

"Working Smartly: Better Communication and Reduced Error through Improved Clinical Informatics"

Healthcare Transformation Services

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Data, Data Everywhere

How do we keep from missing what is truly important?

“We failed to anticipate Pearl Harbor not for want of the relevant materials, but because of a plethora of irrelevant ones.”

Attributed to Roberta Wohlstetter

Objective

At the end of the session, the attendee will be able to:

- Describe challenges faced while attempting to gather information from existing data sources
- Provide examples of how those challenges have been addressed and mitigated through improved clinical informatics



Pressure on caregivers has never been greater

Healthcare workers are under pressure to deliver better quality, value, and outcomes

While being productive and efficient in an era of interruptions and information and data overload

A provider must review data and information from multiple/disparate systems: i.e. labs, meds, vitals, X-rays, etc.



Errors in ICU care delivery



Clinicians today are frustrated with cumbersome EMRs and multiple platforms required to access to receive relevant patient data



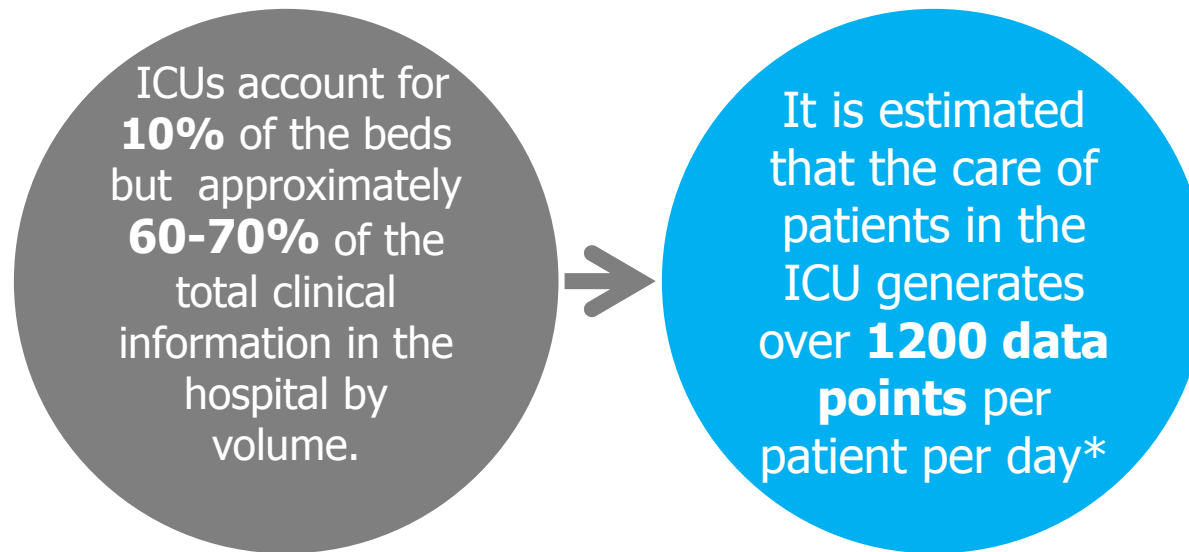
One study reported that an average of **178 processes** of care were delivered to the ICU patient per day of stay with 1.7 of those associated with some error². The same study identified 554 errors and over **200 serious errors** in a single ICU over a 4-month period



Healthcare must make better use of the abundance of data available in order improve care quality and the patient experience

Data, Data Everywhere In Critical Care

It is difficult to determine which data is relevant



*]. O. ManorShulman, J. Beyene, H. Frndova, C.S. Parshuram, Quantifying the volume of documented clinical information in critical illness, J. Crit. Care 23 (2008) 245–250.

Data, Cognitive Load, and Patient Safety

Research by Patricia Potter, PhD, RN, FAAN

- “Cognitive load is about how many activities and distinct pieces of information a person holds in his or her head at any one time.”
- “It’s brain flow not work flow.”
- “[The cognitive work] is invisible to the eye, but it is the stress of what the work is. If that breaks down, if the person just can't carry all that in her head or can't get interrupted and go back, and loses focus, that's a **safety issue.**”

Karen Zander, RN, MS, CMAC, FAAN, in “Cognitive Load Increasing In Health Care,” AHCA Media, April, 2017 discussing Potter’s research



Cognitive Overload Can Lead To Adverse Events

Potential consequences of Adverse Events

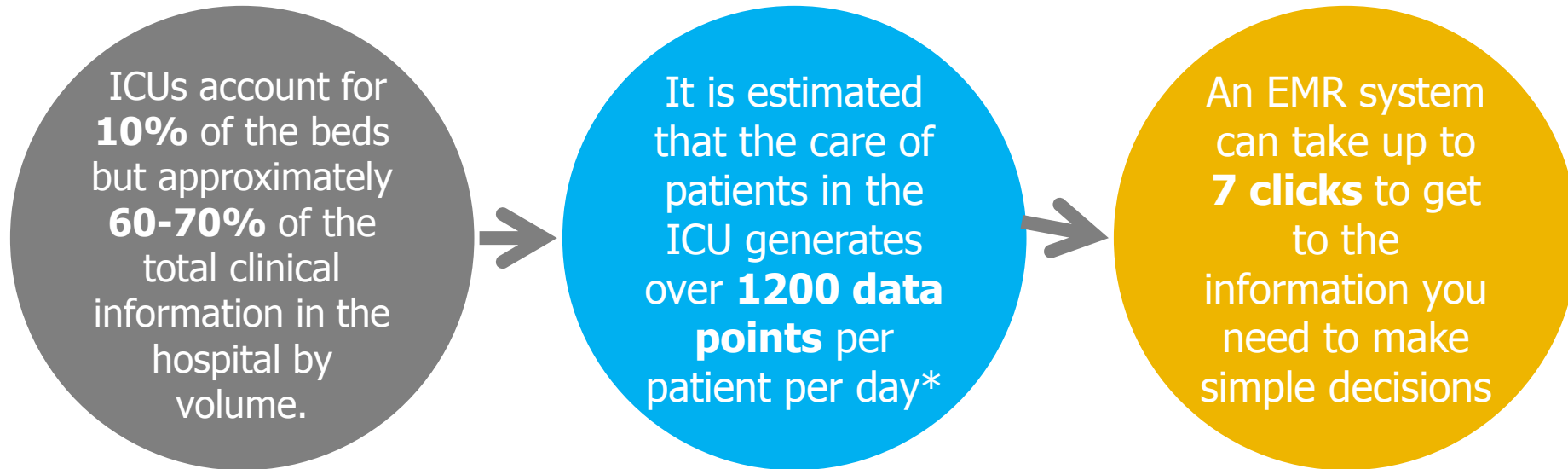
- Preventable adverse events are a leading cause of death in the United States
- Studies have shown that between 44,000 and 98,000 Americans die in hospitals each year as a result of medical errors.
- This is the equivalent of a jumbo jet a day crashing
- Total national costs (lost income, lost household production, disability, health care costs) are estimated to be between \$17 billion and \$29 billion for preventable adverse events.



To Err Is Human, 1999

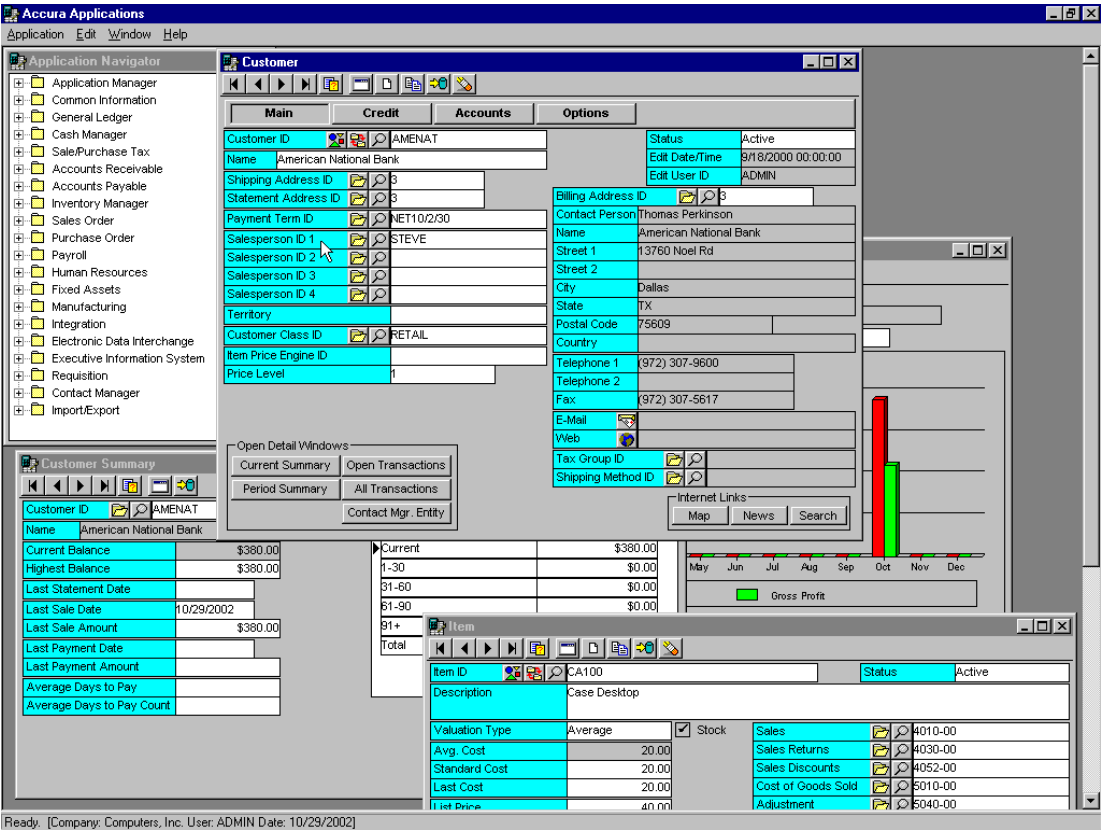
Data, Data Everywhere In Critical Care

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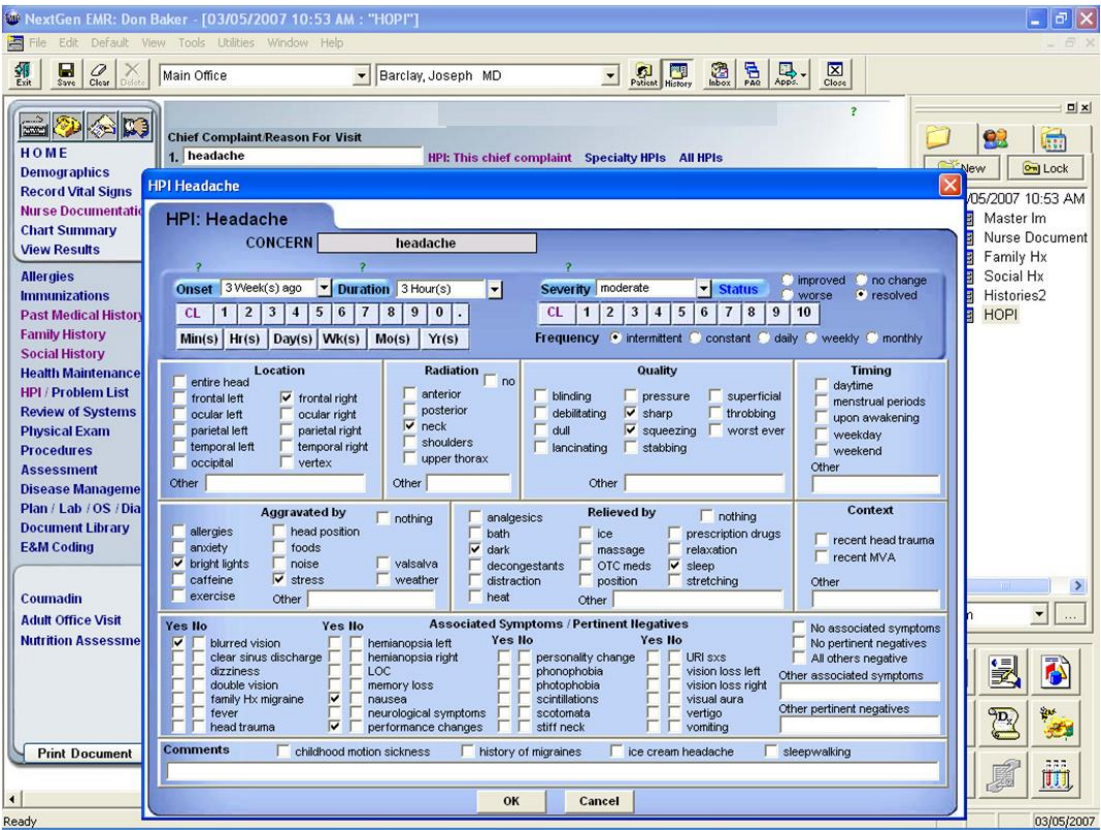


*]. O. ManorShulman, J. Beyene, H. Frndova, C.S. Parshuram, Quantifying the volume of documented clinical information in critical illness, J. Crit. Care 23 (2008) 245–250.

Question: Which of these is an EMR?

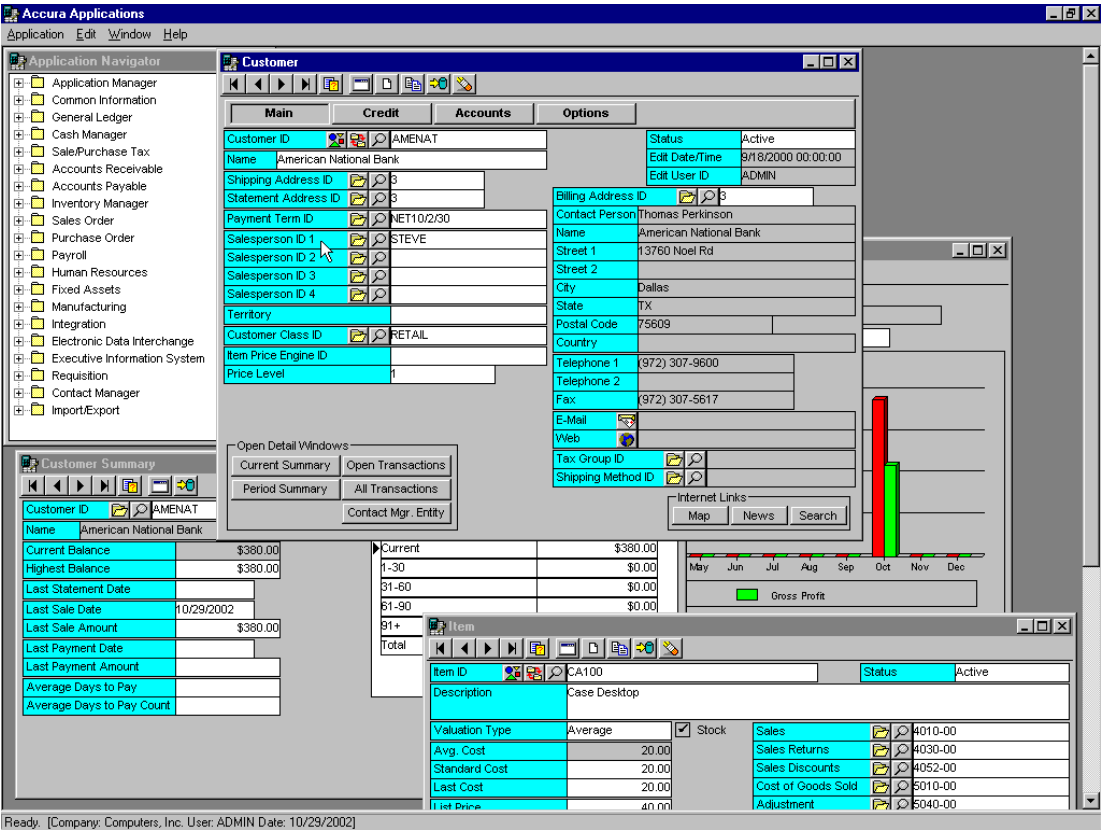


A

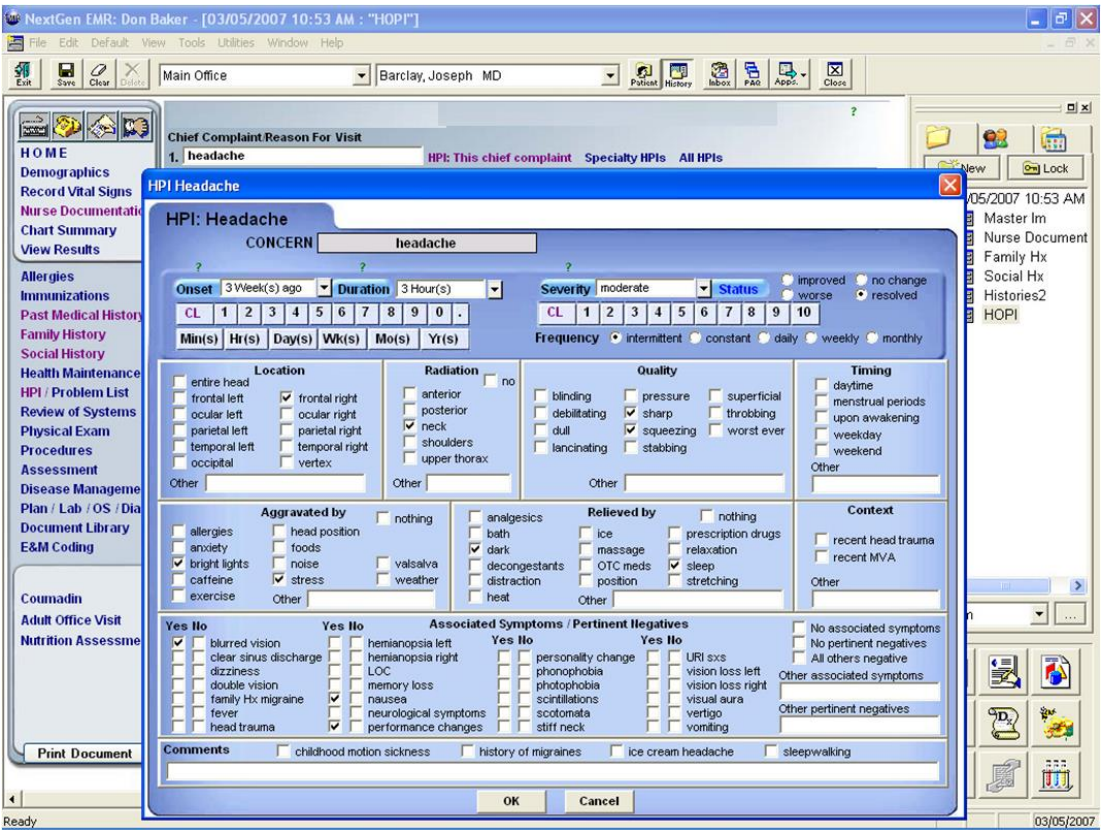


B

Question: Which of these is an EMR?



Accounting System



EMR

EMR Data

Can be not enough or too much

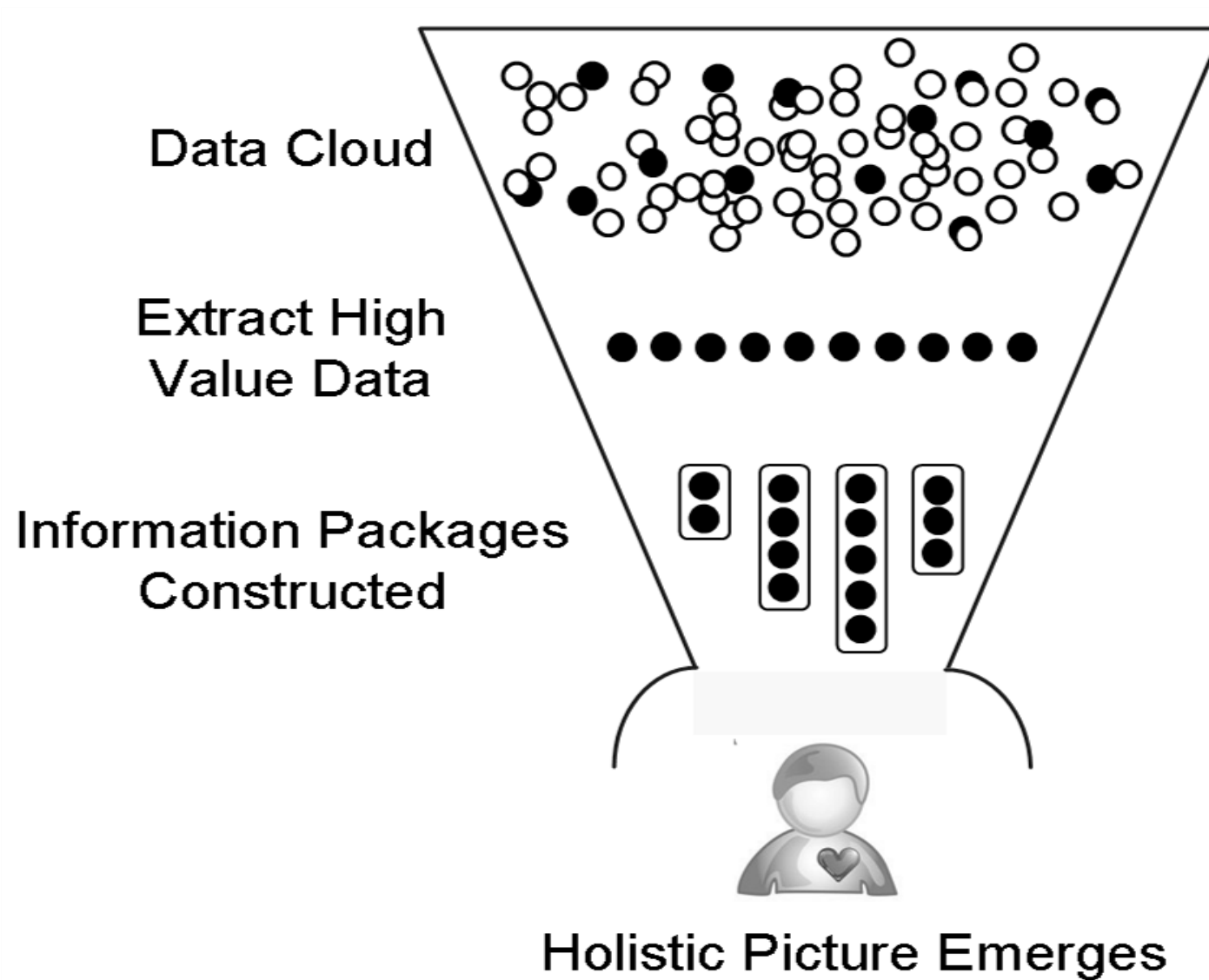
LAB AG	Reference Range	Most Recent	SIH1 06Oct11 00:09	SIH1 04Oct11 21:26	SIH1 04Oct11 13:17	SIH1 04Oct11 12:09	SIH1 04Oct11 04:11	SIH1 04Oct11 02:06	SIH1 04Oct11 01:03	SIH1 04Oct11 00:56	SIH1 03Oct11 17:03
eGFR-Afric...	>60 mL/min/1.73 m²	19	02Oct11								
Creatinine...	0.6-1.4 mg/dL	2.9	02Oct11								
Albumin...	3.5-5.0 g/dL	2.9	05Oct11								
Albumin...	3.5-5.0 g/dL	3.3	28Sep11								
Bld Urea N...	6-21 mg/dL	52	05Oct11								
BUN/Creat...		23	02Oct11								
Chloride...	100-108 mmol/L	105	04Aug11								
Chloride...	100-108 mmol/L	111	05Oct11								
Bicarbonat...	22-29 mmol/L	25	05Oct11								
Anion Gap...	10-20 mmol/L	13	02Oct11								
Calcium lo...	mg/dL	4.45	05Oct11								
pH (POC)	7.32-7.43	7.38	05Oct11								
Calcium lo...	4.65-5.30	5.27	20Jul11								
Lactate, P...	0.6-2.3 mmol/L	0.6	20Jul11								
Lactate, P...	0.6-2.3 mmol/L	0.5	04Oct11								
Cardiac C...											
Troponin...	<0.01 ng/mL	0.02	21Jul11								
Troponin...	0.000-0.01	0.015	28Sep11								
Troponin I...	0.00-0.05	<0.05	20Jul11								
LDH (S)	122-222 U/L	178	03Oct11								
NT-Pro BNP	<166 pg/mL	16687	28Sep11								
ENZYMES AG											
Amylase(S)	26-102 Int...	83	20Jul11								
Lipase	23-300 Int...	367	20Jul11								
ENDOCRINE											
TSH, Sens...	0.30-5.00	0.72	20Jul11								
Aldosteron...	<21 ng/dL	26	01Oct11								
SPECIAL END											
Cortisol...	mg/dL	18	04Oct11								
Cortisol...	mg/dL	28	04Oct11								
Cortisol...	mg/dL	32	04Oct11								
Microbiology											
Bacteria/Ric											
Streptococ...	Negative	Negative	29Sep11								
DRUG ASSAY											
Digoxin(S)	ng/mL	1.5	30Jul11								
Misc DRUG											
Salicylates...	2-20 mg/dL	<5.0	21Jul11								
VANCOMYCL											
Vanco mycl...	mg/mL	23.4	03Oct11								
Metals 63 AG											

LACK OF
INFORMATION



INFORMATION
OVERLOAD

How clinician* works



* - and AWARE

Ambient Warning And Response Evaluation (AWARE)

Developed at Mayo with intent to focus on the patient rather than the service



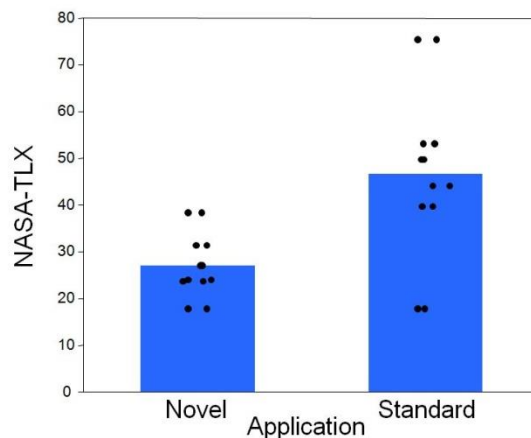
- Mayo physicians recognized prevalence of medical errors and the relationship to information overload in the ICU.
- They were frustrated with the database-centric nature of their Electronic Medical Record
- The clinicians wanted to:
 - Identify, filter and display the most relevant and high priority patient data from multiple data systems in a single application
 - Present the information in an organized dashboard format to save clinicians time
 - Allow clinicians to make decisions better, faster and more collaboratively

AWARE Was Provider Built

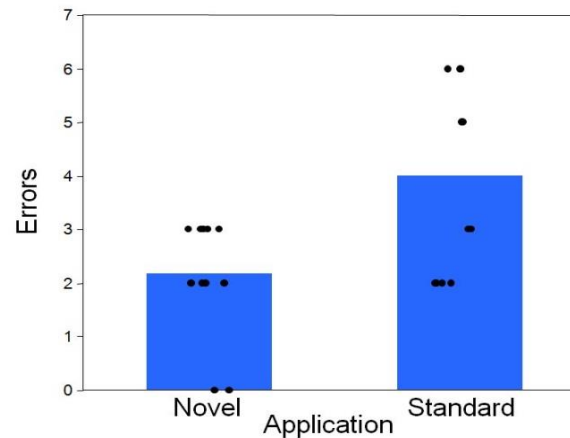
Tested and evaluated at Mayo



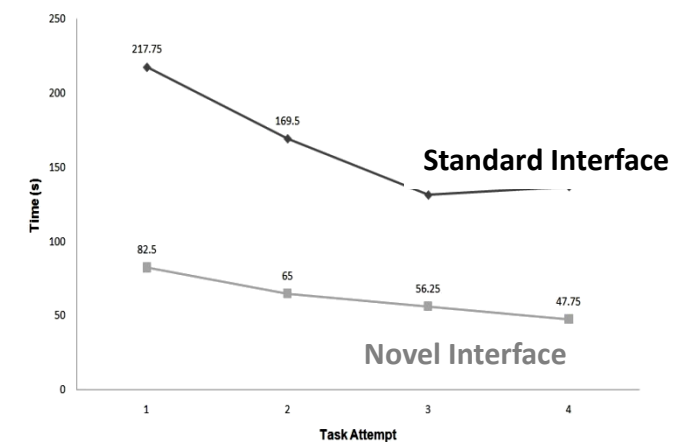
**Reduced cognitive load
(happy clinicians)**



**Reduced errors
(happy patients)**



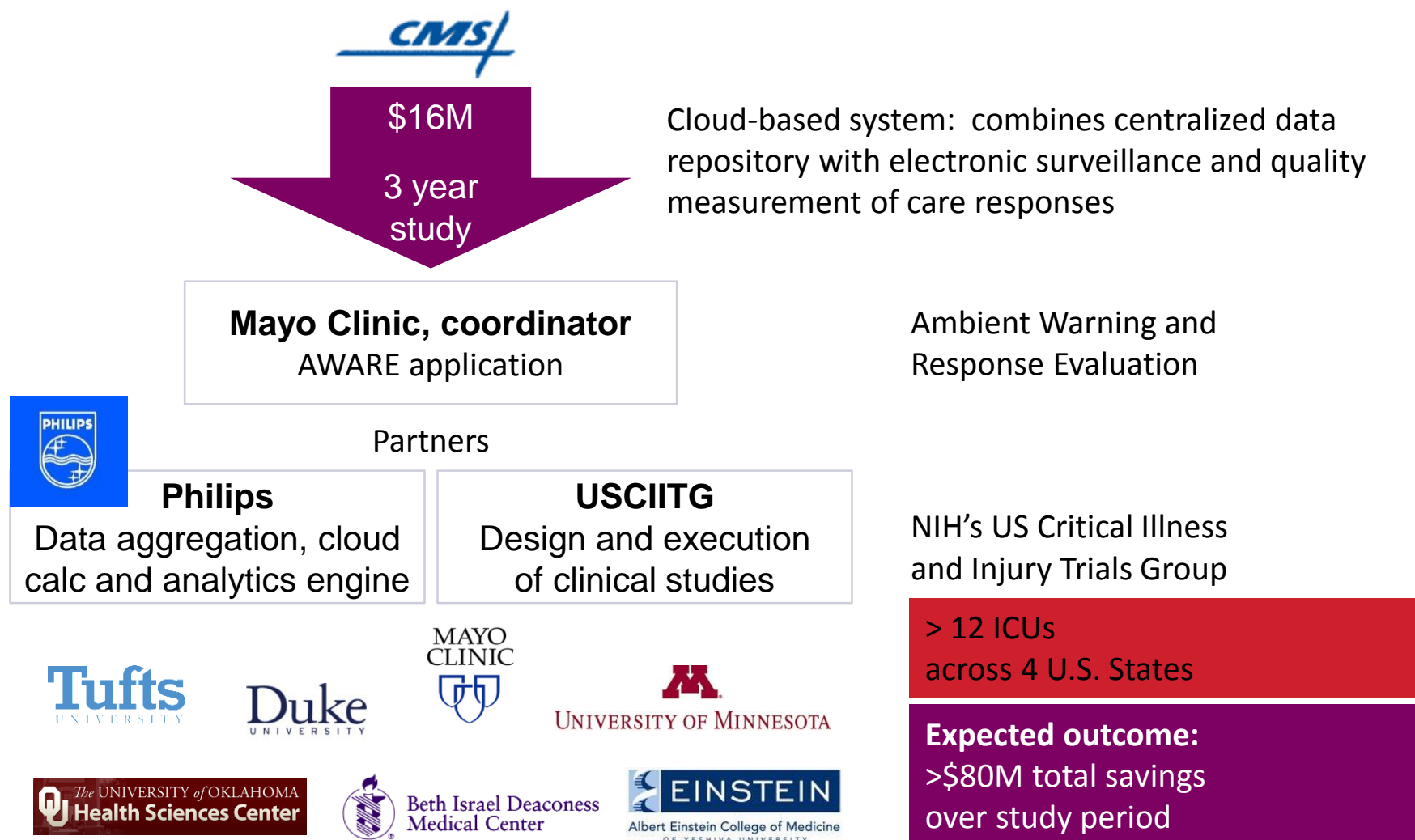
**Reduced time
(happy administrators)**



Ahmed A, Chandra S, Herasevich V, et al. The effect of two different electronic health record user interfaces on intensive care provider task load, errors of cognition, and performance. *Critical Care Medicine* 2011;39(7):1626-1634.

CMS Innovation grant to Mayo Clinic

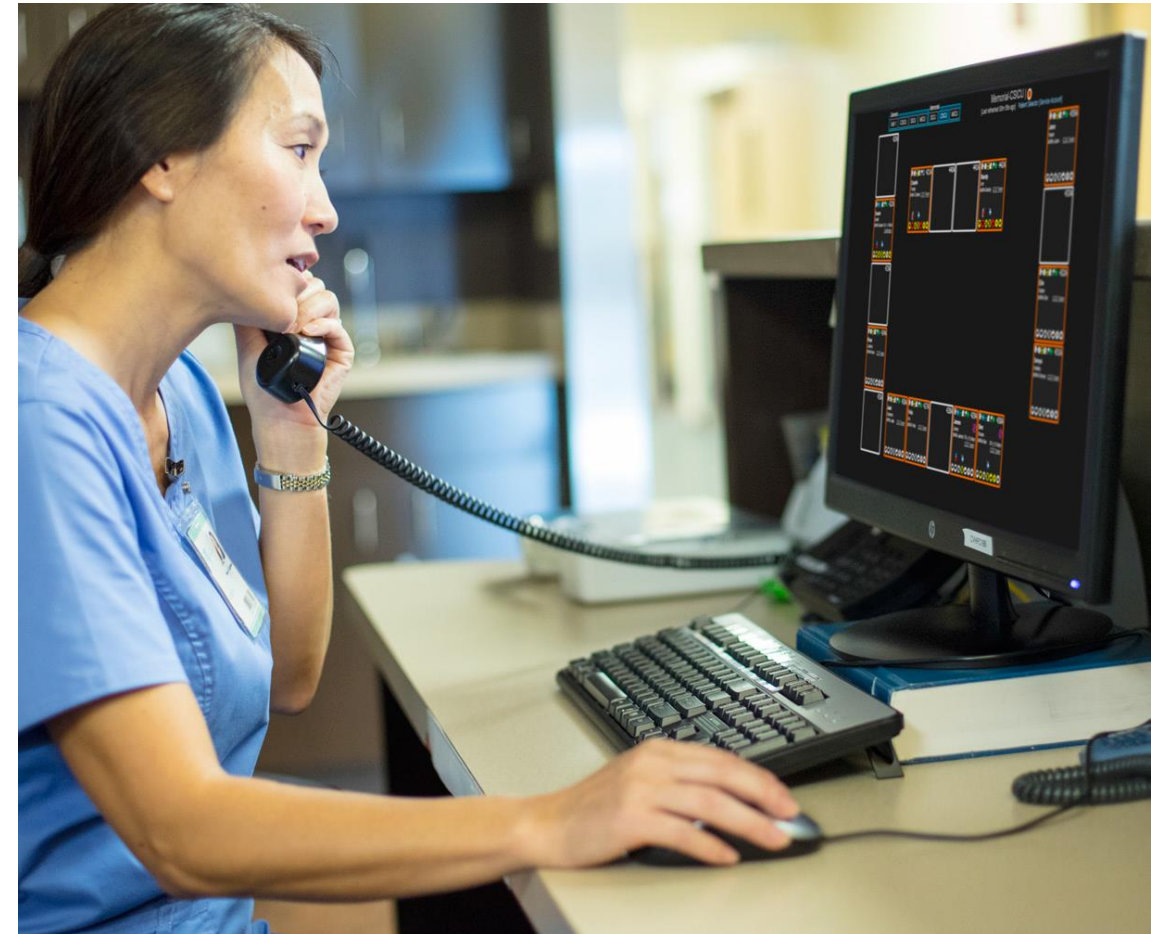
Developing a patient centered cloud-based CDS solution for ICU



IntelliSpace Console Critical Care

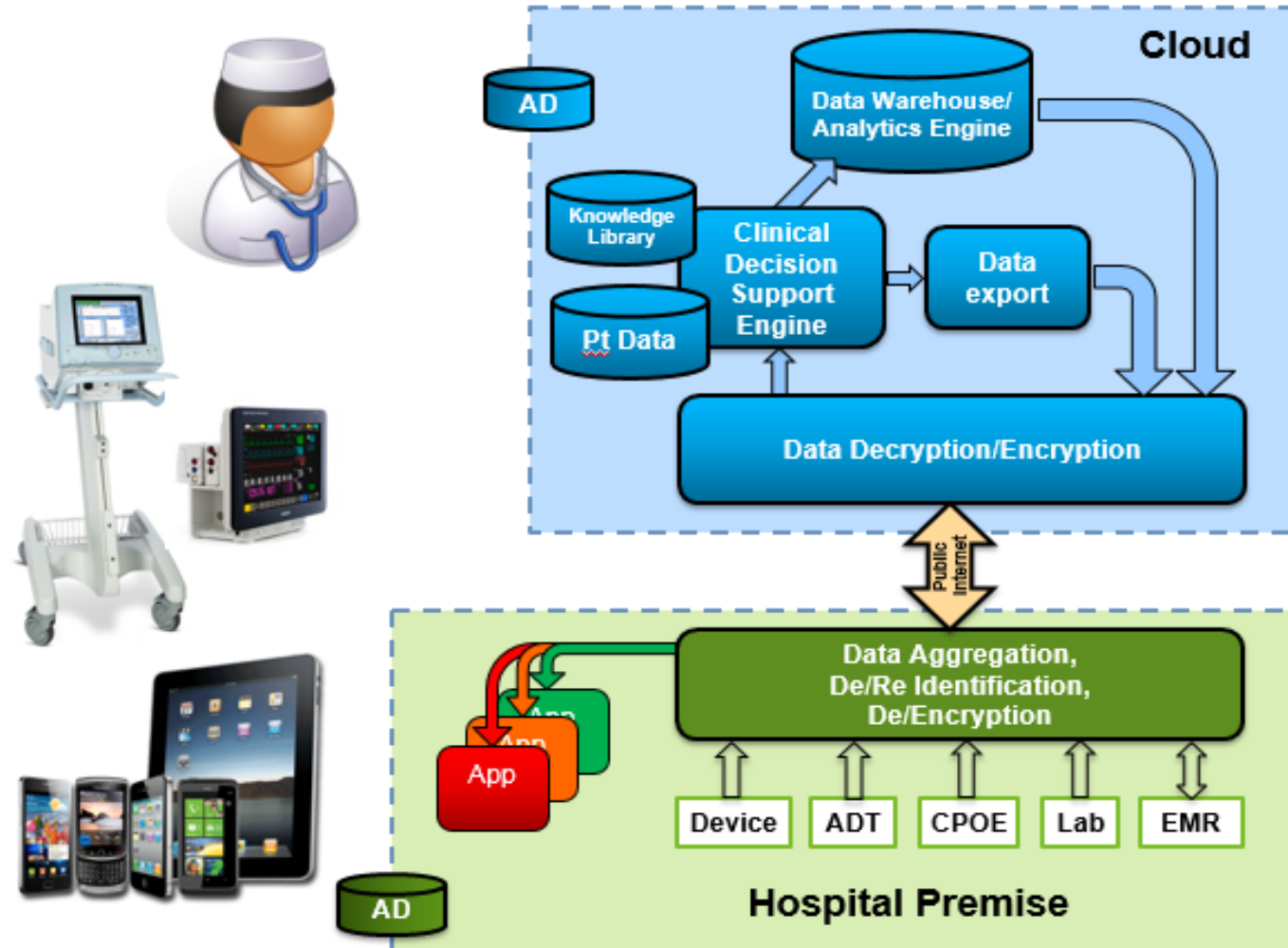
Partnership to commercialize AWARE

- Mayo Clinic receiving the Hospital-Setting Health Care Innovation Award (HCIA) from CMS to study the effect of AWARE in intensive care units (ICUs)
- Mayo Clinic / Ambient Clinical Analytics partnered with Philips to commercialize AWARE as **IntelliSpace Console Critical Care**
- User Interface displays clinical patient data from HIS sources and visually indicates to the clinician actionable clinical data values
- 800+ evidence-based rules (from Mayo Clinic and Philips)



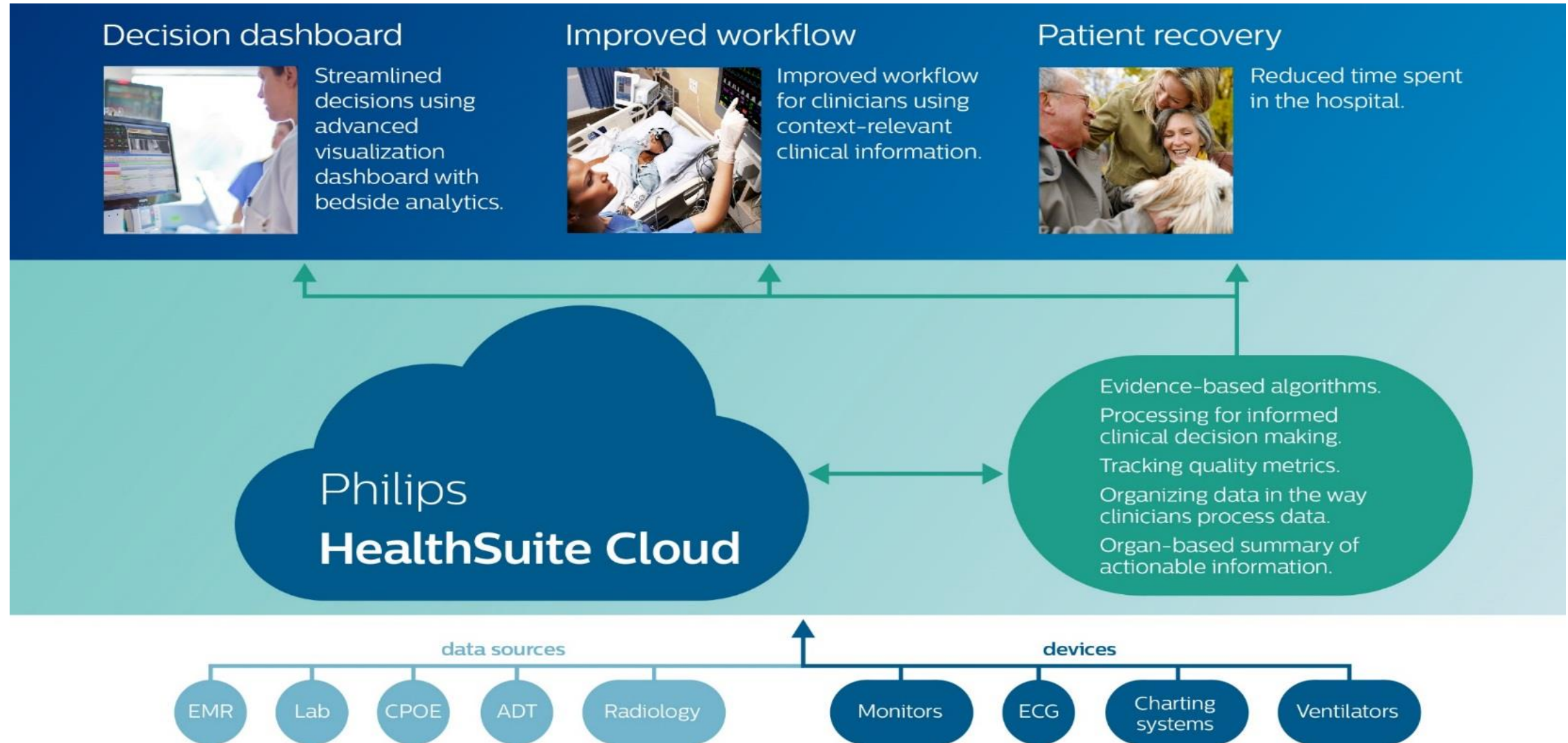
Time-Critical Cloud Based Decision Support and Analytics

Integration with other systems to import data



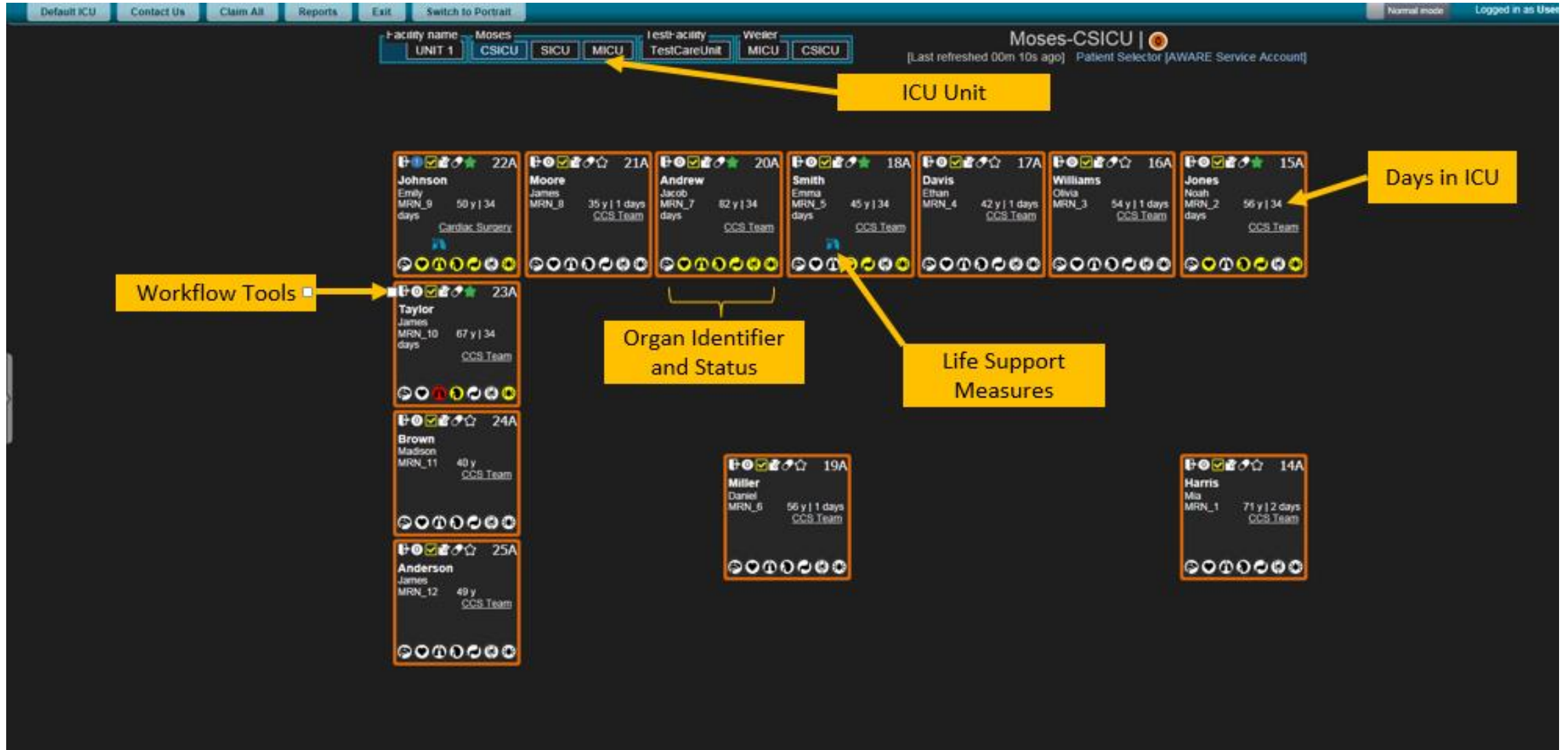
What Challenges Are We Trying To Address?

Focus on making data actionable and easily accessible



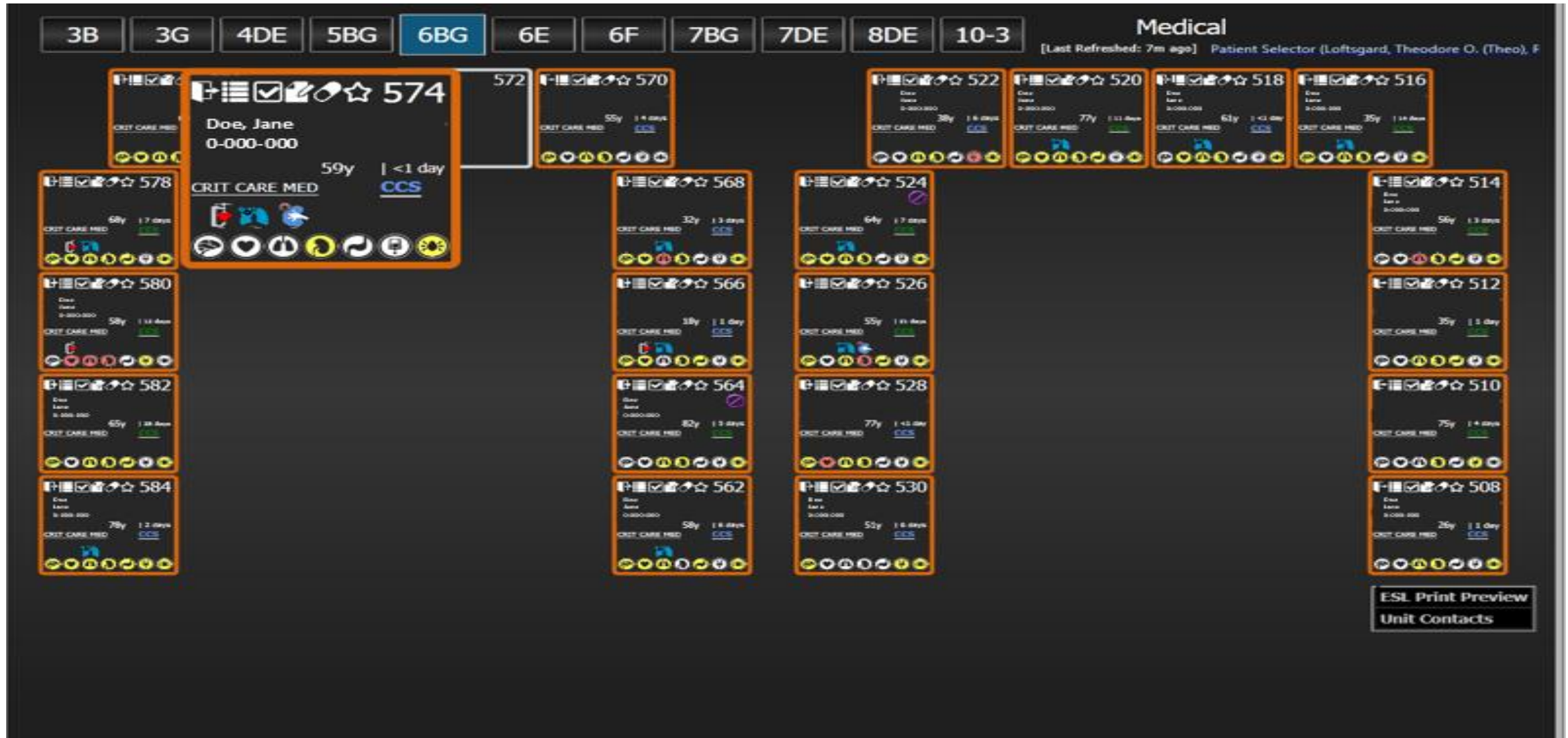
Visual Dashboard Of The Unit

Your unit at a glance: sickest patients, empty rooms, demographic and other information



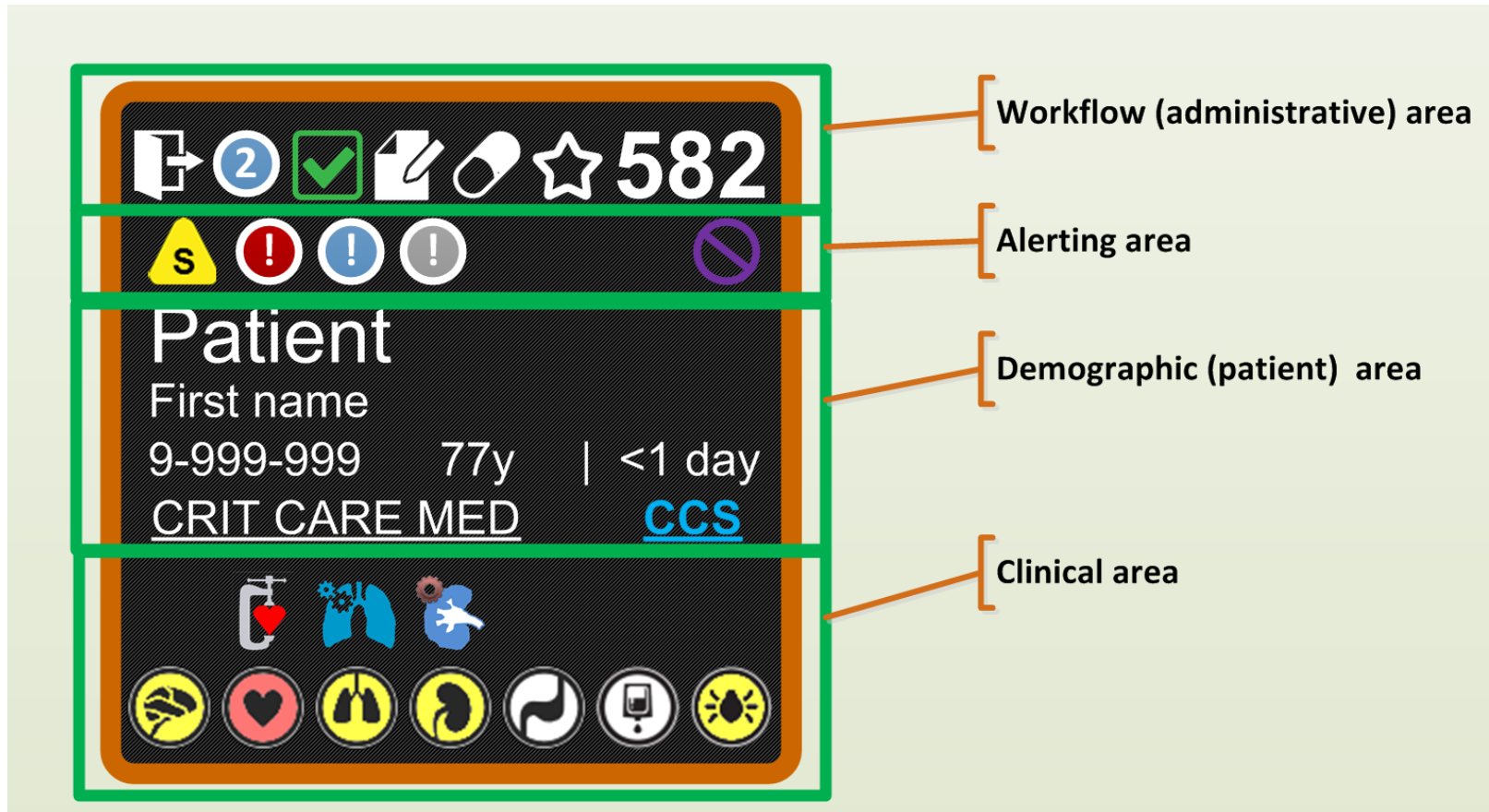
Visual Dashboard Review

Provides standardized prioritization



Overview Patient Room








Information grouped together



Icons And Their Meaning





Color coding assists in prioritization of patients

Organ System Icons

-  Central Nervous System
-  Cardiovascular System
-  Respiratory System
-  Renal System
-  GI System
-  Hematology
-  Infectious Disease



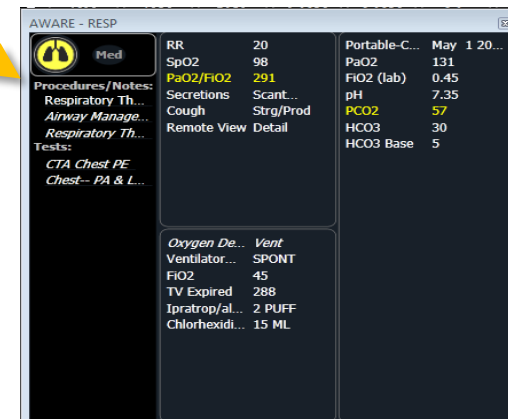
Support Icons


-  ECMO
-  Vasopressor
-  Mechanical Ventilation
-  CRRT

Popup, if hover over

pro-BNP (3202)
Troponin T0 (0.25)
Troponin T3 (0.48)
Troponin T6 (0.5)

Clicking on the icons will provide greater detail about the organ system



AWARE - RESP	
	RR 20
Procedures/Notes:	SpO2 98
Respiratory Th...	PaO2/FiO2 291
Airway Manage...	Secretions Scant...
Respiratory Th...	Cough Strg/Prod
Tests:	Remote View Detail
CTA Chest PE	
Chest - PA & L...	
	Portable-C... May 1 20...
	PaO2 131
	FiO2 (lab) 0.45
	pH 7.35
	PCO2 57
	HCO3 30
	HCO3 Base 5
	Oxygen De... Vent
	Ventilator... SPONT
	FiO2 45
	TV Expired 288
	Ipratrop/al... 2 PUFF
	Chlorhexidi... 15 ML

Drill Down On Individual Patient

Relevant data by organ system

View: **AWARE** Bedside monitor EMR tools AWARE tools Order/Note Rounding Whiteboard (0) Help

0-000-000 Doe, John Born: 11-Oct-1955 Inpatient (29-Jan-2013)
Age: 57y Day: 8
Gender: M Bed: E103302H

Ordered Resuscitation: Full Code No Clinical Alerts recorded Administrative Flag: International Pt Appointment Flag: Interpreter Needed | SPANISH Mobile phone:

Problem List:
#1 Hemorrhagic shock secondary to intraabdominal bleed...
#2 Abdominal compartment syndrome requiring return to L...
#3 Acute hypoxemic respiratory failure
#4 Acute kidney injury secondary to shock, abdominal com...
#5 Resolved Gram-negative septic shock

Notes:
Hospital Admission Note

Procedures:
Line Placement
Line Placement
General Surgery Post-Procedure
Vascular Interventional Radiology PP
Intubation

Operative Notes:
Op Rep - General Surgery
Op Rep - General Surgery

Med:
GCS 8
RASS -3
CAM-ICU ...
Pain Score #1 ...
FNIIR Score (ave) 1
Fentanyl (mcg/ho) 25
Fentanyl 1500 mc... 141 MCG

CT Brain N/A
MRI Brain N/A
CNS Angio N/A
EEG N/A
EMG N/A

Lab:
HR 99
MAP 74
CVP 12
ST Lead II ...
ST Lead III -0.3
Remote View Detail
Fluids In [2 hours] 174
Norepinephrine (L... 0.08
Vasopressin (unit/L... 0.04

ECG Tracing Jan 31 2013 6:2...
Echo Report Text Feb 5 2013 8:20...
Troponin T0 ...
Troponin T3 ...
Troponin T6 ...
Lactate 9.5
ScvO2 66.8
2) TDC Int Jug R
5) Art Cath Radial R
7) STCVC Int Jug L

Lab:
RPI 39
SpO2 94
PaO2/FiO2 110
Secretions Small Clear...
Cough None
Remote View Detail
Intubation Diffic... 0: easy
Oxygen Device VENT
Ventilator Mode ...
FiO2 80
TV Preset 440
P Plat 35
Chlorhexidine or... 15 ML

Procedures/Notes:
Airway Management
Airway Management
Respiratory Therapy

Portable-Chest Feb 5 2013 11:1...
PaO2 66
FiO2 (lab) 0.6
pH 7.25
pH(v) 7.3
PCO2 39
PvCO2 40
HCO3 16
HCO3 Base -10
CT Chest N/A

Lab:
UOP [24 hours] 24
Fluid Balance [fro... 56
Admission Weight 104.6
Daily Weight 122
Urinary Catheter UCI 04Feb20...
Urinary Status No Urine
Sodium Phosphat... 10
Calcium Chloride... 27
Magnesium sulfat... 2 GM
CRRT Output [4 h... 1269

Procedures/Notes:
Nephrology Consult

Creatinine 2.6
Na 140
Cl 105
K+ 5.1
HCO3 16
Anion Gap 12
iCa2 4.33
Mg2+ 2.2
PO4 8.1
BUN 27
eGFR 23
Ca total 9.8
Urinalysis View Labs

Lab:
Diet Type NPO
Abd. Assmt Distension
Bowel Status Loose
Bowel Sounds Hypoactive
Hydrocortisone 10... 50 MG
Lactulose 1 gm/1... 20 GM
Pantoprazole 40... 40 MG

Procedures/Notes:
Gastroenterology Consult
Tests: MRI Abd w/o sw

Portable-Abdomen Feb 4 2013 11:1...
CT ABDOMEN w/... Feb 1 2013 8:12...
Albumin 3.7
Bilirubin 8.1
Glucose 127
TSH N/A
Ammonia 81
AST 25420
ALT 7890
Protein 646

Lab:
Hemoglobin 9.5
Platelets 115
INR 2.8
APTT 33
Fibrinogen 184
Phytonadione 10... 5 MG

V+IRAD Vascu... Feb 4 2013 9:4...
Tr. RBC 1
Tr. Platelets 1
Tr. FFP 2
Tr. Cryoprecipitate 2
Active Type O Pos
US Extremity Ver... N/A
Transfusion Review

Lab:
Temperature 36.1 (37.6)
WBC 43.1
Microbiology 11
Urine WBC 1-3
Braden Skin Score 9

Procedures/Notes:
Infectious Disease Consult

Meropenem 1 gm... 1 GM
Vancomycin 5000... 1800 MG

Rounding Tool/Checklist

Provides consistent format and review process

Their rounding process prior to Aware:

“Before we saw a patient, we would *spend 25-30 minutes* per patient digging through EMR data *at a computer terminal*.”

“We would then *write the information* from the computer terminal *on paper* and use that in a bedside meeting, or we would *gather the team around the computer in the backroom and do a virtual round* using the information, taking 15-20 minutes per patient.”

“Then we would communicate our thoughts to those on the floor. We could easily *spend 2 to 2 ½ hours* on this, and then another 1 ½ hours communicating that on the floor.”

“However, the piece of *information that was relevant* when collected at 7 a.m. had *changed by the time we discussed it* at 11 a.m. and required another round of information gathering, so it wasn’t an efficient use of people’s time.”

Rounding Tool/Checklist

Provides consistent format and review process

The screenshot displays the 'Rounding Tool - Synthesis AWARE' interface. The left sidebar contains a checklist of clinical tasks, each with a 'Yes' or 'No' column. A modal window is open over the 'Current wt and admission wt, link to fluid balance' item, showing a table with fluid balance and weight data. The main panel on the right contains sections for 'Reason for admission', '24 Hour Events', 'Examination', and 'Problem List'. The 'Problem List' section includes a detailed entry for hemorrhagic shock.

Task	Yes	No
Sedation break today?		
No Delirium detected		
Pain controlled		
Remove 5) Art Cath, Located at Radial R , Inserted on 2013-02-04 ?		
Remove 7) STCVC, Located at Int Jug L , Inserted on 2013-02-05 ?		
Switch to lung protective ventilation strategy?		
Spontaneous breathing trial today?		
Even or negative fluid goal today?		
Current wt and admission wt, link to fluid balance		
Start mechanical DVT prophylaxis?		
Patient safe for enteral nutrition?		
Continue current antibiotics?		
Is there adequate source control?		
Skin integrity/wound care reviewed		
Medications reviewed with the pharmacist?		

Fluid Balance [from midnight]	Admission Weight	Daily Weight
-2988.9200	104.60	121.900

Task	Yes	No
Start mechanical DVT prophylaxis?		
Patient safe for enteral nutrition?		
Continue current antibiotics?		
Is there adequate source control?		
Skin integrity/wound care reviewed		
Medications reviewed with the pharmacist?		

Reason for admission

24 Hour Events

Examination

Problem List

- #1 Hemorrhagic shock secondary to intraabdominal bleed, resolved syndrome requiring return to the operating room for clot evacuation, February 4, 2013
- ory failure, intubated February 4, 2013
- itary to shock, abdominal compartment syndrome, and radicontrast dye, CRRT started February 5, 2013
- septic shock

lan (optional)

INFX

ENDO

SKIN

Other

Linkage To Other On Premise Applications

Accessible in one system

Critical Care Surgery Progress [Author: Evelyn Kevin Thomas]

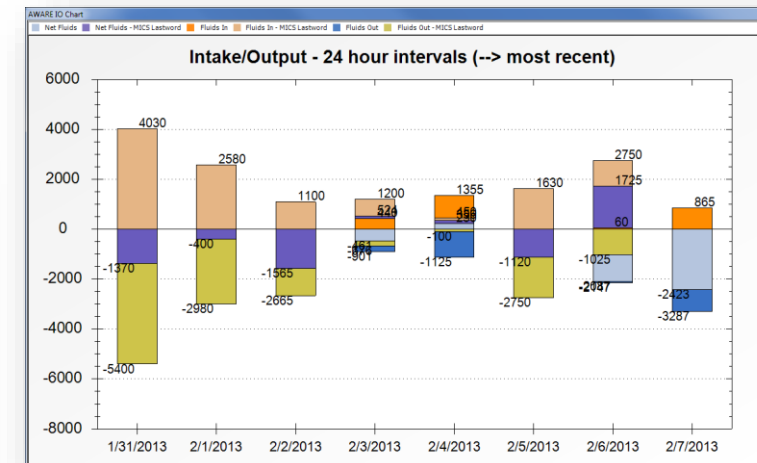
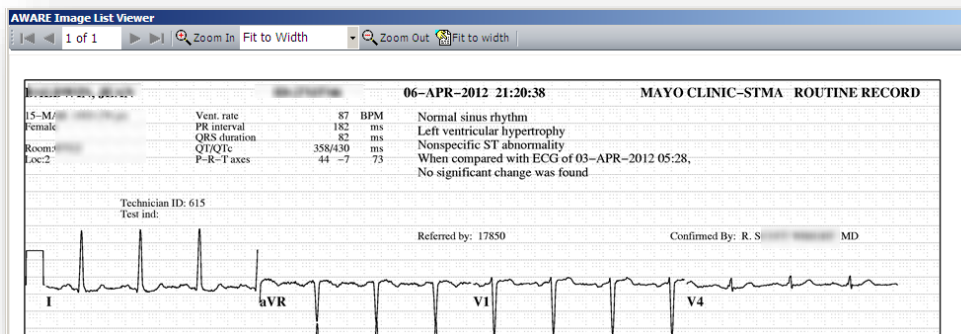
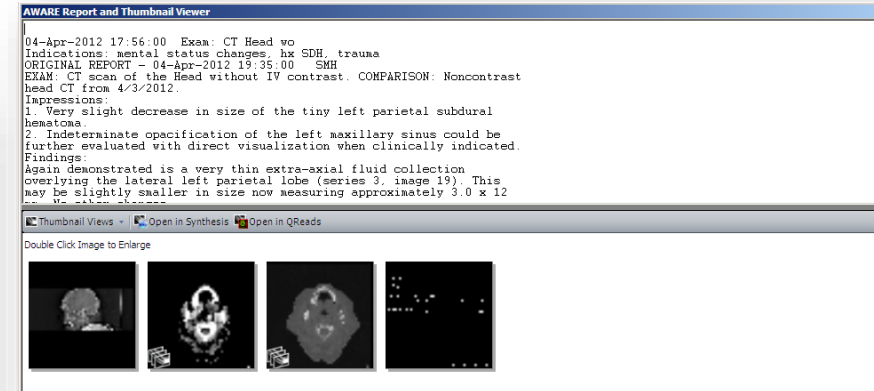
DEMOGRAPHIC INFORMATION:
 Clinic Number: 1000000
 Patient Name: Mrs. Jean Lucille Baldwin
 Age: 79 Y
 Birthdate: 03-Mar-1933 Sex: F
 Address: 3000 S. 10th Street NE City: Grand Rapids, MI 49508-1708

Service Date/Time: 06-Apr-2012 07:53
 Provider: Kevin T. Behr, MD Pager: 327-10004
 Service: TCGSCI Type/Desc: PROG Status: Fnl Revision #: 1

SUBJECTIVE:
 Mrs. Baldwin is a 79 y/o female s/p fall that resulted in severe left sided rib fractures and a subdural hematoma from a fall from standing height. Patient underwent rib fracture fixation yesterday. She tolerated the procedure well and returned to the SICU for ongoing care. Patient was stable over night and was weaned from vent per protocol. Patient is currently on CPAP with minimal setting in preparation for extubation this morning.

VITAL SIGNS:
 These are the most recent vital signs from 05-Apr-2012 at 07:56:04 to 06-Apr-2012 at 07:56:04. The exception is maximum temperature, which is the maximum from the last 24 hours.

Maximum temperature (Temperature-Manual): 37.8
 Maximum temperature (Temperature-1): 36.9



Reporting Options

Provides metrics and improvement opportunities

ON PREMISE

Patient Summary
Census, Unit Status
Console Usage Summary
Console Visit Summary
Patient Visit Summary

CLOUD

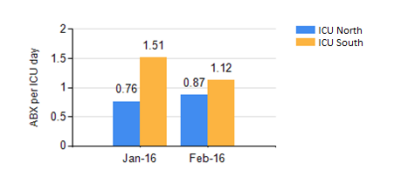
ICU Stay
Time from ED to ICU
Vascular Line Usage
Urinary Catheter Usage
Antibiotics Usage
Red Blood Cell Usage
Mechanical Ventilation Usage
IV Sedative Usage
ICU Adjusted Stay Usage
Lung Protective Ventilation

Sample Reports

Provides metrics and improvement opportunities

Antibiotics Usage Report

Graphical Section



Summary Section

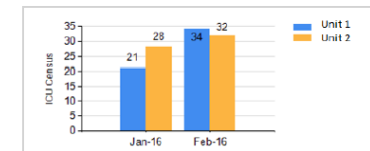
Clinical Unit		Jan-16	Feb-16
ICU North	Total ICU Census	21	34
	Total ICU Days	109.08	107.44
	Count ICU patients with ABX	18	28
	Total ABX Days	83	93
	ABX Days per ICU day	0.76	0.87
ICU South	Total ICU Census	28	32
	Total ICU Days	121.17	129.62
	Count ICU patients with ABX	26	29
	Total ABX Days	183	145
	ABX Days per ICU day	1.51	1.12

Antibiotics Usage Report

Patient Name	Age	Life Time Number	Clinical Unit	ICU Admit Date	ICU D/C Date	Hosp Admit Date	Hosp D/C Date	ABX Order	ABX Order Start	ABX Order Stop	ABX Admin	ABX Days	ICU Days
Doe, John	XX	8977234	ICU_North	2/5/16 8:11 AM	2/11/2016 20:37	2/2/2016 21:15		CEFEPIIME HCL/DSW 2 G/50 ML PB IV, 2, IV, QBAD	2/5/2016 5:19:00 PM	2/12/2016 12:00:00 PM		3	1.38

ICU Stay Report

Graphical Section



Summary Section

Clinical Unit		Jan-16	Feb-16
Unit 1	ICU Census	21	34
	ICU Average LOS	5.22	3.17
	ICU Median LOS	4.92	1.96
	n Stay < 12	1	4
	n Stay < 24	3	7
	n Stay > 24	18	27
	ICU Readmit	0	1
	Readmit Rate	0.00	0.03
	Average daily census	10.55	11.75
	ICU Death	2	4
	ICU Death %	9.52 %	11.76 %
	Discharge home	3	5
	Discharge home %	14.3 %	14.7 %
	Discharge LTCH	2	0
	Discharge LTCH %	9.5 %	0 %
	Discharge hospice	0	1
	Discharge hospice %	0 %	2.9 %
	Discharge other	0	2
	Discharge other %	0 %	5.9 %
Unit 2	ICU Census	28	32
	ICU Average LOS	4.35	4.07
	ICU Median LOS	3.21	2.92
	n Stay < 12	2	1
	n Stay < 24	4	4
	n Stay > 24	24	28
	ICU Readmit	6	1
	Readmit Rate	0.21	0.03
	Average daily census	12.45	13.08
	ICU Death	1	0
	ICU Death %	3.57 %	0.00 %
	Discharge home	2	4
	Discharge home %	7.1 %	12.5 %
	Discharge LTCH	3	2
	Discharge LTCH %	10.7 %	6.2 %
	Discharge hospice	0	1
	Discharge hospice %	0 %	3.1 %
	Discharge other	3	0
	Discharge other %	10.7 %	0 %

Note: these are examples from research implementation

Why Use It?

Reduce information overload

Convenient, efficient access to important patient data

Consistency and standardization

Creates a safer patient care environment

Metrics Assessed

Better Care → **Better Health** → **Lower Cost**

Metrics Measured	Metrics Measured	Metrics Evaluated
Adherence to and appropriateness of processes of care	Ventilator free days	Total costs of care (30 days)
Compliance with ventilator bundle & ventilator tidal volume	Cases of ventilator associated events	Cost of index hospitalization
Central line usage	Cases of catheter related blood stream infections	ICU/Hospital Length of Stay
Urinary catheter usage	ICU/Hospital Admissions	Medicare Free Days
Antibiotic usage	ICU/Hospital Readmissions	Resource use: RBC
Continuous IV sedation	ICU/Hospital Mortality	
Provider satisfaction	Discharge Location	
	30-day Mortality	
	1-year Survival	

Some Mayo Findings

*“This system helps us get
back to
human-centered
decision-making.”*

The majority of clinically
relevant
information is available
within the first
two clicks.

Rounding time reduced:
110 minutes saved (total
mean time) with data
gathering activities in 20
bed surgical ICU.

Using the NASA TLX scale
to measure cognitive
load, there was a
45 % decrease.

Reduction in medical
errors in the ICU by 50%

Reduction in central line
days, antibiotic use days,
and ICU length of stay.

“There has been a shift from data-gathering and regurgitation to decision-making and patient interaction.”

-Brian Pickering

