Tele-ICU

The Story Behind the Data

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Disclosures

I have no disclosures or financial support or otherwise to report

OBJECTIVES

Describe the history of the Tele-ICU

Explain the role of Tele-ICU in the care of critically ill and injured patient

Examine the evolution of the eICU Research Institute (eRI)

Review a study design using the complete eRI dataset

Evolution of Telehealth

1924
Teledactyl envisioned

1906
First EKG transmitted by telephone

1948
First radiologic images transmitted by telephone

1959
Nebraska hospitals establish first interactive video link

1960s
NASA takes on telemedicine

1960s
Telehealth Program Pilot Dept. of Public Health, DOD, Health & Human Services

1963
MGH opens remote medical outpost at Logan Airport

1964
Norfolk State Hospital provided TeleHealth services

1974
First Telenursing Article Published

1980
MIT Media Lab pioneers "Talking Heads" telepresence

1989
Dawn of the modern Internet

1993
American Telemedicine Association (ATA) founded

1999
CMS begins reimbursing for TeleHealth consults in under-served rural areas

2000
First TeleICU opens Norfolk VA

2003-2006
First Wave of TeleICUs open across the US

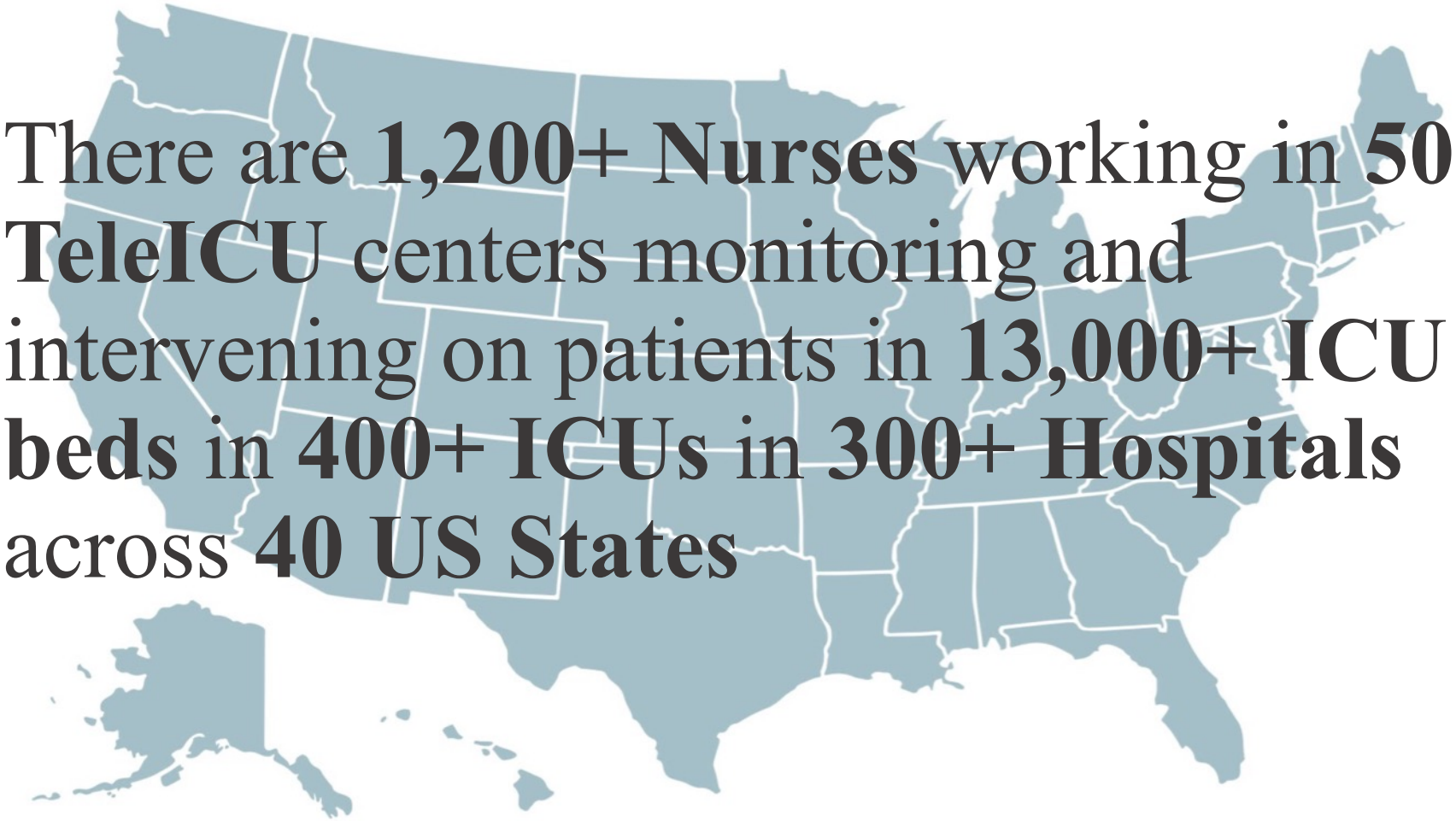
2008
eICU Research Institute formed

2011
First study from eICU Research Institute Published

Explosion of mobile apps, eVisits and mHealth

"Congratulations, you're my first mouse call…"

TELEICU FAST FACTS



There are **1,200+ Nurses** working in **50+ TeleICU** centers monitoring and intervening on patients in **13,000+ ICU beds** in **400+ ICUs** in **300+ Hospitals** across **40 US States**

WHY USE TELEICU?

WHY USE TELEICU?

The sub-specialty of teleICU is not well understood. Most agree that the practice of healthcare using telehealth technologies (telehealth) emerged in the 1960s. In 1974 the first paper on telehealth nursing was published. The first telehealth intensive care unit (teleICU) opened in 2000 at a hospital system on the East Coast. By 2003 several other health systems began to use teleICU centers to support critically ill and injured patients. Today there are over 50 teleICU centers monitoring and intervening on patients in over 13,000 ICU beds in more than 400 ICUs across 40 States in the USA!

THE FACTS

GROWING SERVICE

50 teleICU centers and **13,000 ICU beds** in more than **400 ICUs** across **40 US States**

400 in 40

IMPACT ON OUTCOMES

Better adherence to best practices, decrease in length of stay, more lives saved

Lives saved!

SHORTAGTES

Shortage of **clinical experts** is growing

Knowledge deficit

COST EFFECTIVE

UMASS Critical Care **$50 million** to the good after a decade of teleICU services

$50 million

WHAT IS TELEICU?

TELEICU DEFINED

TeleICU is a centralized remote model of critical care delivery that uses special tools to leverage clinical expertise across a variety of clinical settings and geographical areas.

STRUCTURE TYPES

Care teams working in a defined physical structure are centralized. When care providers are not confined to a physical space it is considered decentralized.

TELEICU MODELS OF CARE

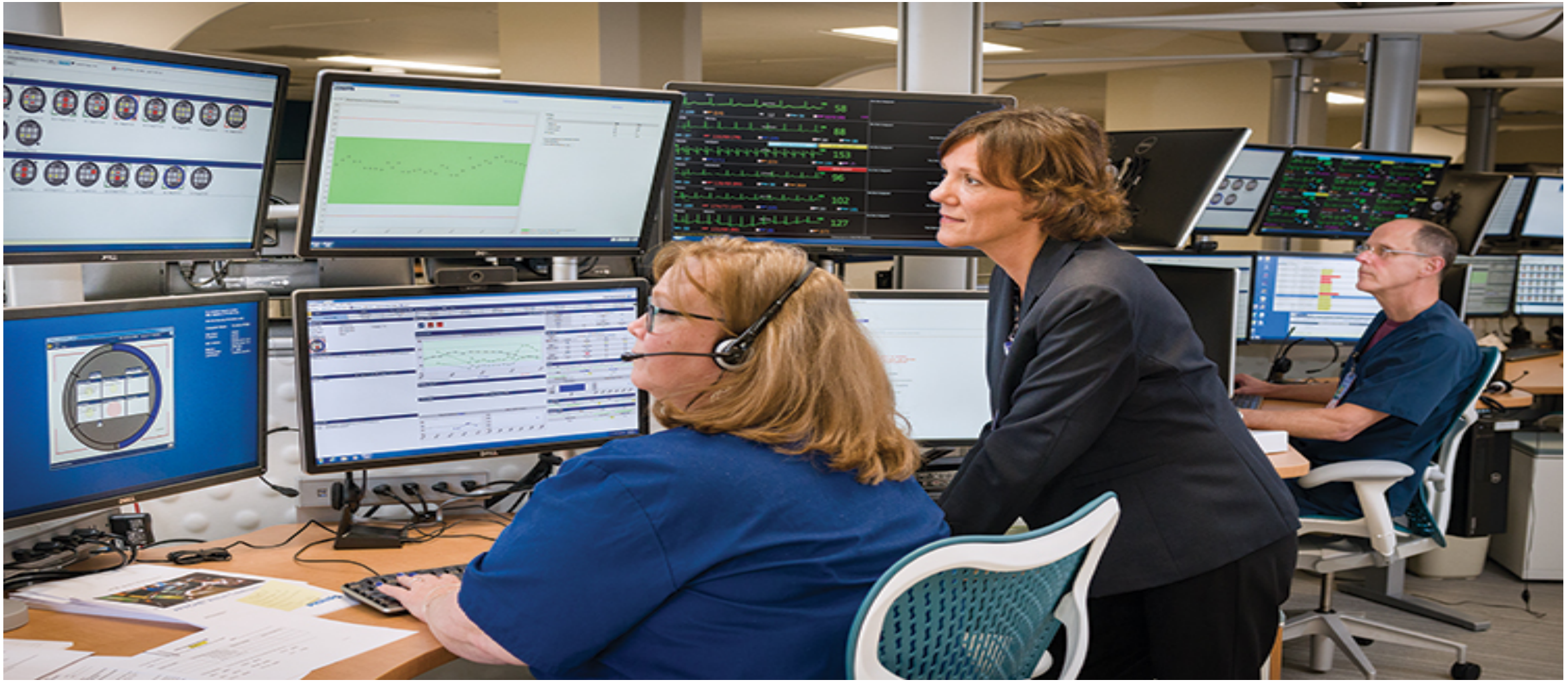
- Continuous Care is monitoring without interruption
- Responsive (Reactive) Care is unscheduled and prompted by an alert, alarm, page, telephone call…
- Scheduled Care are scheduled periodic consultations

SPECIAL TOOLS

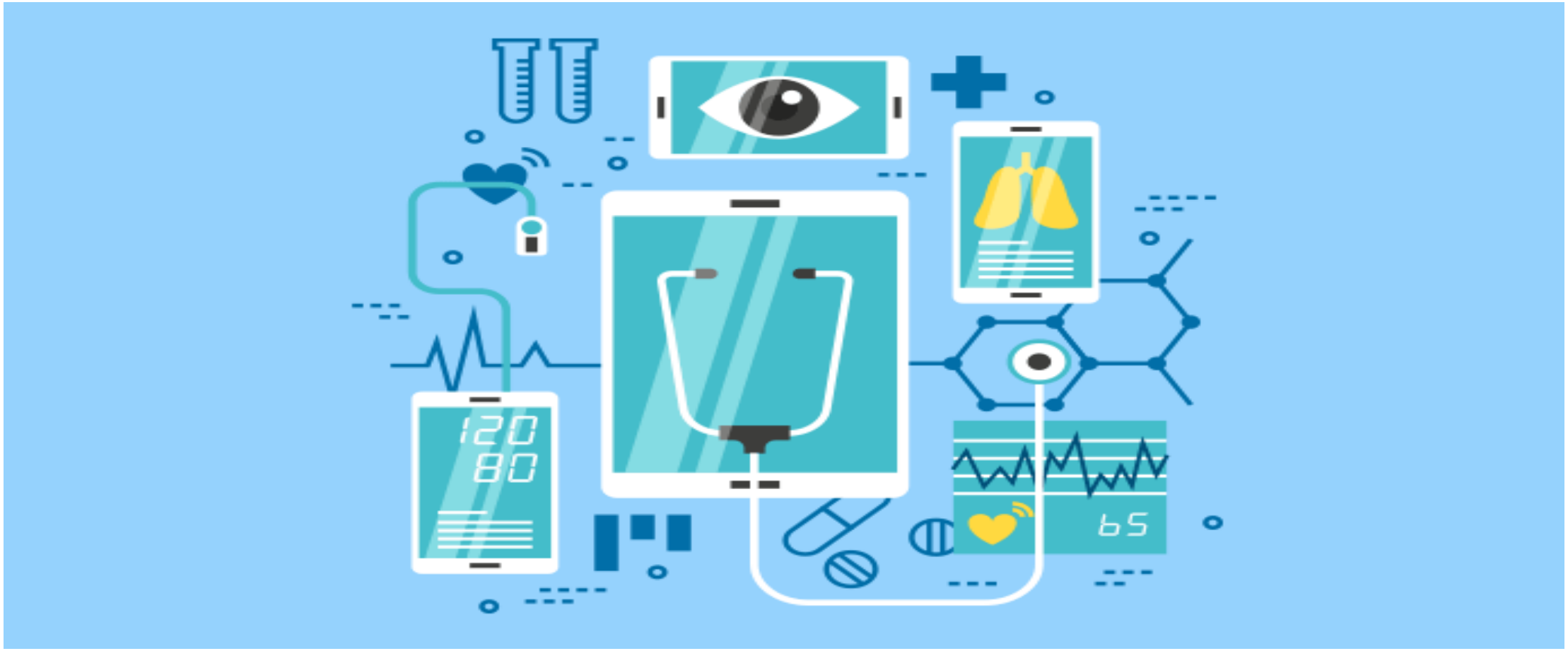
- Alerts are tools designed to recognizing signs of clinical deterioration
- Clinical decision support systems reduce the need to remember everything
- Tools support continuous capture, analyses, and disseminating of information
- Audio-video tools support remote assessment

1. ATA TeleICU Practice Guidelines Work Group. Guidelines for TeleICU Operations. ATA Standards & Guidelines. 2014;2014(June 21). http://www.americantelemed.org/resources/standards/ata-standards-guidelines#.U7gm1hbZf1p.
2. Lilly CM, Zubrow MT, Kempner KM, et al. Critical care telemedicine: evolution and state of the art. Crit Care Med. 2014;42(11):2429-2436.
3. Lilly CM, Motzkus C, Rincon T, Cody SE, Landry K, Irwin RS. ICU Telemedicine Program Financial Outcomes. Chest. 2017;151(2):286-297.

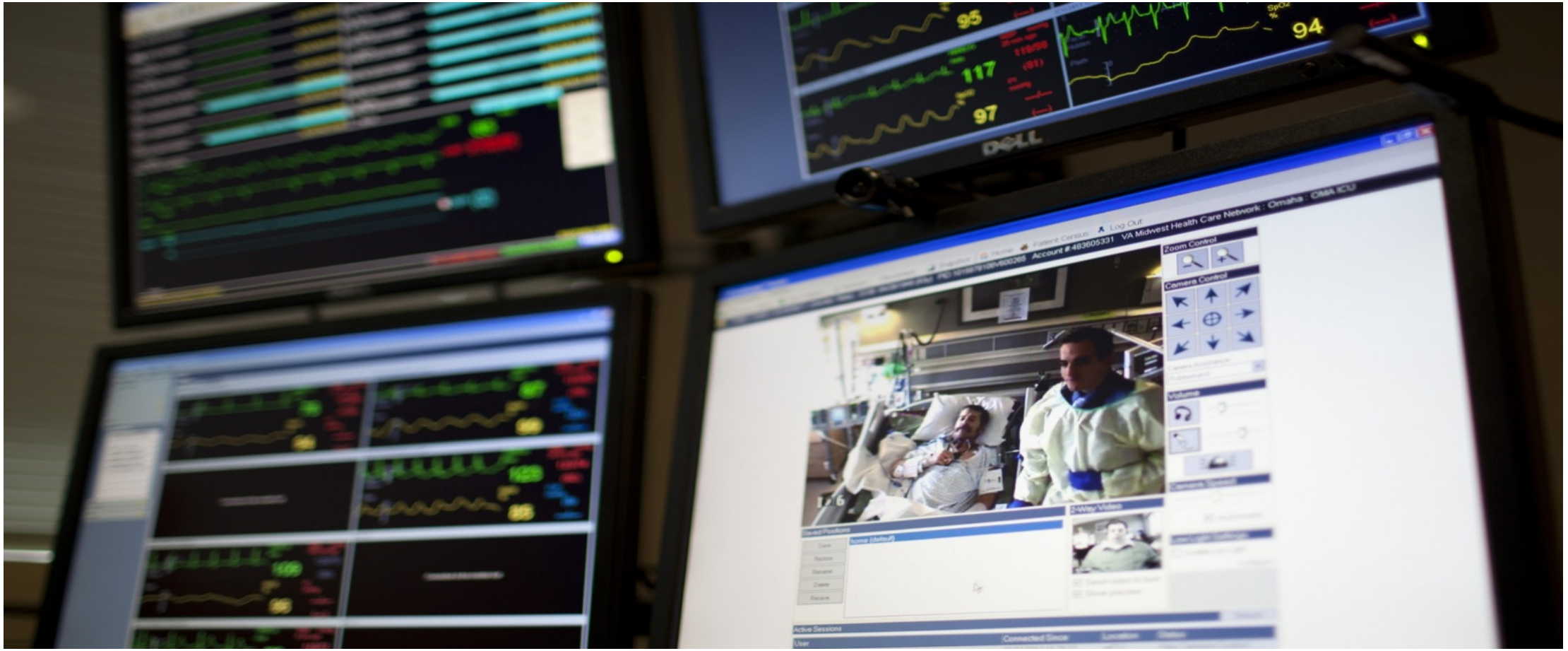
Special alerts designed to recognize signs of clinical deterioration



Clinical decision support systems reduce the need to remember everything



Audio-video tools support remote assessment



Inter-professional team of experts share knowledge

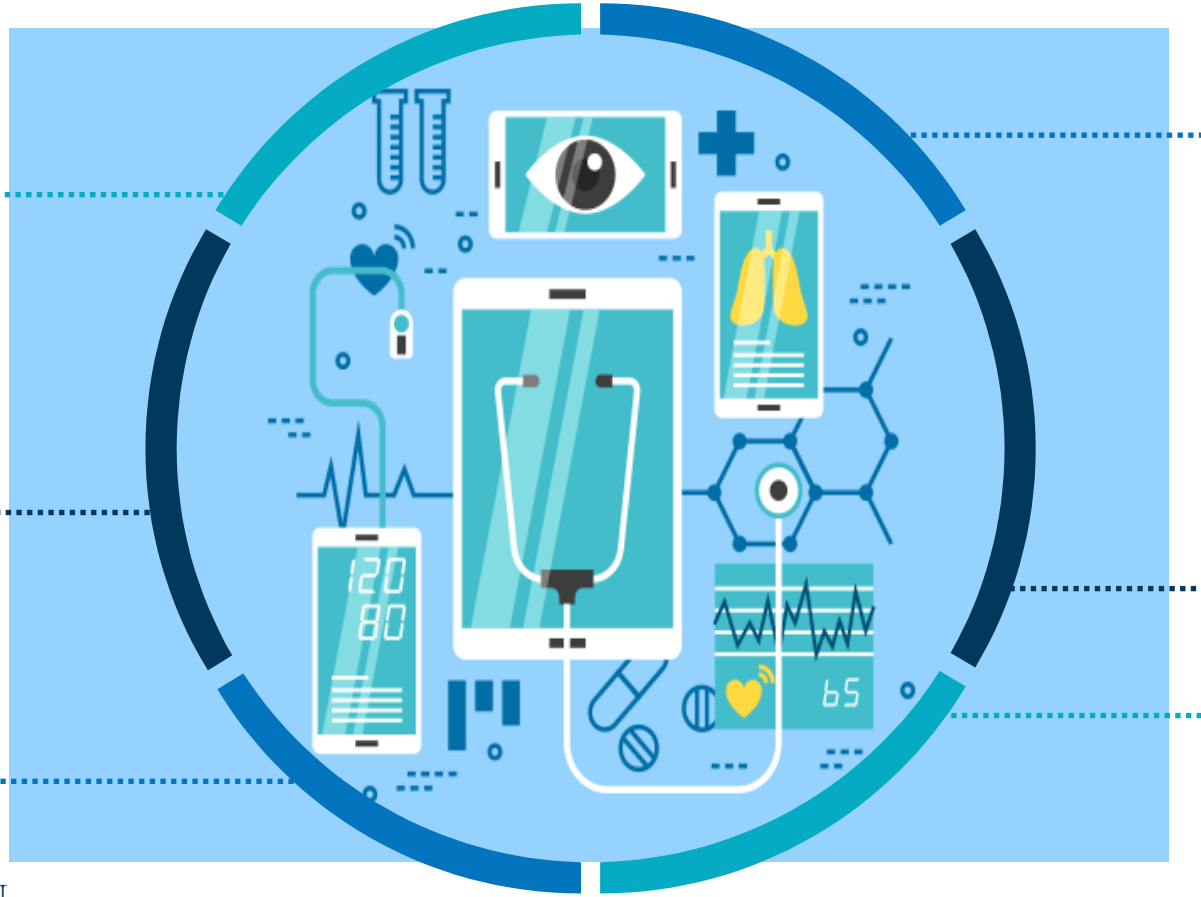

BIG DATA
VOLUME
ANALTYTICS
RESEARCH
TEAM
SKILLS
HEALTHCARE
SQL
STORAGE
EXTRACTS
R
SIZE
MISSINGNESS
TECHNIQUES
TECHNOLOGY
STATISTICS
SUBSET
HIPAA
TEAMWORK
LABORATORY
CLINICAL INSIGHT
VITAL SIGNS
MEDICATIONS
POPULATION
MANAGEMENT
DATA TABLES
SOFTWARE
INTEGRITY
RELATIONAL
VISUALIZATION
MEMORY
DATA MINING
RAM
PETABYTE
PROCESSING
CREATIVE
CONCEPTUAL
GOAL
EXPERTISE
OBJECTS
BRAINPOWER
INFORMATION
COLLABORATION
ADT
STRENGTH
DEMOGRAPHICS
PEOPLE
ARCHITECTURE
COMPUTER
QUERY
RESULTS
POWER
COMPLEXITY
CODE
BIAS
GUID
COURAGE
REPRODUCIBLE
VISION
MATRIX
VARIABLES
TRENDS

eICU RESEARCH INSTITUTE

Complete Dataset

ACHEIVEMENTS: MULTIPLE PEER-REVIEWED MANUSCRIPTS AND PREDICTIVE MODELING AND CLINICAL DECISION SUPPORT SYSTEMS

STAYS 800+ BILLION LAB VALUES



PATIENT DATA FROM 400+ ICUs AT 300+ HOSPITALS ACROSS 40 STATES

100+ MILLION MEDICATION ORDERS

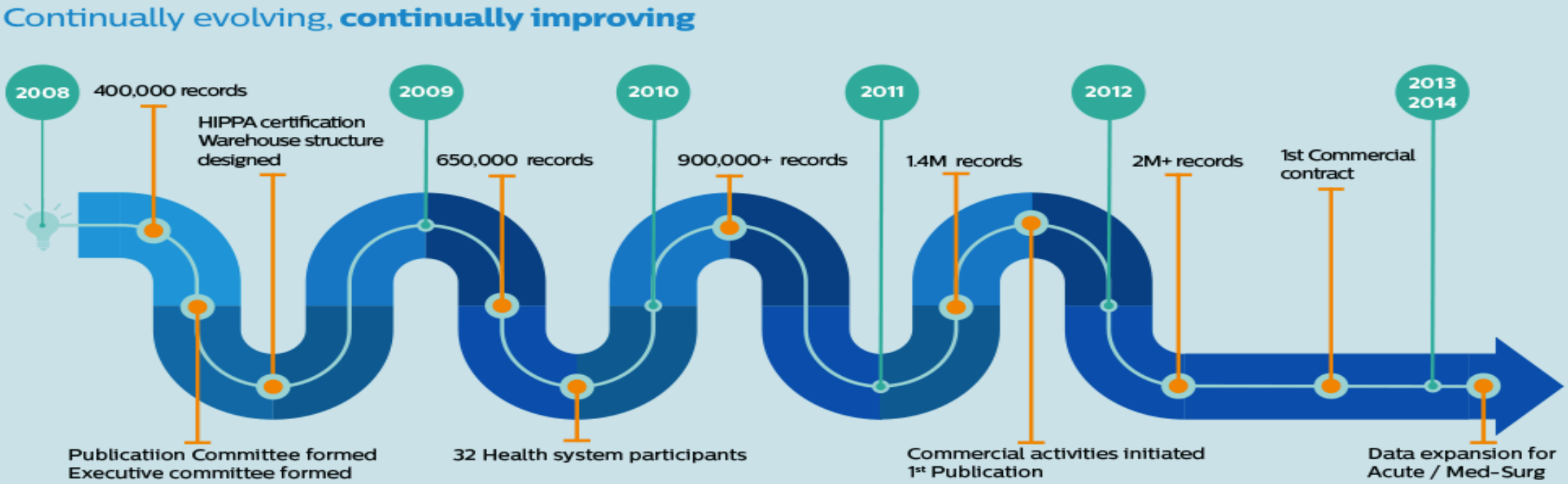
CLINICAL DIAGNOSES DATA ON 3+ MILLION ICU PATIENT

2.8+ BILLION VITAL SIGN MEASUREMENTS

https://www.usa.philips.com/healthcare/solutions/enterprise-TeleHealth/eri

CHANGES OVER TIME

https://www.usa.philips.com/healthcare/solutions/enterprise-TeleHealth/eri



Primary documentation tool

Interfaces for ADT, Labs & VS

Med interfaces come later

More manual data entry

Additional clinical decision support tools and alerts developed

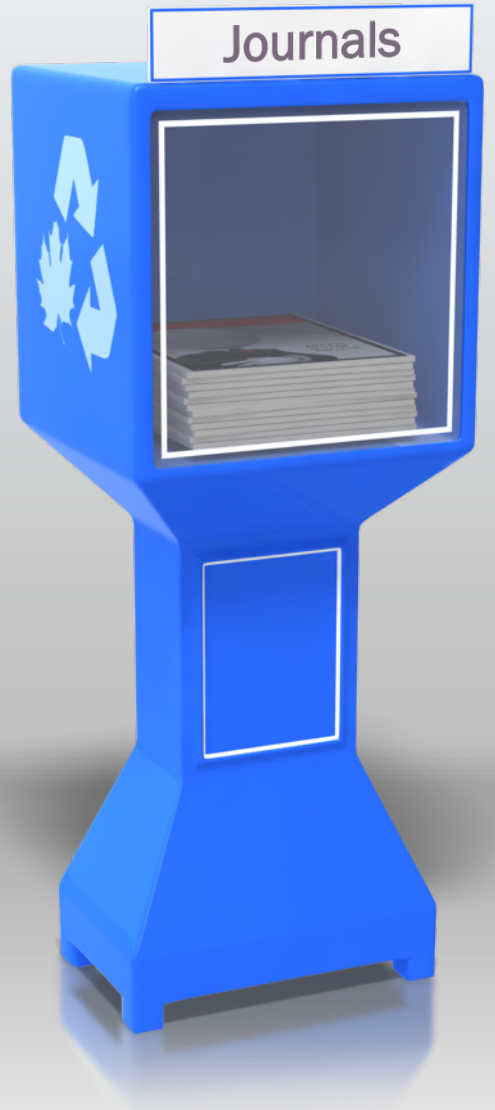
Meaningful use emerges

Hot fixes/upgrades

Primary documentation shifts to large EHR vendors

Reliance on interfaces

REVIEW OTHER eRI STUDIES



243,553 eligible patients in 271 ICUs 2008

Lilly C. et al Benchmark data from more than 240,000 adults that reflect the current practice of critical care in the United States. *Chest.* 2011

194,722 eligible patients 2008-2010

Badawi O et al. Association between intensive care unit–acquired dysglycemia and in-hospital mortality*. *Critical Care Medicine.* 2012

207,702 eligible patients in 344 ICUs 2008-2010

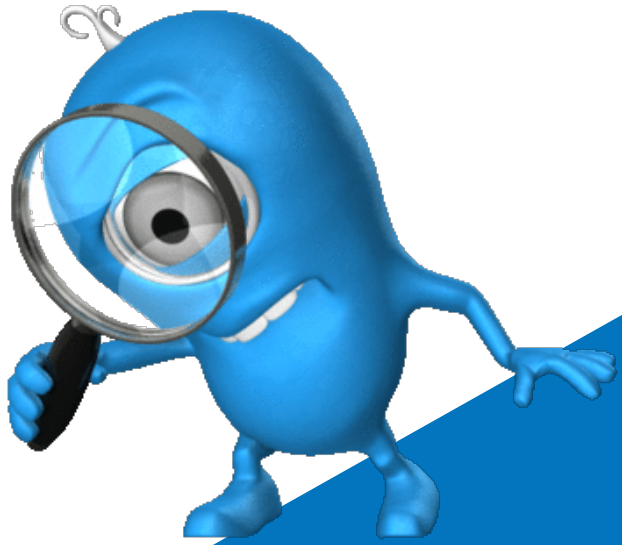
Waite MD, et al. Intensive care unit acquired hypernatremia is an independent predictor of increased mortality and length of stay. *Journal of Critical Care. 2013*

2,014 eligible patients in 344 ICUs 2008-2010

McPhee LC et al. Single-Dose Etomidate Is Not Associated With Increased Mortality in ICU Patients With Sepsis: Analysis of a Large Electronic ICU Database*. *Critical Care Medicine.* 2013

MY DISSERTATION STUDY

Prognostic accuracy of the SOFA score and a sepsis prompt in discriminating in-hospital mortality among patients with sepsis in the intensive care unit



RAPID BREATHING

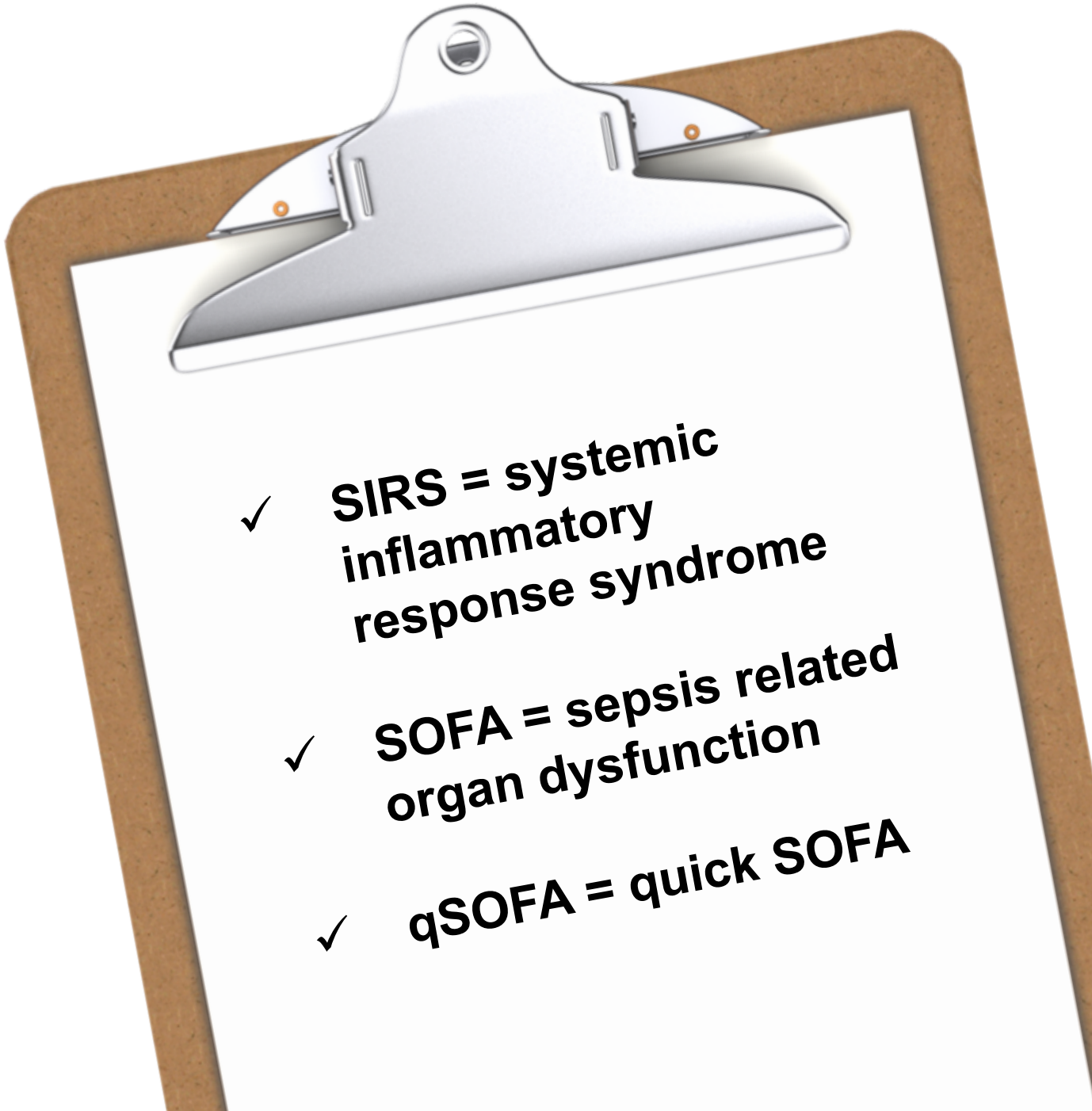
FAST HEART RATE

FEVER & CHILLS

CONFUSION

MY DISSERTATION STUDY

The **primary objective** is to conduct a retrospective study using a large data repository to determine if an electronic prompt that uses SIRs and organ failure criteria can detect sepsis AND to determine the prognostic accuracy of the SOFA score and the sepsis prompt in discriminating in-hospital mortality among patients with sepsis in the intensive care unit.



ELIGIBLE PATIENTS

All ICU admissions from January 1, 2010 to December 31, 2015	Estimated number of ICU admissions = 2,400,000
2% will be <18 years and will be excluded	Estimated number of eligible patients = 2,352,000
20% will be readmissions and will be excluded	Estimated number of eligible patients = 1,881,600
80% will have APACHE (severity of illness) scores ≥ 1	Estimated number of eligible patients = 1,505,320
80% will have valid medication, laboratory, and vital sign data	Estimated number of eligible patients = 1,204,264
11% will have sepsis	Estimated number of eligible patients = 132,469

DETERMINING THE OUTCOME VARIABLES

Severe Sepsis:

A binary classification was made based on patients having one of the following diagnosis codes present within the first 24 hours of admission:

1. severe sepsis with/without septic shock OR
2. septic shock without severe sepsis OR
3. infection AND organ failure

Hospital discharge disposition:

alive versus expired

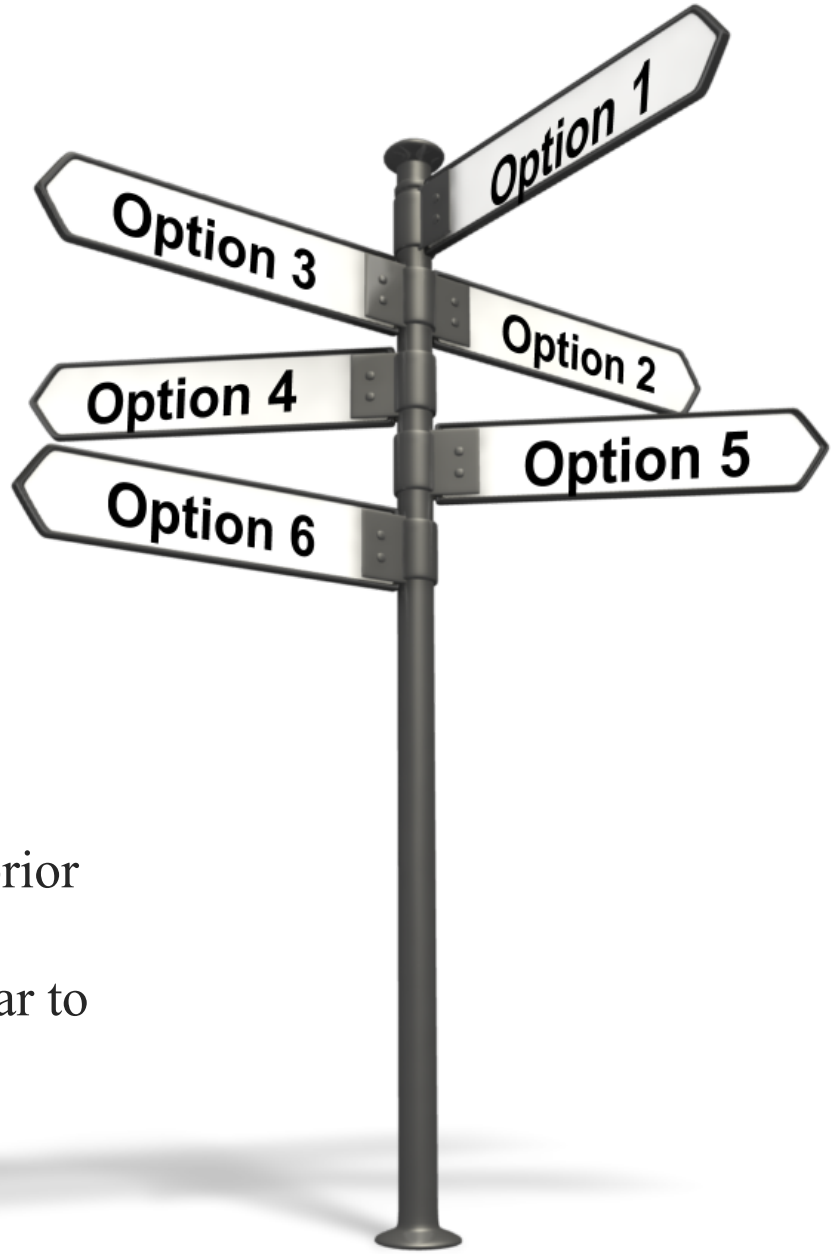
MAKING SENSE OF THE SEPSIS PROMPT VARIABLES

Multiple sepsis prompt variables

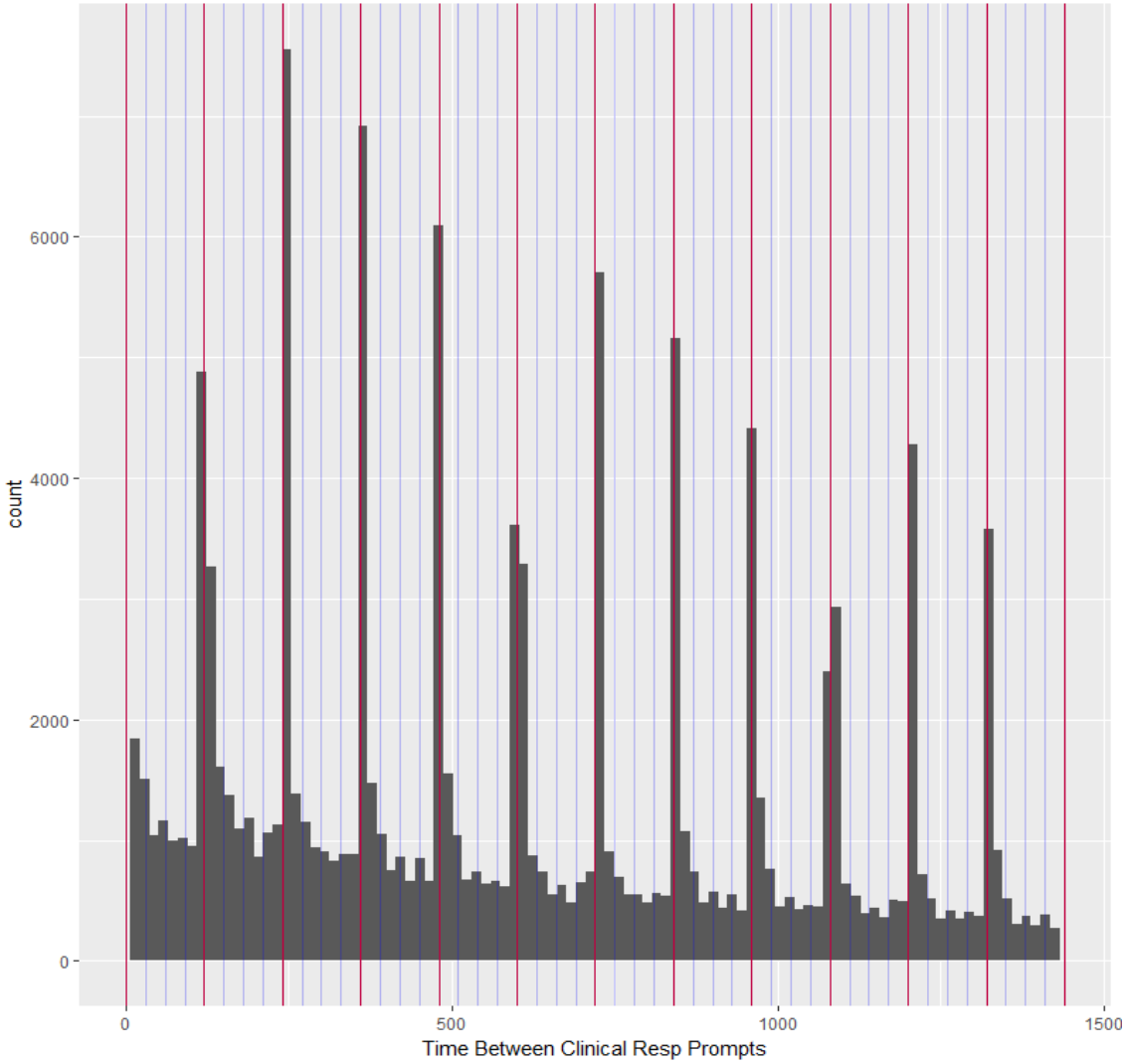
- prompt_severe_sepsis
- prompt_sepsis
- prompt_inflam
- prompt_inflam_with_org_dys
- prompt_clinical_response_req

Timing of the prompt

- Some cases had negative trigger off sets (trigger time prior to ICU admission)
- Prompt activity varied from hospital to hospital and year to year



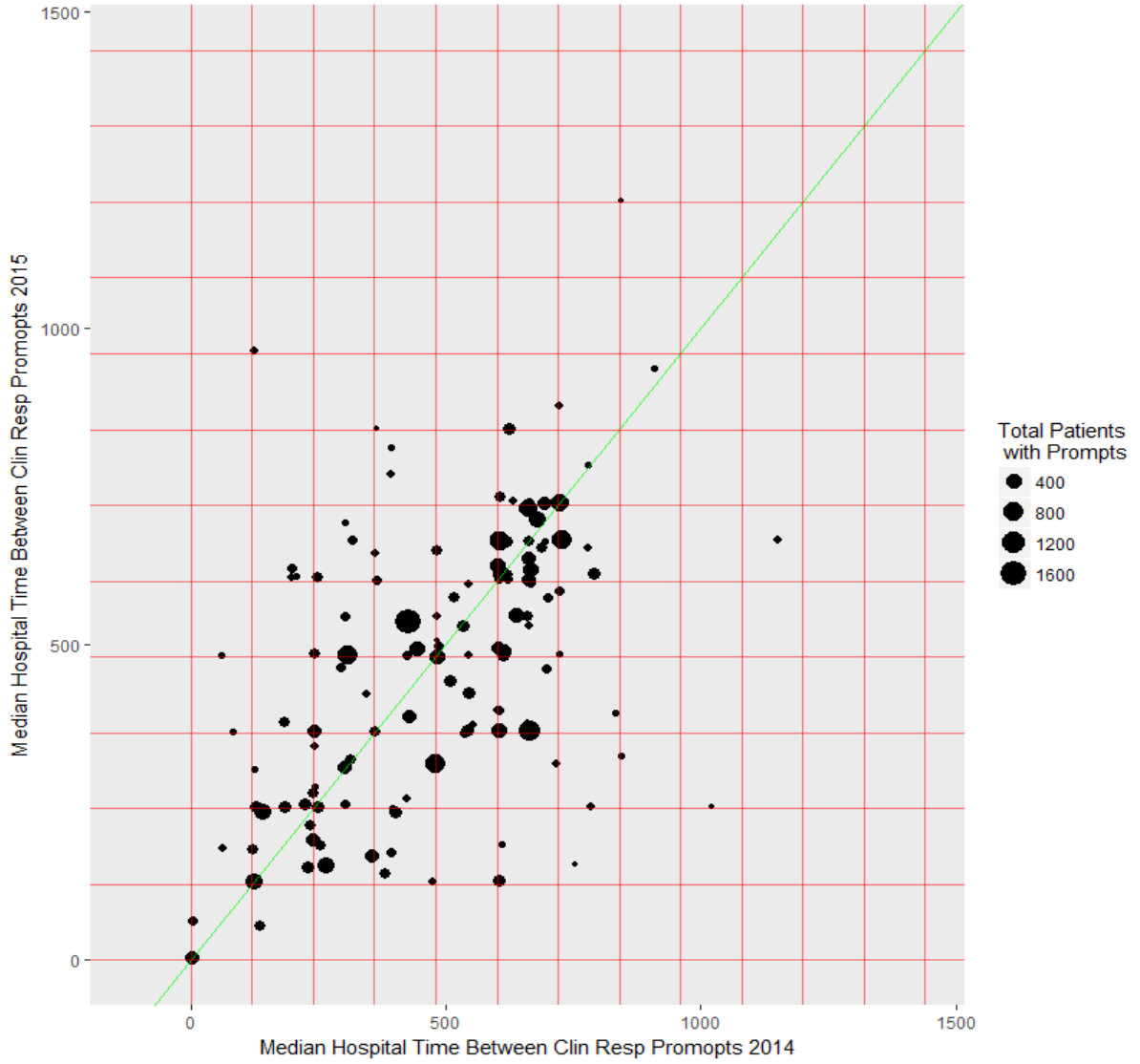
Sepsis Prompt Trigger Offsets



- Filtered out smaller hospitals (to be included hospitals must have >100 patients with at least two triggers)
- Variability in the spikes was visualized with the largest ones at four hours and ten hours
- The end user can choose to suppress the sepsis prompt for 2 hours or 72 hours
- Prompt only fires if/when conditions are met

Sepsis Prompt Trigger Offsets

- Gap time does appear to be correlated from 2014-15, but there appears to be considerable variation across hospitals (i.e., the median gap time varies between practically 0 and over 1000)
- Since these are in patients with at least two prompts, we wouldn't imagine this is due simply to variation in patient populations across the hospitals.



REASONS TO REVERSE ENGINEER THE PROMPT

Points/weights can be applied to the prompt criteria much like SOFA score criteria.

Reason 1

Centers applied version upgrades and hotfixes at different times. Need to reduce variation of prompt activity

Reason 2

Some Tele-ICU centers use the prompt for sepsis surveillance outside of the ICU

Reason 3

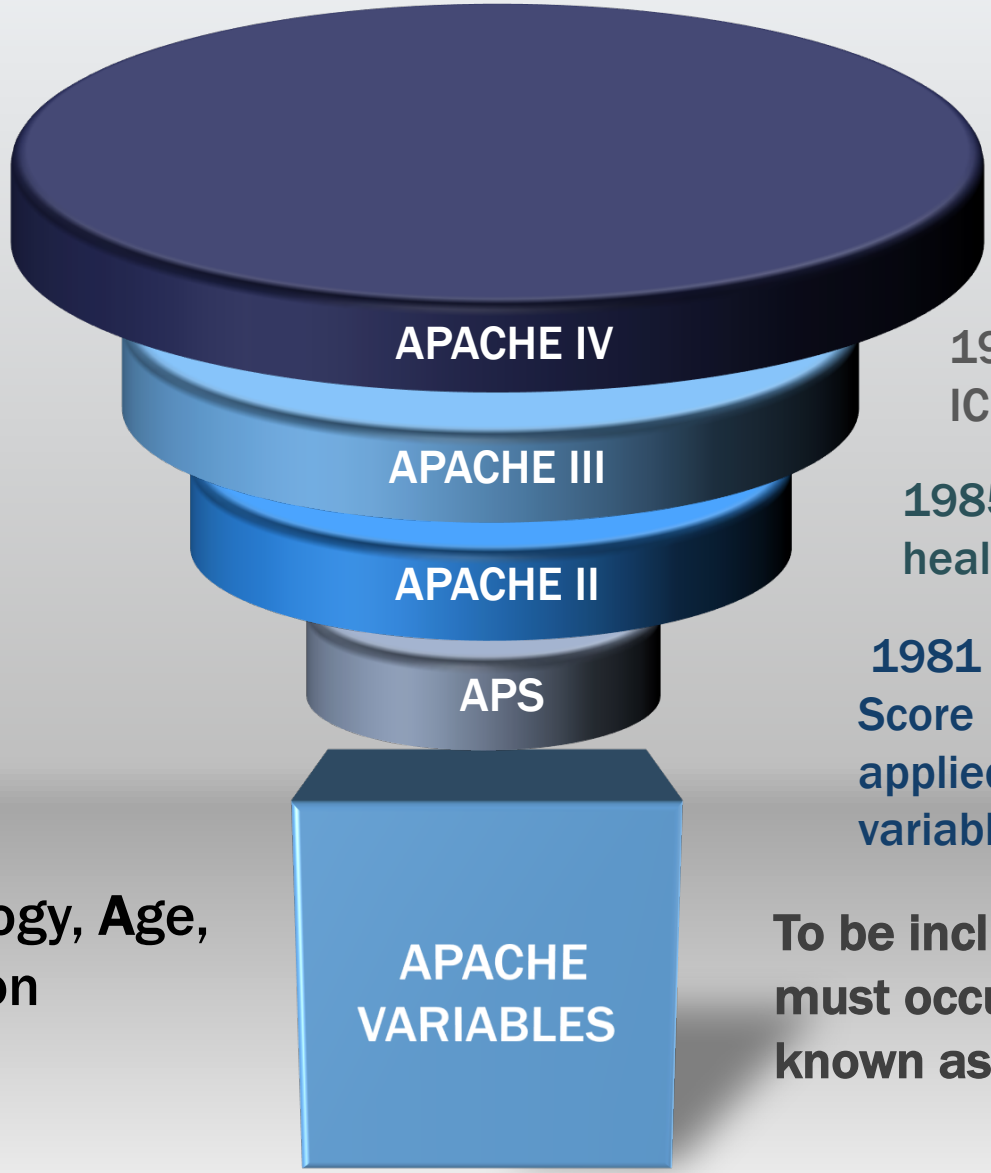
THE COMPONENTS AND CONTEXT OF THE TABLES

- Charted/documented data versus interfaced variables
- Validated vital sign data versus un-validated vital sign data
- Understanding APACHE data values
- Making sense of medication tables
- Admission diagnosis versus active diagnoses

EVOLUTION OF APACHE

Four Major Components:

- Age
- Acute (current) physiology
- Prior site of healthcare (e.g., hospital floor, emergency room, etc.)
- Major disease category (reason for ICU admission)



2006 APACHE IV model further refined

1991 APACHE III adds reason for ICU admission to the algorithm

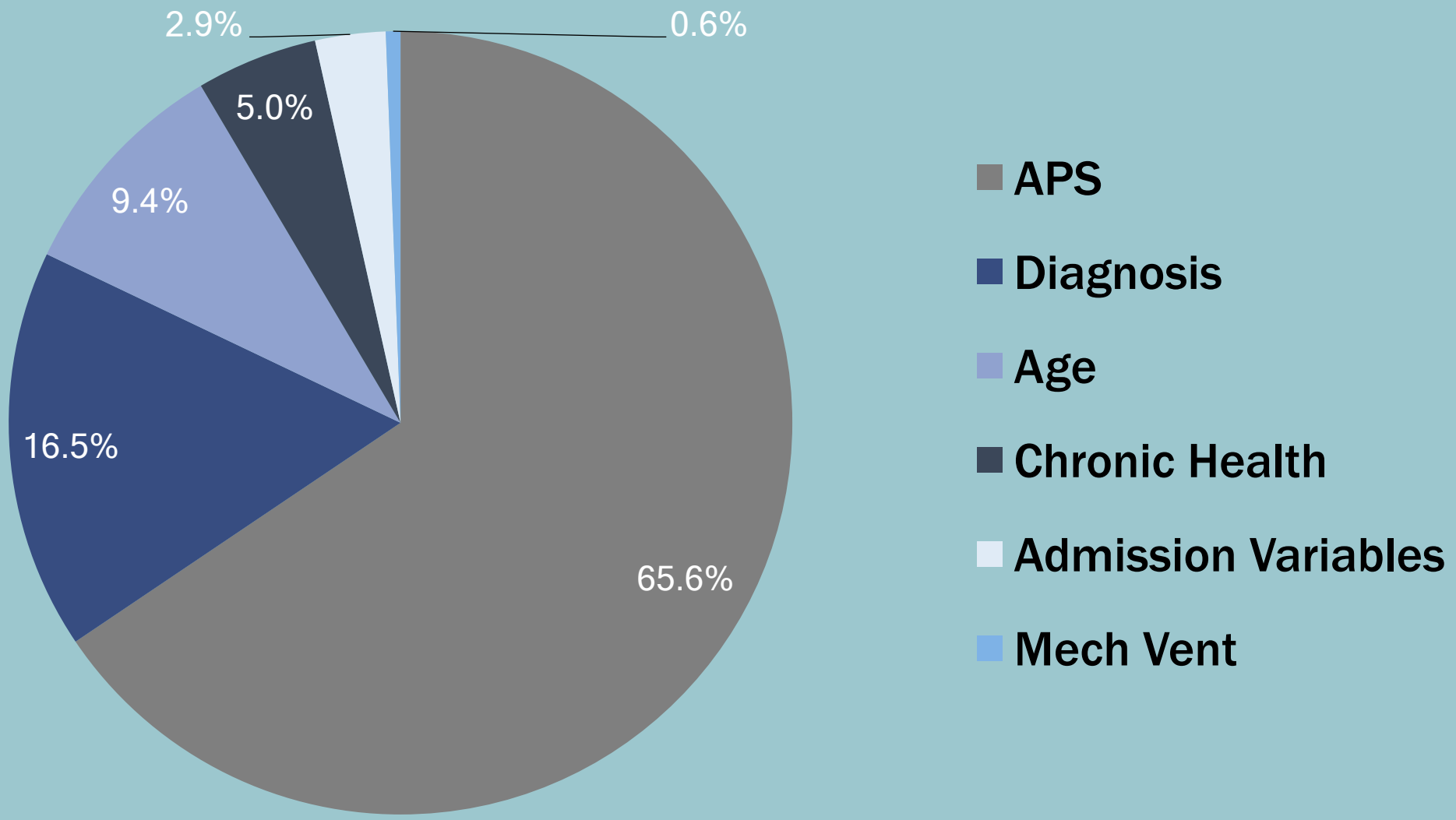
1985 APACHE II: APS and chronic health evaluation

1981 APS = Acute Physiology Score uses a relative value scale applied to 12 objective physiologic variables

APACHE = Acute Physiology, Age, Chronic Health, Evaluation

To be included in the model all variables must occur within defined time limits known as the APACHE day

APACHE IV Hospital Mortality Predictive Equation Components



Information in this presentation are taken from the APACHE Foundations Guide. Manganaro L, Stark M. APACHE Foundations User Guide. Cerner Corporation; 2010:1-49. https://apachefoundations.cernerworks.com/apachefoundations/resources/APACHE%20Foundations%20User%20Guide.pdf

THINGS TO CONSIDER

H&P and Physical Exam

Who is entering the data? Bedside providers or TeleICU nurses?

Vital Sign (VS) Tables

Which table contains charted (validated) VS data versus raw VS data? Which data do I need?

RT/RN Charting

Are data interfaced or entered by primary documentation method? When did a hospital move to interfaced data?

MEDICATION

Does the hospital have a medication interface for every year in the study? For continuous infusion meds like vasopressors is there nurse charted data?

WRAP IT UP

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