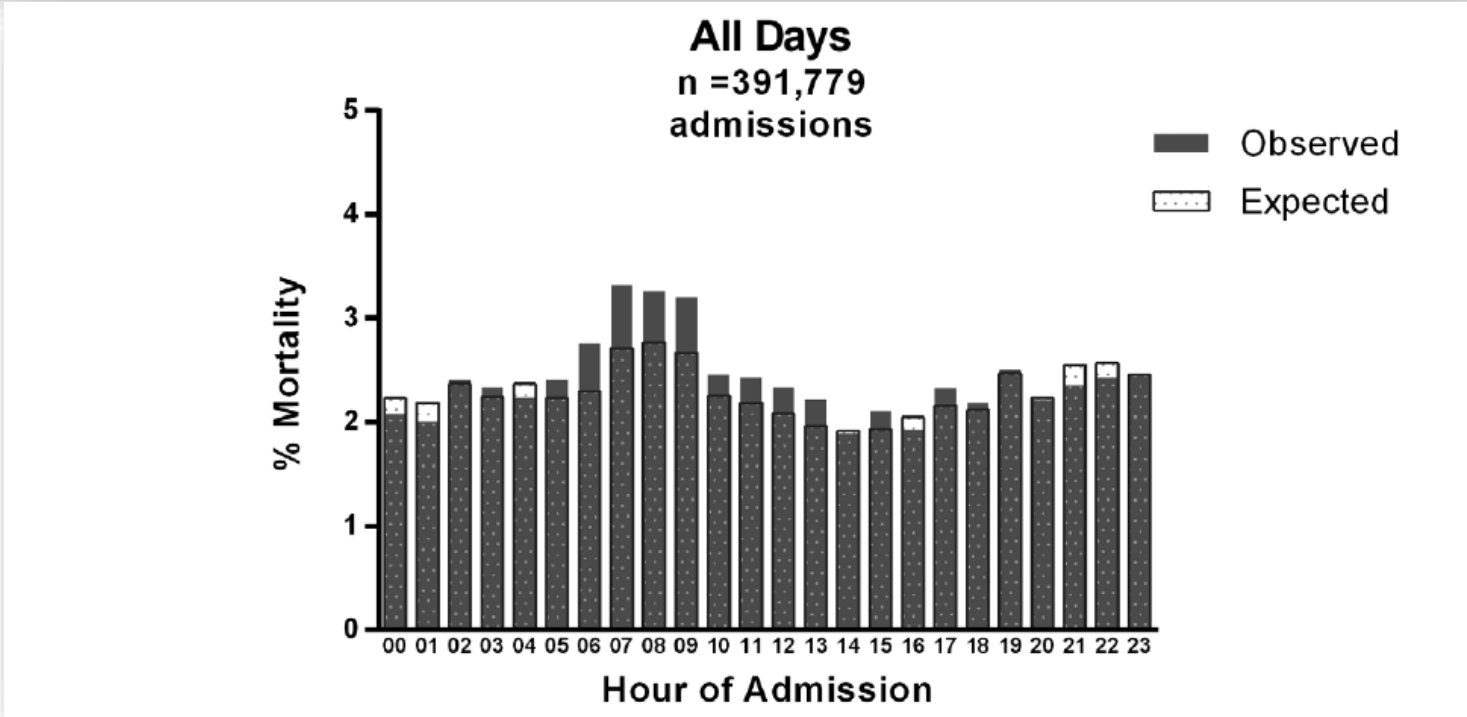
- Albumin dialysis
- Plasmapheresis and exchange

- Renal replacement therapy/continuous dialysis

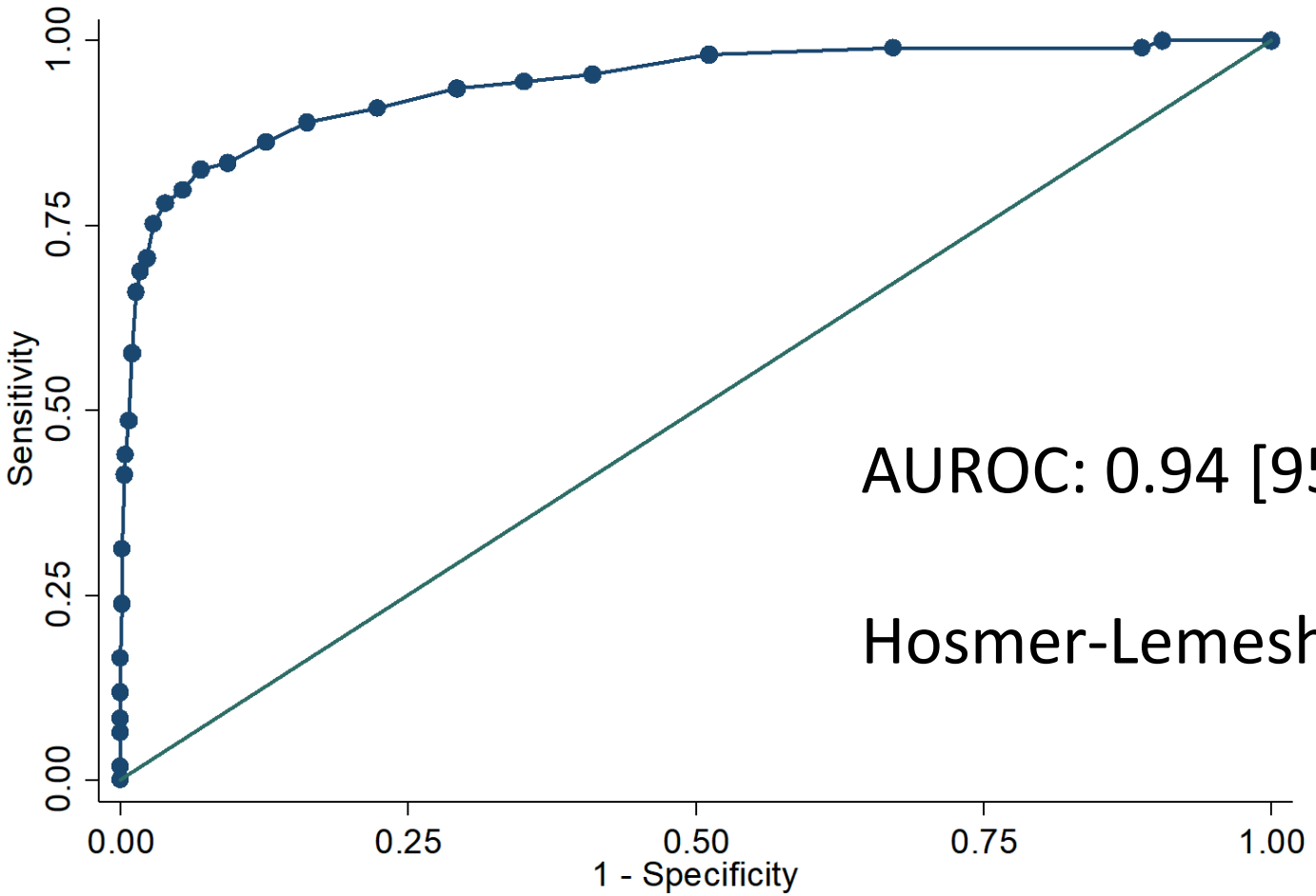
- Diagnostic and therapeutic endoscopy

Time of Admission to the PICU and Mortality*

Michael C. McCrory, MD, MS[1]; Michael C. Spaeder, MD, MS[2]; Emily W. Gower, PhD[3]; Thomas A. Nakagawa, MD[4,5]; Sean L. Simpson, PhD[6]; Mary A. Coleman, MSN, RN[7]; Peter E. Morris, MD[8]



e-PELOD2 (n = 5,118 PICU encounters)

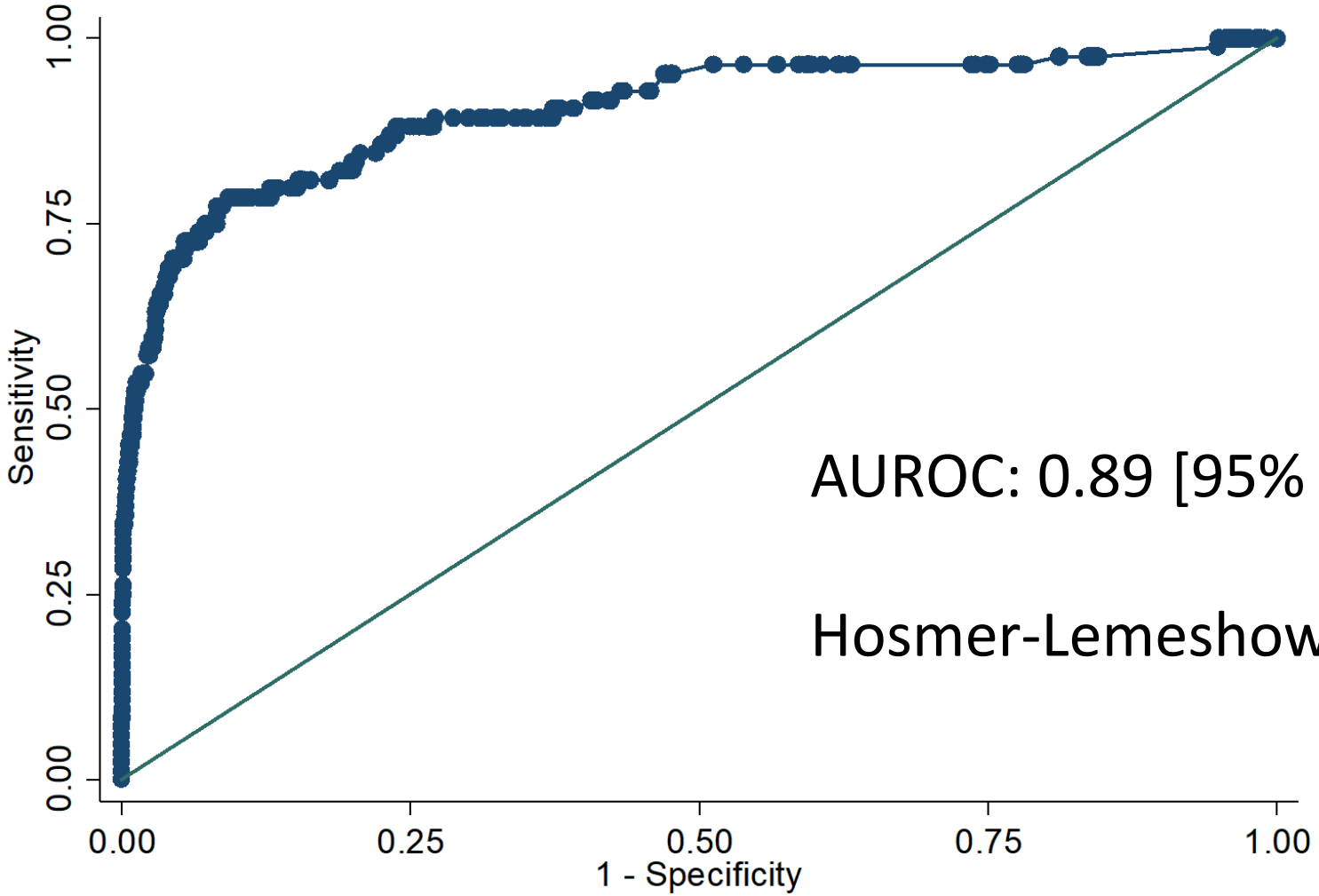


PELOD2 calculated for entire encounter and death during hospitalization

AUROC: 0.94 [95% CI 0.91 – 0.97]

Hosmer-Lemeshow Goodness of Fit *P*=0.12

e-PRISM IV (n = 5,118 PICU encounters)



PRISM calculated for first PICU admission and prediction of death in the PICU

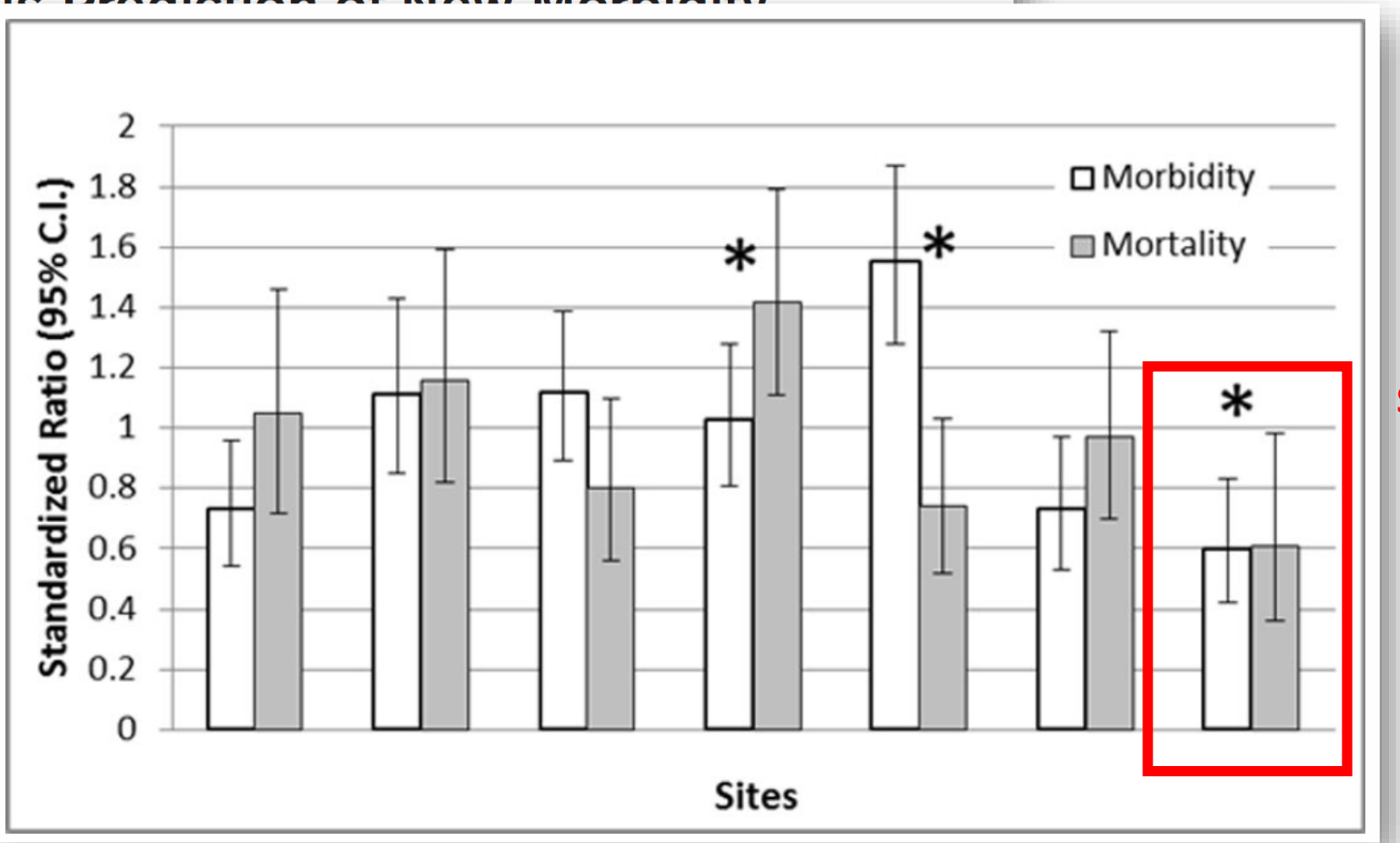
AUROC: 0.89 [95% CI 0.86 – 0.94]

Hosmer-Lemeshow Goodness of Fit *P*=0.19

Simultaneous Prediction of New Morbidity, Mortality, and Rehospitalization From Pediatric Intensive Care for Outcom

Murray M. Pollack,
Amy E. Clark, MS[3];
Frank Moler, MD[9];
Rick E. Harrison, MD
J. Michael Dean, MD
Development Collab

Crit Care Med. 20



SMR = 0.6

PICU Actual and Expected Mortality

Year	Admissions	Deaths	Actual Mortality	Expected Mortality	Ratio
2015	2642	43	1.63%	2.72%	0.60
2016	2476	41	1.66%	2.80%	0.59
Grand Total	5118	84	1.64%	2.76%	0.60

Accessible Data Visualization

- Qlik Business Intelligence Analytics
- Embed rules and definitions for e-PELOD2 and e-PRISM IV
- Track performance in near-real-time

the brain care institute

e-PICU

Children's Hospital of Pittsburgh of UPMC

Children's Hospital of Pittsburgh | of UPMC

CRITICAL CARE MEDICINE

the brain care institute

electronic- Performance Improvement Suite for Clinical Use

Children's Hospital of Pittsburgh of UPMC

CRITICAL CARE MEDICINE

Outcomes | Duration | Volume | GeoAnalytics | Custom Report Generator | How To | Definitions | All Data

Children's Hospital of Pittsburgh of UPMC — BCI

2015 | 2016 | 2017 | 2018 | Q1 | Q2 | Q3 | Q4 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Information + | Current Selections and Filters +

Current Selections

Search

< Clear All >

Month-Year	
Date	
Encounter ID	
Unique Patient ID	
Initial Location	
Final Location	
Currently In House	
Diagnosis Type	
Diagnosis Code	
Diagnosis Description	

Number of Distinct Encounters: 9732

Number of Distinct ICU Encounters: 11867

Number of Unique Patients: 6772

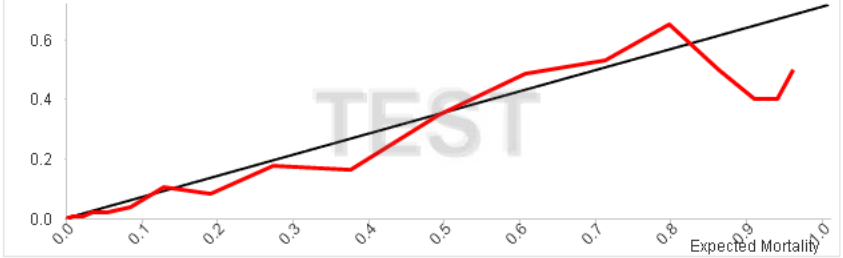
SMR 0.87

-1 | 46 | 94 | 161 | 236 | 323 | 441 | 564 | 716 | 1009

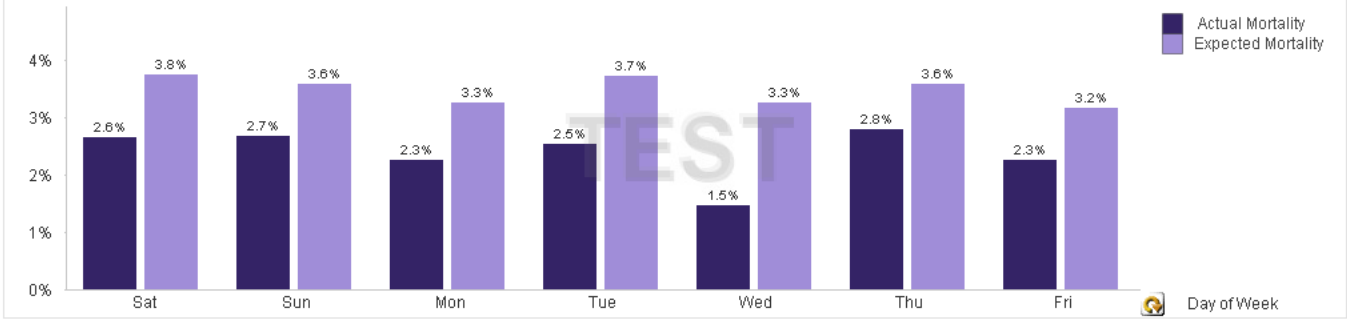
Mortality Slider Scale: Death Post Discharge

Month-Year	Admissions	Deaths Overall	ICU Deaths	Actual Mortal...	Expected Morta...	Mortality Ratio
	6772	**306**	**172**	**3.01%**	**3.46%**	**0.87**
Jan-2015	268	19	3	1.12%	2.61%	0.43
Feb-2015	212	16	4	1.89%	4.29%	0.44
Mar-2015	251	22	5	2.39%	3.05%	0.78
Apr-2015	257	19	5	1.95%	3.84%	0.51
May-2015	257	13	2	0.78%	2.35%	0.33
Jun-2015	236	26	5	3.81%	4.83%	0.79
Jul-2015	265	27	4	3.02%	3.24%	0.93
Aug-2015	234	13	4	1.71%	3.52%	0.49
Sep-2015	233	20	6	2.58%	3.46%	0.75
Oct-2015	246	16	7	2.85%	2.41%	1.18

Calibration Plot - Actual vs Expected Mortality



Actual vs Expected Mortality



Children's Hospital of Pittsburgh of UPMC

CRITICAL CARE MEDICINE

Outcomes | Duration | Volume | GeoAnalytics | Custom Report Generator | How To | Definitions | Variables | Notes | Table Info | KPI | QC | Template | All Data

Children's Hospital of Pittsburgh of UPMC BCI

2015 2016 2017 2018 | Q1 Q2 Q3 Q4 | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | QC + | Information + | Current Selections and Filters +

Current Selections

DIAGNOSIS_NAME 20 of 8717
DIAGNOSIS_TYPE Final

Search

< Clear All >

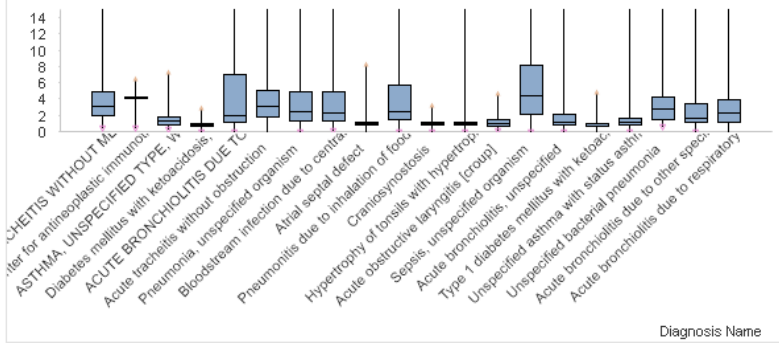
Month-Year
Date

Encounter ID
Unique Patient ID
Initial Location
Final Location
Currently In House
Diagnosis Type: Final
Diagnosis Code
Diagnosis Description

Number of Distinct Encounters: 2394 **Number of Distinct ICU Encounters:2366** **Number of Unique Patients:1892**

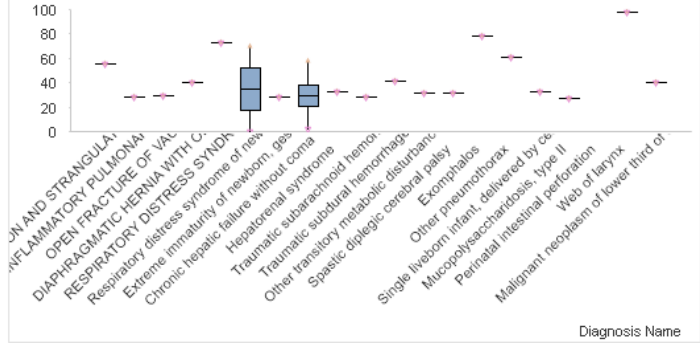
Top 20 Encounters

Selections must be made for this chart to render.



Top 20 Median LOS

Selections must be made for this chart to render.



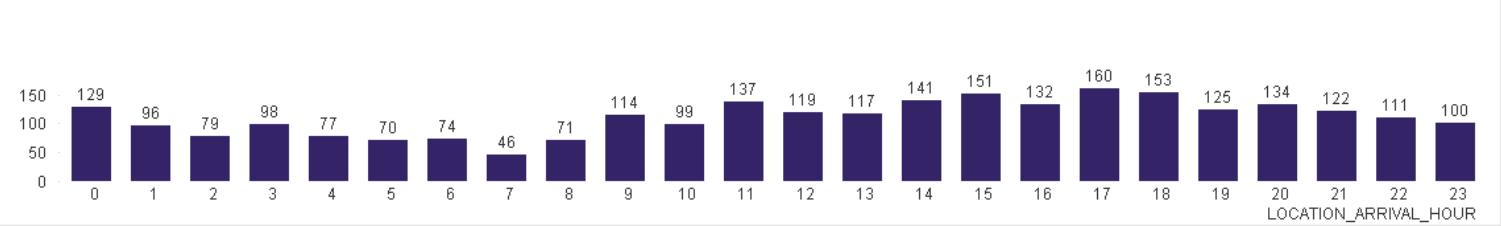
Top 20 Encounters

Final Diagnosis	# Encounters	Min LOS	Max LOS	Median LOS
Type 1 diabetes mellitus with ketoacidosis without coma	388	0.00	4.73	0.73
Acute bronchiolitis due to respiratory syncytial virus	238	0.00	28.84	2.26
Unspecified asthma with status asthmaticus	207	0.00	15.39	1.13
Acute tracheitis without obstruction	179	0.00	43.91	3.04
Pneumonia, unspecified organism	174	0.00	105.05	2.43
Sepsis, unspecified organism	149	0.00	84.16	4.34
Diabetes mellitus with ketoacidosis, type I [juvenile type], uncont...	115	0.06	2.79	0.74
ASTHMA, UNSPECIFIED TYPE, WITH STATUS ASTHMATICUS	101	0.33	7.25	1.24
Pneumonitis due to inhalation of food and vomit	88	0.02	57.74	2.48
Bloodstream infection due to central venous catheter, initial enc...	85	0.15	31.57	2.24
Hypertrophy of tonsils with hypertrophy of adenoids	81	0.03	34.88	1.01
Unspecified bacterial pneumonia	71	0.58	25.23	2.79
Acute bronchiolitis, unspecified	69	0.00	26.09	1.19
Atrial septal defect	68	0.00	8.12	1.01
Acute bronchiolitis due to other specified organisms	66	0.00	29.61	1.56
Craniosynostosis	66	0.00	3.11	0.97
ACUTE BRONCHIOLITIS DUE TO RESPIRATORY SYNCYTIAL...	65	0.01	29.50	1.91
ACUTE TRACHEITIS WITHOUT MENTION OF OBSTRUCTION	64	0.49	29.54	3.03
Encounter for antineoplastic immunotherapy	62	0.55	6.35	4.18
Acute obstructive laryngitis [croup]	58	0.11	4.60	0.97

Top 20 Median LOS

Final Diagnosis	Median LOS	Min LOS	Max LOS
Perinatal intestinal perforation	128.73	128.73	128.73
Web of larynx	98.01	98.01	98.01
Exomphalos	78.18	78.18	78.18
RESPIRATORY DISTRESS SYNDROME IN NEWBORN	72.29	72.29	72.29
Other pneumothorax	61.18	61.18	61.18
ASPHYXIATION AND STRANGULATION	54.95	54.95	54.95
Traumatic subdural hemorrhage with loss of consciousness greater...	40.92	40.92	40.92
Malignant neoplasm of lower third of esophagus	40.34	40.34	40.34
DIAPHRAGMATIC HERNIA WITH OBSTRUCTION	39.86	39.86	39.86
Respiratory distress syndrome of newborn	35.04	0.15	69.93
Hepatorenal syndrome	33.00	33.00	33.00
Single liveborn infant, delivered by cesarean	32.25	32.25	32.25
Spastic diplegic cerebral palsy	31.99	31.99	31.99
Other transitory metabolic disturbances of newborn	31.46	31.46	31.46
OPEN FRACTURE OF VAULT OF SKULL WITH INTRACRANIAL ...	29.76	29.76	29.76
Chronic hepatic failure without coma	29.06	2.20	57.13
POSTINFLAMMATORY PULMONARY FIBROSIS	28.67	28.67	28.67
Extreme immaturity of newborn, gestational age 26 completed weeks	27.83	27.83	27.83
Traumatic subarachnoid hemorrhage with loss of consciousness g...	27.75	27.75	27.75
Mucopolysaccharidosis, type II	27.36	27.36	27.36

ICU Encounter Arrival by Hour of Day



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Children's Hospital of Pittsburgh of UPMC

CRITICAL CARE MEDICINE

Our 5 Best Practices

1) Build an accessible data infrastructure: Making best use of the EHR

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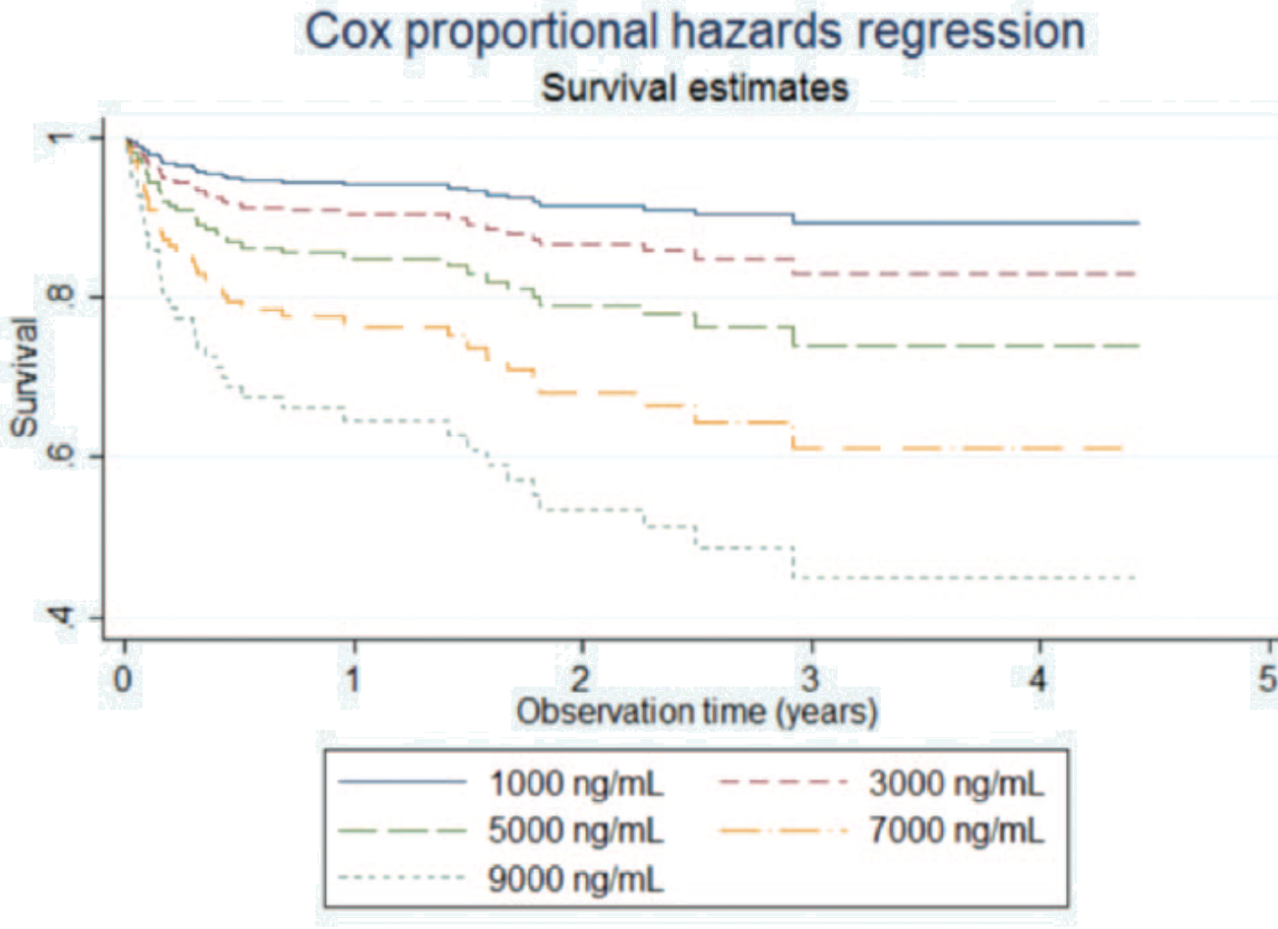
5) Acknowledge uncertainty: Modern, probabilistic decision-making

Very high serum ferritin levels are associated with increased mortality and critical care in pediatric patients

Tellen D. Bennett, MD, MS; Kristen N. Hayward, MD, MS; Reid W. D. Farris, MD; Sarah Ringold, MD, MS; Carol A. Wallace, MD; Thomas V. Brogan, MD

Table 1. Select clinical and demographic features of study groups

Feature	Ferritin >3000 ng/mL (n = 68)		Ferritin 1000–3000 ng/mL (n = 103)	
	Died	Survived	Died	Survived
Total	26 (38.2%)	42 (61.8%)	12 (11.7%)	91 (88.3%)
Age, yrs (mean ± SD)	9.3 ± 6.3	10.0 ± 5.8	7.1 ± 8.0	9.9 ± 6.4
Female, n (%)	8 (30.1%)	23 (54.5%)	7 (58.3%)	35 (38.5%)
Hematopoietic stem cell transplant, n (%)	13 (50.0%)	8 (19.1%)	2 (16.7%)	14 (15.4%)
Solid organ transplant, n (%)	2 (7.7%)	1 (2.4%)	2 (16.7%)	8 (8.8%)
Hemoglobinopathy, n (%)	2 (7.7%)	5 (11.9%)	0	14 (15.4%)
Preexisting rheumatologic disease, n (%)	2 (7.7%)	15 (35.6%)	0	12 (13.2%)



Pediatr Crit Care Med 2011 Vol. 12, No. 6

A Systemic Inflammation Mortality Risk Assessment Contingency Table for Severe Sepsis*

Joseph A. Carcillo, MD[1]; Katherine Sward, PhD[2]; E. Scott Halstead, MD, PhD[1]; Russell Telford, MAS[2]; Adria Jimenez-Bacardi, MD[1]; Bita Shakoory, MD[3]; Dennis Simon, MD[1]; Mark Hall, MD[4]; on behalf of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network Investigators

Pediatric Critical Care Medicine
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Box A 'Intermediate Risk' CRP < 4.08 mg/dL, and Ferritin ≥ 1,980 ng/mL **Mortality 0/0 (0%)**	Box B 'High Risk' CRP ≥ 4.08 mg/dL, and Ferritin ≥ 1,980 ng/mL **Mortality 6/13 (46.15%)**
Box C 'Low Risk' CRP ≤ 4.08 mg/dL, and Ferritin ≤ 1,980 ng/mL **Mortality 0/44 (0%)**	Box D 'Intermediate Risk' CRP ≥ 4.08 mg/dL, and Ferritin < 1,980 ng/mL **Mortality 2/43 (4.65%)**

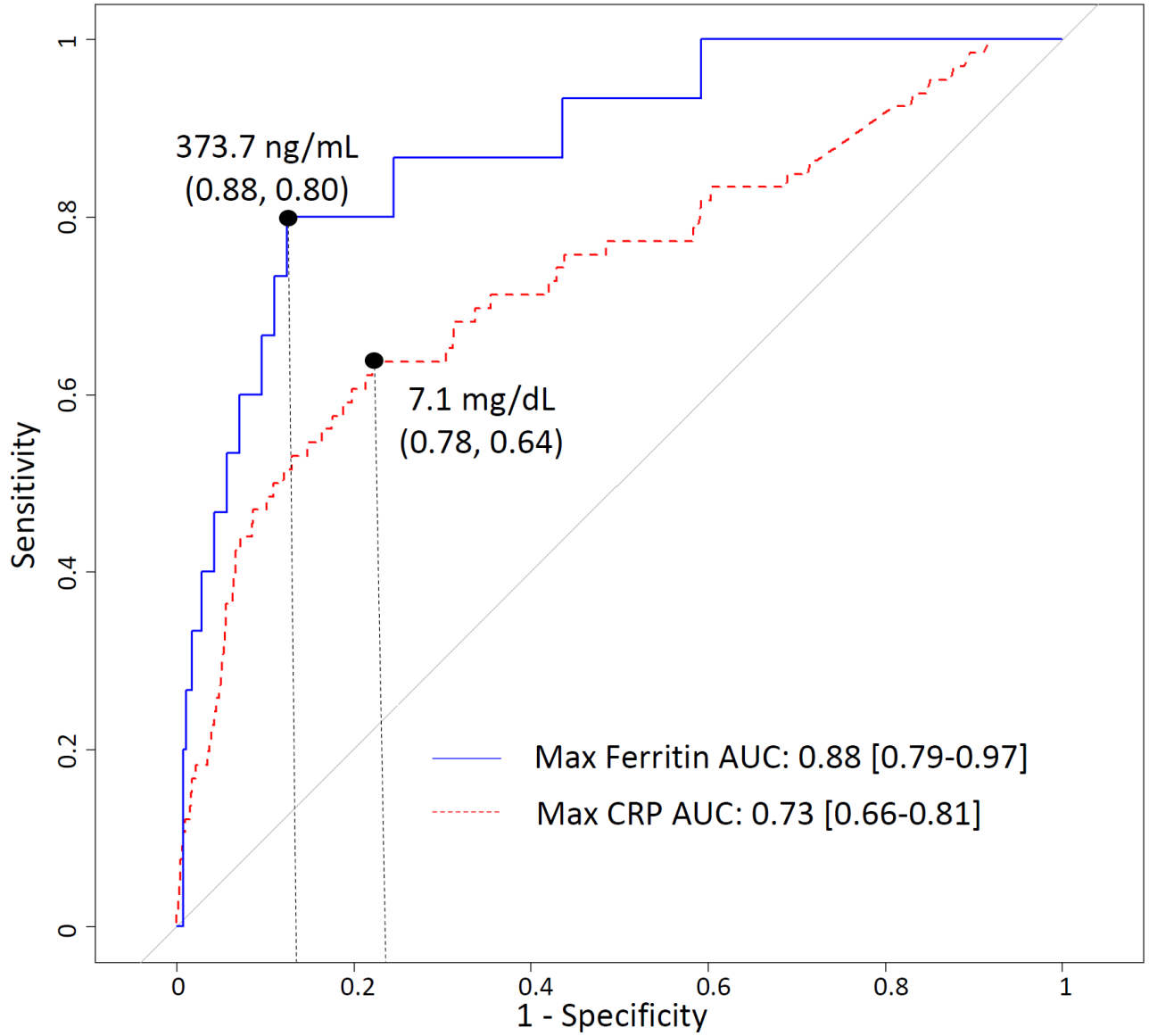
Table 1. Cohort characteristics

	CRP	Ferritin	CRP and Ferritin	
# Total Values	14,927	653	--	
Unique Hospitalizations	5,313	317	172	
Unique Patients, N	4,142	297	172	
Characteristic, median (IQR) or n (%)				
Age (months)	80.4 (21.4, 156.2)	125.4 (38.6,189.3)	110.3 (42.2,184.1)	
Female	1901 (45.9)	156 (52.5)	84 (48.8)	
			CRP	Ferritin
Presenting Value*	1.19 (0.32,5.01)	47.4 (17.2,146.4)	1.29 (0.32,6.72)	85.9 (18.4,209.3)
Maximum Value*	1.72 (0.32,6.45)	17.2 (49,153.3)	2.1 (0.32,13.5)	85.9 (18.4,243.1)
Positive Culture	836 (20.2)	68 (22.9)	49 (28.5)	
Blood	180 (4.3)	29 (9.8)	15 (8.7)	
Urine	269 (6.5)	29 (9.8)	16 (9.3)	
Respiratory	503 (12.1)	34 (11.5)	33 (19.2)	
Cerebrospinal Fluid	20 (4.8)	2 (0.7)	2 (1.2)	
Other (Pleural or Peritoneal)	23 (5.6)	9 (3.0)	7 (4.1)	
Hospital Length of Stay (days)	3.0 (2.0, 7.0)	5.6 (3.6,12.1)	4.9 (2.5,13.4)	
PICU Admission	1522 (36.7)	81 (27.2)	61 (35.5)	
PICU Length of Stay (days)	2.4 (1.2,5.9)	7.3 (1.5,19.2)	5.9 (1.5,15.1)	
Hospital Mortality	46 (1.1)	12 (4.0)	8 (4.7)	
90-day Mortality	66 (1.6)	15 (5.0)	10 (5.8)	
1-Year Mortality	95 (2.3)	16 (5.4)	11 (6.4)	

*Ferritin (ng/mL), CRP (mg/dL)

Table 2. Receiver operating curve characteristics for c-reactive protein, ferritin and hospital, 90-day and 1-year mortality

Biomarker	Hospital Mortality			90-day Mortality			1-year Mortality		
	AUROC [95% CI]	Cutpoint [95% CI]	*P*	AUROC [95% CI]	Cutpoint [95% CI]	*P*	AUROC [95% CI]	Cutpoint [95% CI]	*P*
N = 4142									
Presenting CRP	0.45 [0.35-0.54]	--	--	0.56 [0.49-0.64]	--	--	0.55 [0.49-0.62]	--	--
Maximum CRP	0.76 [0.68-0.85]	7.1 [4.2-12.0]	<0.001	0.73 [0.66-0.81]	7.1 [3.8-10.1]	<0.001	0.69 [0.63-0.75]	6.9 [1.8-7.4]	<0.001
N = 297									
Presenting Ferritin	0.80 [0.69-0.90]	123.4 [0-342.4]	0.27	0.79 [0.69-0.89]	123.4 [0-247.3]	0.05	0.79 [0.69-0.88]	123.4 [27.7-219.1]	0.01
Maximum Ferritin	0.90 [0.83-0.98]	373 [0-1056.4]	0.28	0.88 [0.79-0.97]	373.7 [24.7-722.7]	0.04	0.87 [0.78-0.96]	135.0 [0-423.7]	0.36

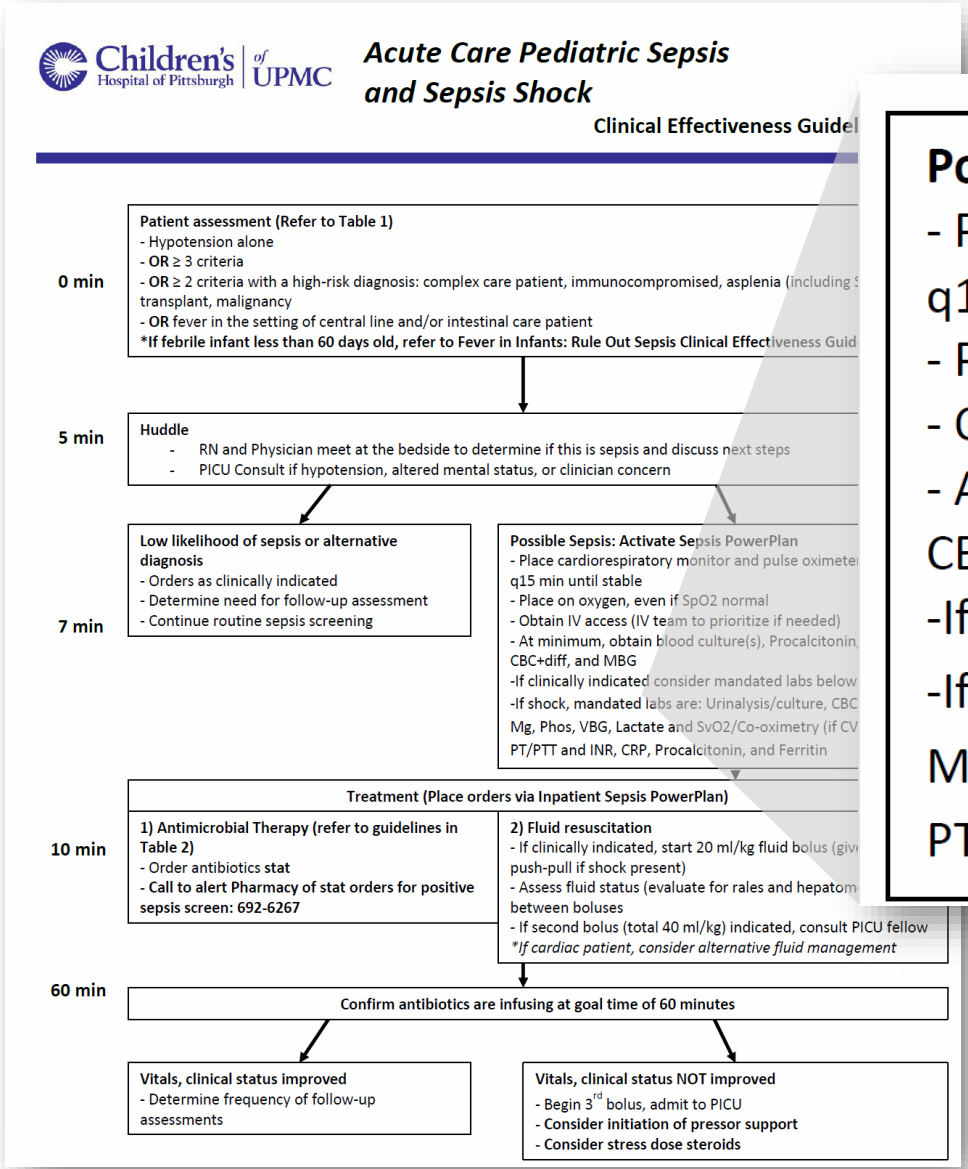

373.7 ng/mL
(0.88, 0.80)
7.1 mg/dL
(0.78, 0.64)
Max Ferritin AUC: 0.88 [0.79-0.97]
Max CRP AUC: 0.73 [0.66-0.81]
Sensitivity
1 - Specificity
0
0.2
0.4
0.6
0.8
1

	Ferritin ≤373 ng/mL	Ferritin >373 ng/mL
CRP >7.1 mg/dL	**Intermediate Risk** **Hospital Mortality:** 2 / 35 (5.7) **90-day Mortality:** 2 / 35 (5.7) **1-year Mortality:** 2 / 35 (5.7) **PELOD2 (n=16):** 8.5 (5.5,13)*	**High Risk** **Hospital Mortality:** 5 / 23 (21.7) **90-day Mortality:** 7 / 23 (30.4) **1-year Mortality:** 7 / 23 (30.4) **PELOD2 (n=13):** 12 (15,17)*
CRP ≤7.1 mg/dL	**Low Risk** **Hospital Mortality:** 0 / 100 (0) **90-day Mortality:** 0 / 100 (0) **1-year Mortality:** 1 / 100 (1) **PELOD2 (n=24):** 6 (2,8.5)*	**Intermediate Risk** **Hospital Mortality:** 1 / 14 (7.1) **90-day Mortality:** 1 / 14 (7.1) **1-year Mortality:** 1 / 14 (7.1) **PELOD2 (n=8):** 9.5 (4.5,13)*

Data is displayed as n / N (%) for mortality outcomes

*Significant difference in high/intermediate versus low risk quadrants; *P*<0.001 by Mann-Whitney test

PELOD2, Pediatric Logistic Organ Dysfunction Score 2



Possible Sepsis: Activate Sepsis PowerPlan

- Place cardiorespiratory monitor and pulse oximeter, vital signs q15 min until stable
- Place on oxygen, even if SpO2 normal
- Obtain IV access (IV team to prioritize if needed)
- At minimum, obtain blood culture(s), Procalcitonin, BMP, CBC+diff, and MBG

-If clinically indicated consider mandated labs below

-If shock, mandated labs are: Urinalysis/culture, CBC+diff, BMP, Mg, Phos, VBG, Lactate and SvO2/Co-oximetry (if CVL), cortisol, PT/PTT and INR, CRP, Procalcitonin, and Ferritin

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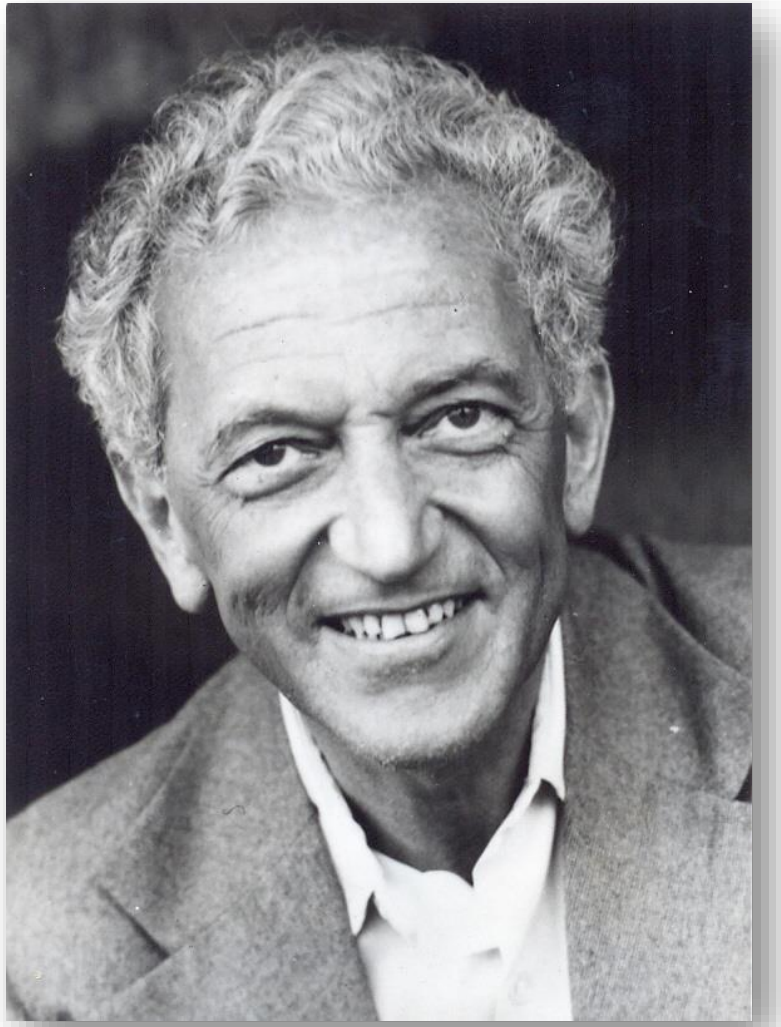

Dr. Peter Safar

Rule No. 11

“Perfection is not optional.”

Thank You!

Sajel Kantawala

Gabriella Butler

Chris Myers

Daniel Rohm

Bob Clark

Pat Kochanek

Suresh Srinivasan

Joe Carcillo

<u>Not Pictured:</u>

Thomas Brown
John Snyder
Kelly Bricker
Janice Daugherty
Sue Park
Denee Marasco
Kristi Russo

Children's Hospital of Pittsburgh | of UPMC

CRITICAL CARE MEDICINE

Thank You

Questions?

NATIONAL DEVELOPMENT PLAN 2020

EUROPEAN UNION
European Social Fund

INVESTING IN YOUR FUTURE

Christopher.Horvat@chp.edu

Children's Hospital of Pittsburgh of UPMC

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