Revolutionizing Point of Care Medicine

Harnessing AI, Cognitive Decision Support, and Living Guidance for Physicians

DEPARTMENT OF SURGERY

Christopher Tignanelli, MD MS FACS FAMIA

Associate Professor of Surgery

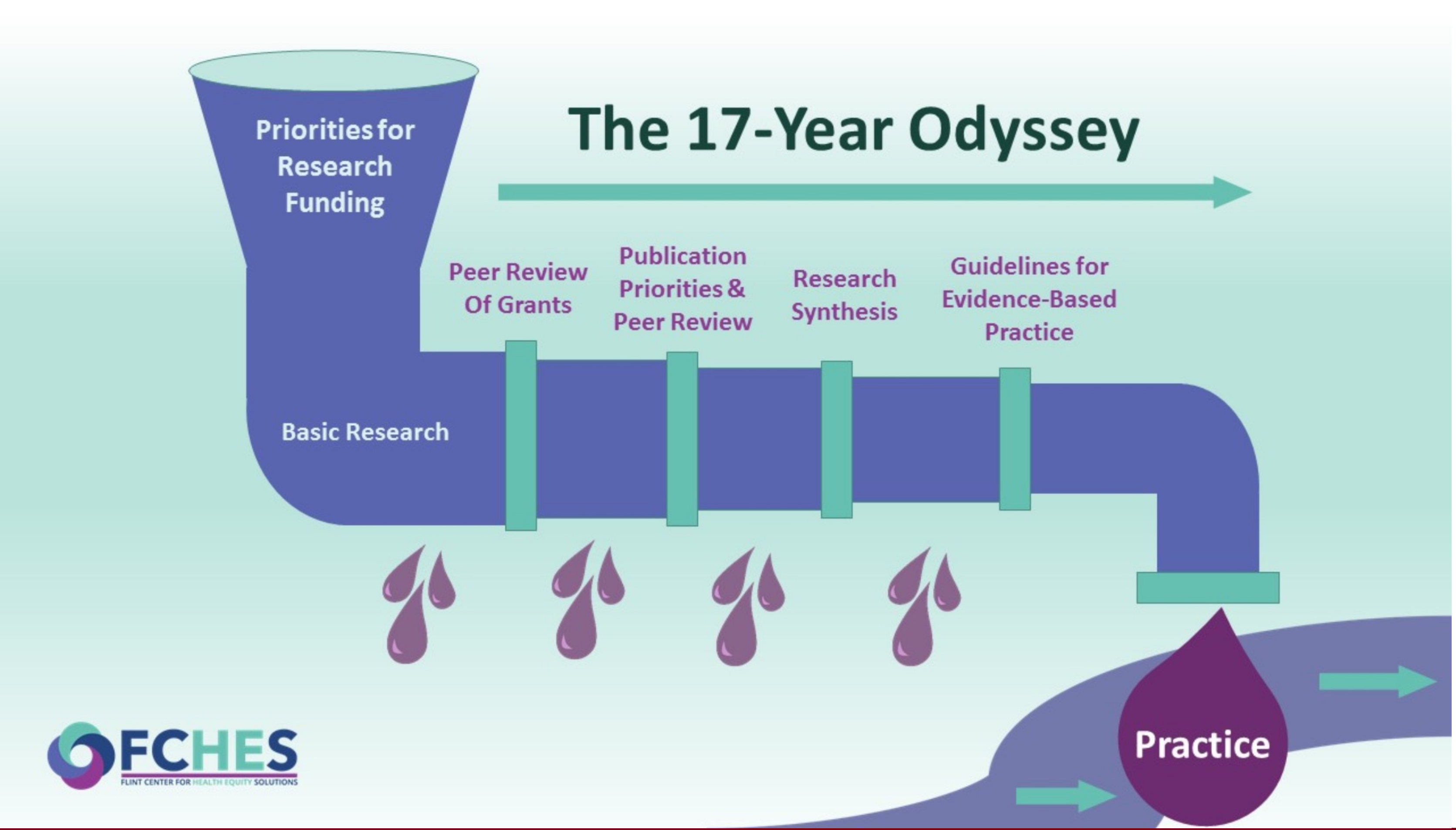
Associate Dean of Data Science

Affiliate Faculty, Institute for Health Informatics

Scientific Director, Program for Clinical Artificial Intelligence

Director, UMN Center for Quality Outcomes, Discovery and Evaluation

We **still** suffer from an evidence to practice translation gap



17 years for 14% of original research to benefit patients

Balas, 1998; Balas and Boren, 2000; Green et al., 2009

University of Minnesota
Driven to Discover℠

And even when we do get evidence into guidelines time constraints limit our ability to deliver best practice

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PMID: 35776372

Revisiting the Time Needed to Provide Adult Primary Care

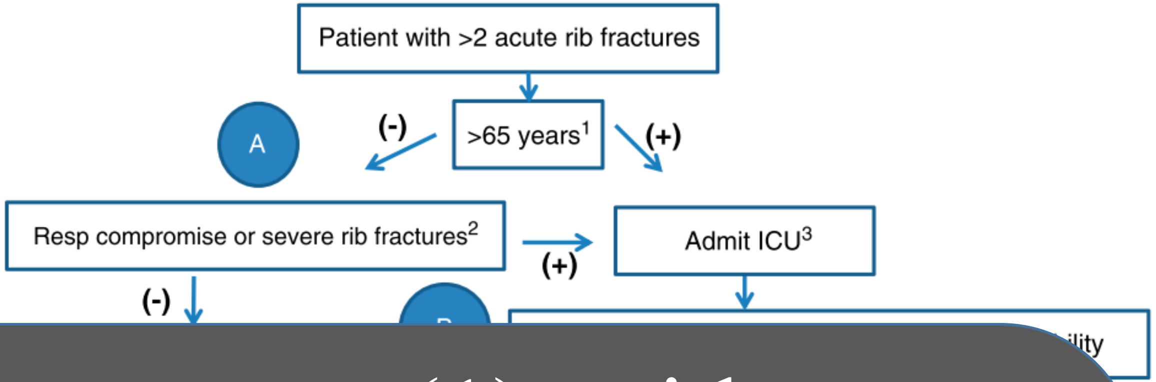
Justin Porter, MD,[1] Cynthia Boyd, MD, MPH,[2] M. Reza Skandari, PhD,[3] and Neda Laiteerapong, MD, MS[4]

"Our study found that a primary care physician (PCP) would need an infeasible 26.7 hours per day to provide preventive, chronic disease, and acute care for an average US adult patient."

Porter, 2023

One thing done to help remedy this problem

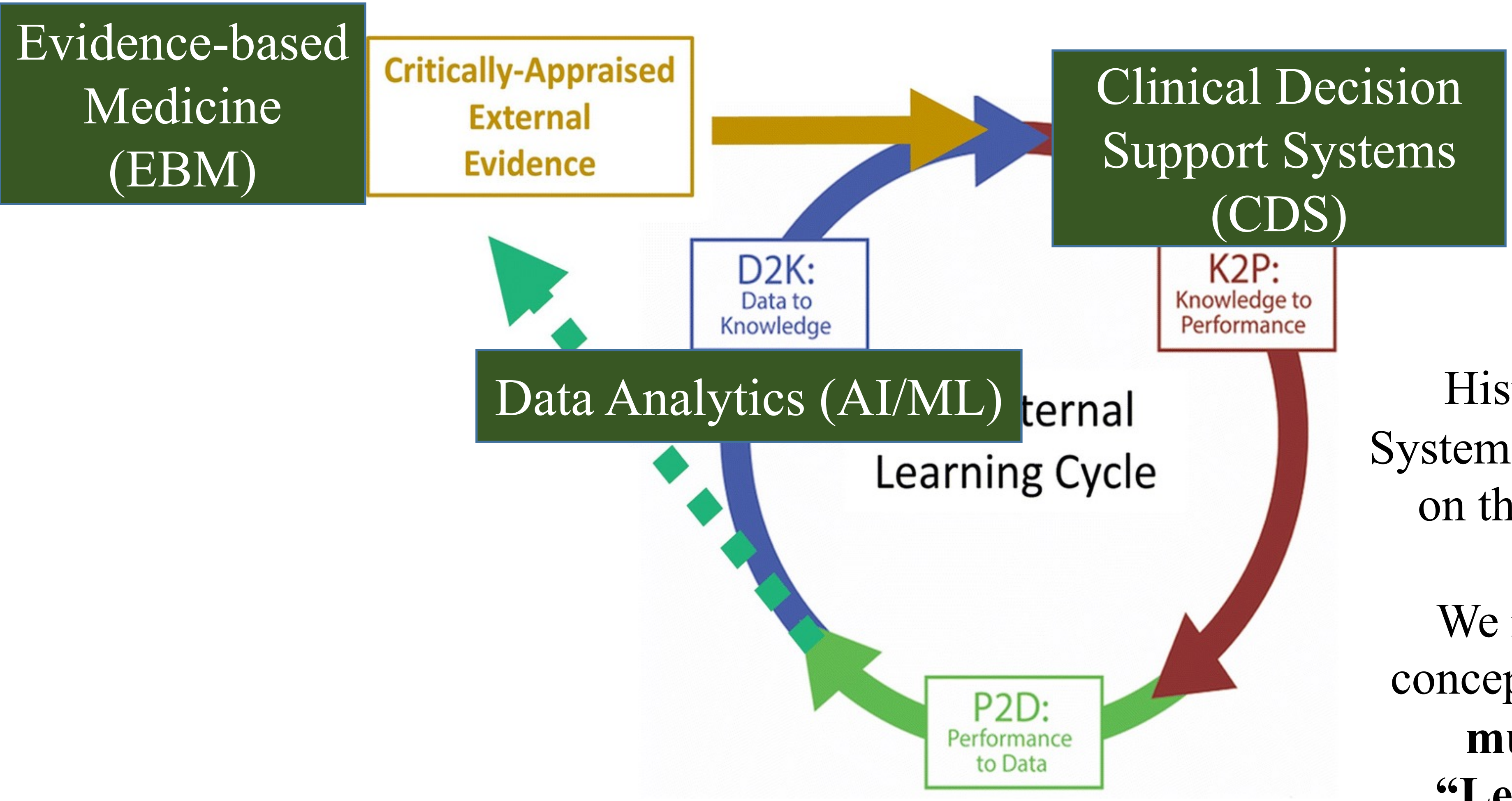
- We created easy to memorize treatment algorithms
- **<u>The problem with this solution:</u>**
    - **Contributes to a one size fits all approach**



Is it possible to overcome these gaps: (1) evidence to practice gap, (2) physician cognitive overload, (3) one size fits all approach

and transform medical delivery to provide more efficient evidence-based and personalized care?

The Learning Health System integrates three disciplines: EBM + AI/ML + CDS



Historically, Learning Health Systems have primarily concentrated on the **healthcare system level**.

We need to aim to elevate this concept to a national scope linking **multiple systems within a "Learning Health Network"**

What is Clinical Decision Support?

HEALTH
FAIRVIEW

M Health Fairview COVID-19 Anticoagulation Pharmacy Guide for
NON-Pregnant ADULTS (≥ 18 years old) with COVID-19
(Modified from the UNC Chapel Hill Protocol) Revision Date: 7/14/20
UMMC - Non-Malignant Hematology Section, Division of Hematology, Oncology, and Transplantation

Highly suspected or confirmed ADULT, NON-Pregnant* COVID-19+ patient**
****Please consult OB provider for pregnant/breastfeeding women who are COVID-19 positive* (Pregnancy OB Admission Recommendations during COVID-19)

Labs on admission: D-dimer, reticulocyte count, PT/INR, aPTT, fibrinogen, Antithrombin, ferritin, LDH, CMP and CBC with diff
Daily Labs: D-dimer, reticulocyte count, PT/INR, aPTT, fibrinogen, CBC with diff

VTE prophylaxis for ALL hospitalized highly-suspected or confirmed COVID-19+ patients

D-dimer < 10 x ULN# and NO other Risk Factors$

eGFR* >/= 30 mL/min
- BMI > 40 kg/m²: Enoxaparin 40 mg SQ BID**
- BMI 18-40 kg/m²: Enoxaparin 40 mg SQ Q24 Hrs
- BMI < 18 kg/m²: Enoxaparin 30 mg SQ Q24 Hrs
- *Enoxaparin anti-Xa goal = 0.3-0.5. Testing only recommended if concern for under or over-treatment.*

eGFR* < 30 mL/min
Heparin 5,000 units SQ q8 Hrs

If pharmacologic prophylaxis contraindicated (active bleeding, PLT < 30,000): Apply SCDs

D-dimer ≥ 10 x ULN# AND/OR in the ICU, active cancer OR history of VTE

eGFR* >/= 30 mL/min
Enoxaparin 0.5 mg/kg BID** (Max dose = 90 mg)
Check *Enoxaparin anti-Xa* on any dose > 80 mg.
Target *Enoxaparin anti-Xa* (4 hrs after 4th dose) = 0.4-0.7

eGFR* < 30 mL/min
- HealthEast: Heparin LOW Intensity Protocol
  HE Heparin-Xa goal = 0.25-0.6
- Fairview: COVID Heparin Protocol
  FV Heparin-Xa goal = 0.25-0.5

If pharmacologic prophylaxis contraindicated (active bleeding, PLT <30,000): Apply SCDs

Therapeutic anticoagulation

On therapeutic anticoagulation prior to admission
- Continue PTA anticoagulation if no contraindications

Highly-suspected or confirmed VTE

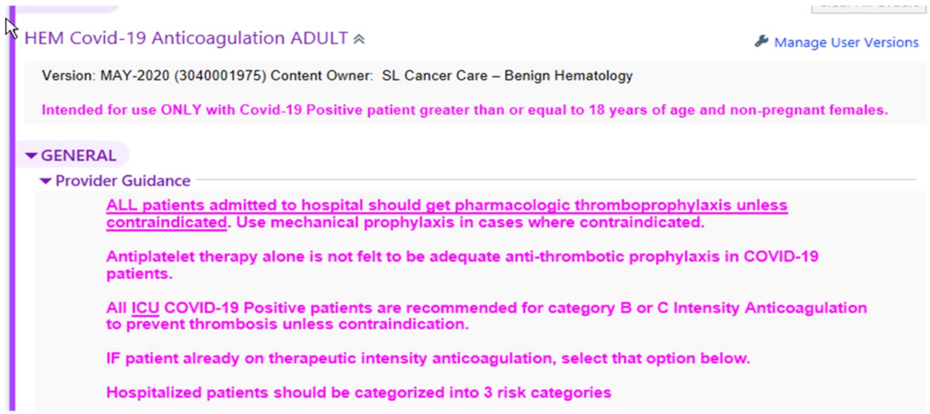
eGFR*>/= 30 mL/min
Enoxaparin 1 mg/kg SQ BID** *(Max dose= 190 mg)*
Check *Enoxaparin anti-Xa* on any dose > 140 mg.
Target *Enoxaparin-Xa* (4 hrs after 4th dose) = 0.6-1.

eGFR*<30 mL/min
IV UFH HIGH-intensity protocol
Heparin-Xa goal = 0.3-0.7

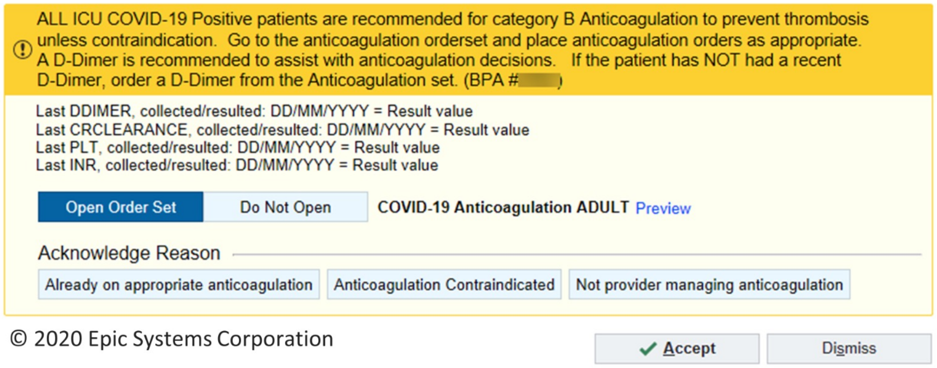
Clinical Decision Support to deploy COVID-19 clinical practice guidelines

Supplemental Figure 2: Screenshots of COVID-19 anticoagulation clinical decision support system's passive and interruptive elements

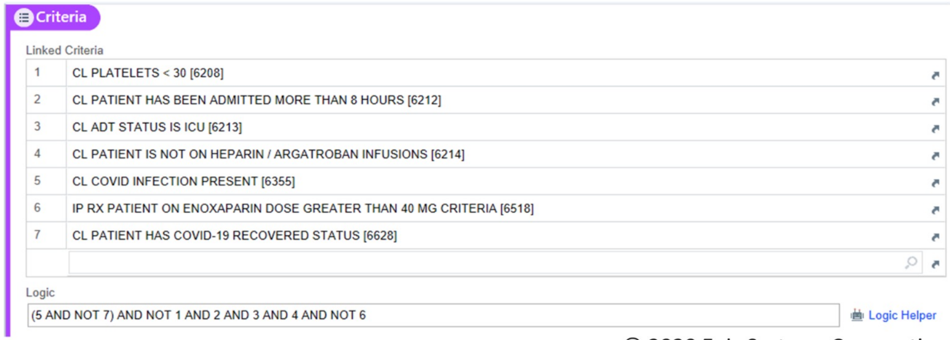
Passive COVID-19 Anticoagulation Orderset



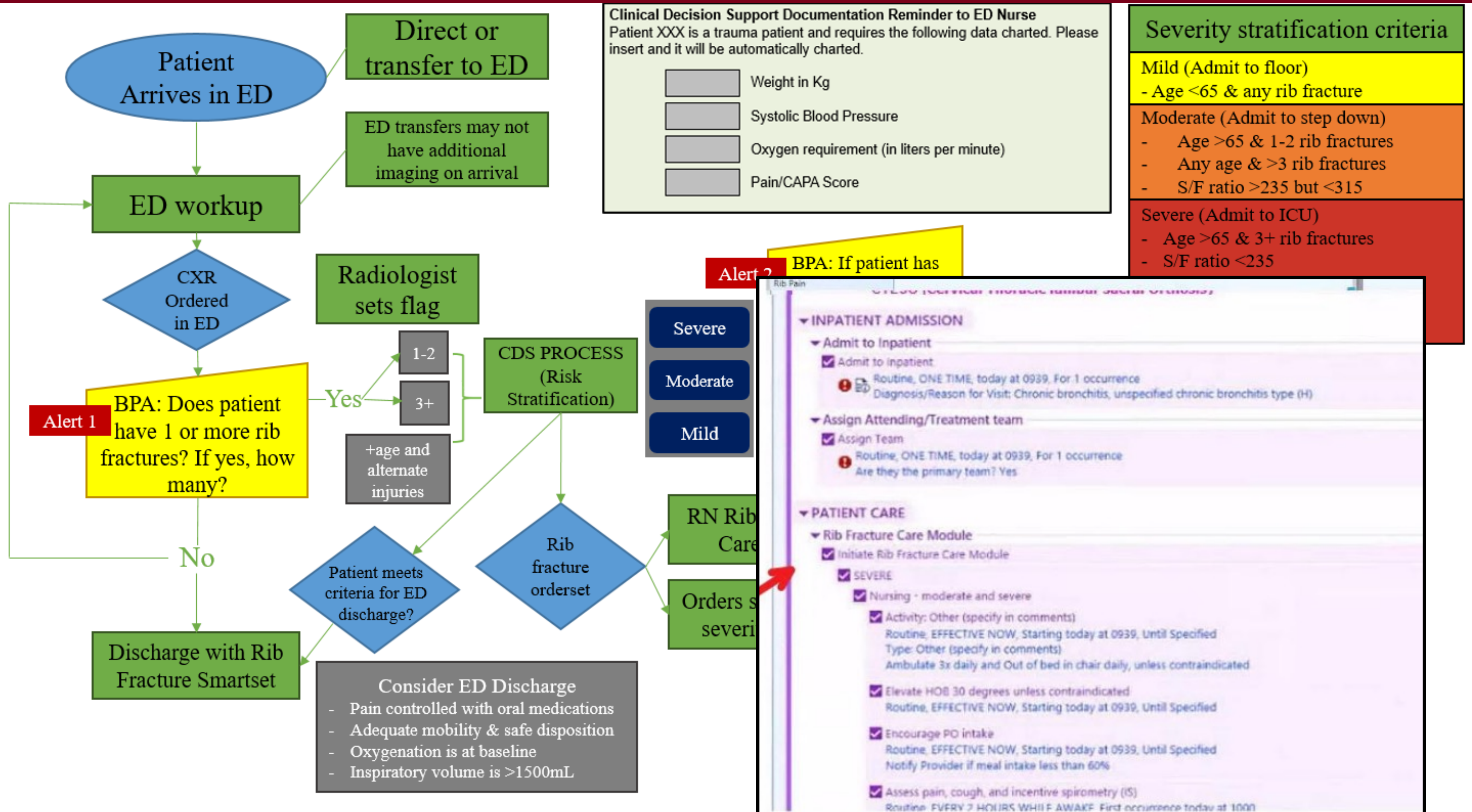
Interruptive BPA within Admission Orderset Navigator



Interruptive Alert Logic



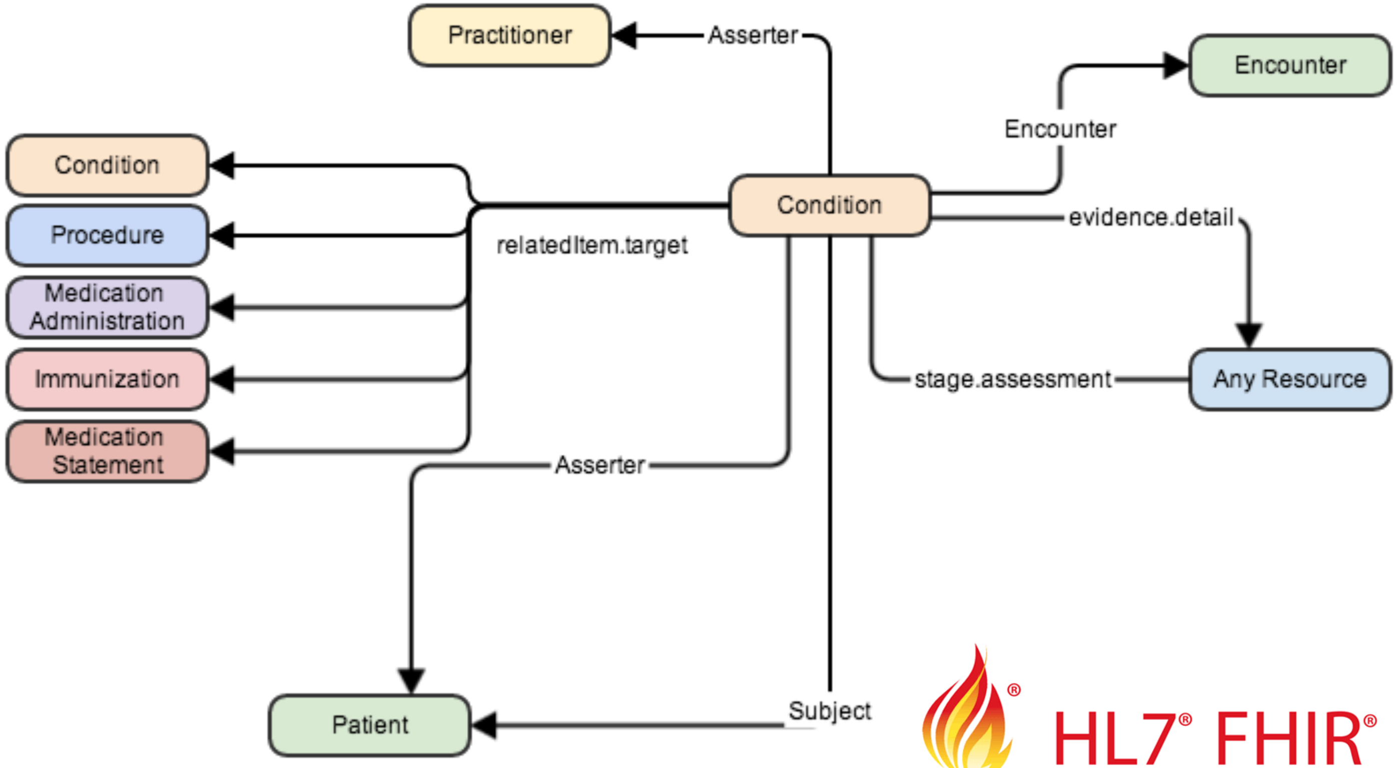
Rib Fracture Clinical Decision Support Care Map



<u>Problem with these examples of decision support shown which are commonplace:</u>

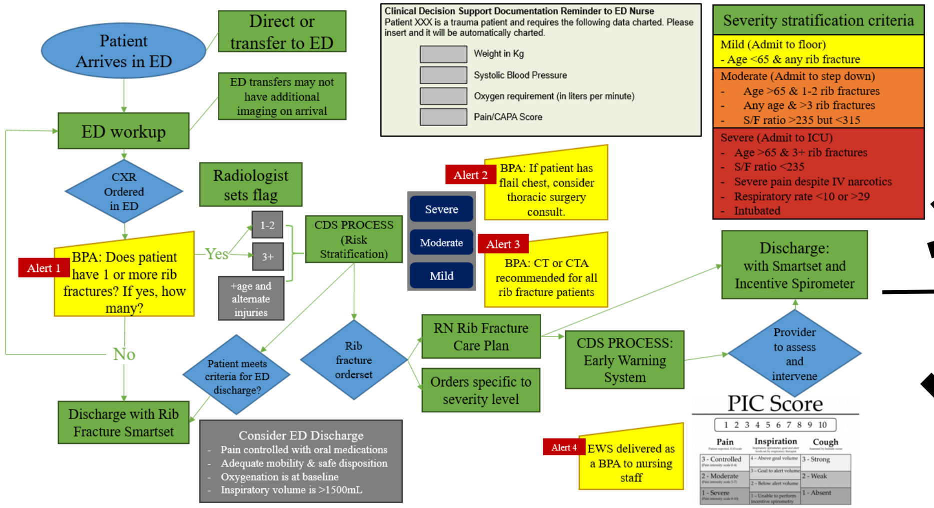
1.) **INTEROPERABILITY** - Institution and EHR (i.e. Epic, Cerner)- specific
2.) **MANUALLY INTENSIVE** – Each institution to build and deploy, not computable, not plug and play
3.) **Usability (UI/UX) nightmare**

HL7 FHIR allows a standardized interoperable set of rules to exchange electronic healthcare data

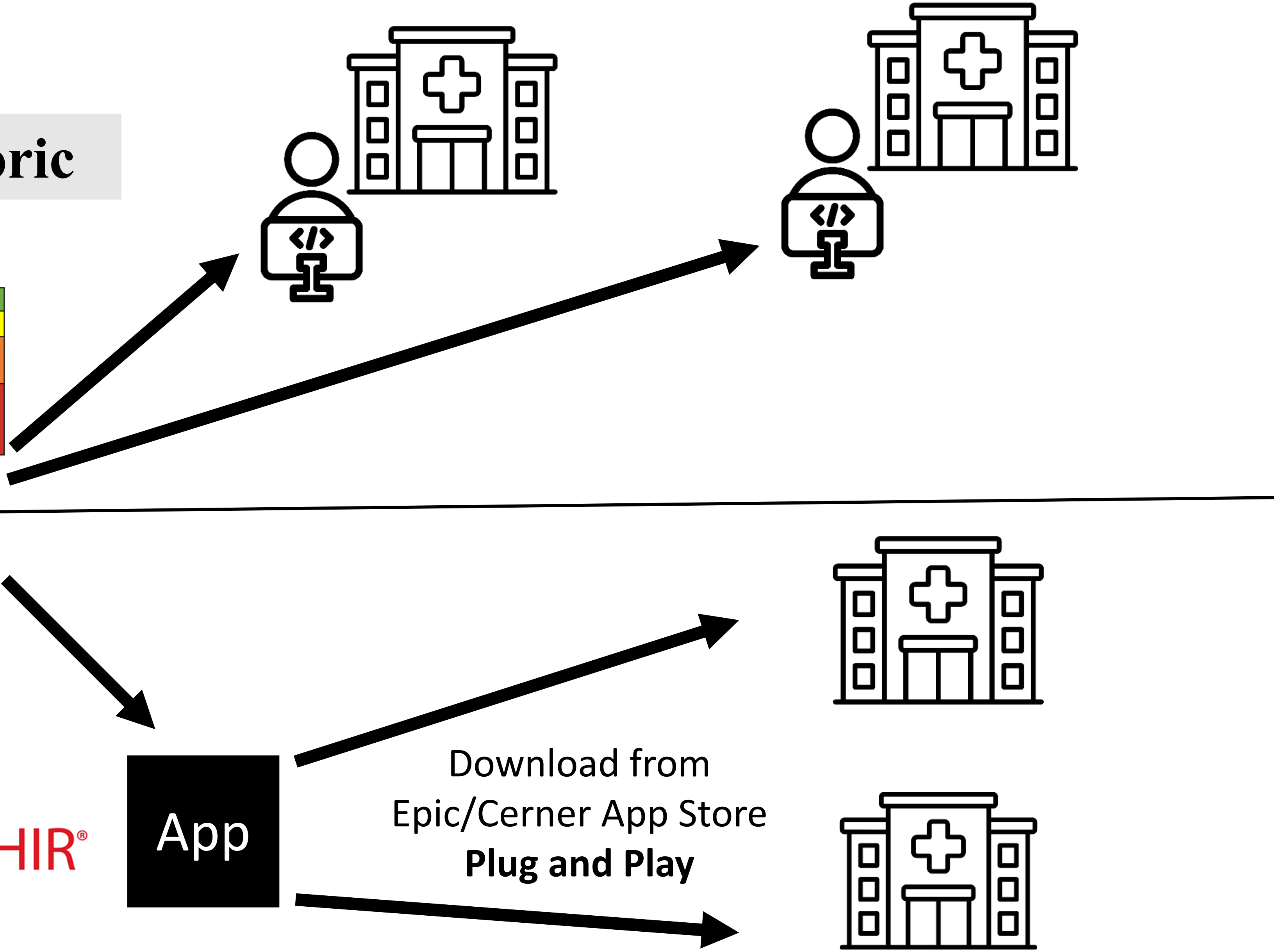


HL7® FHIR®

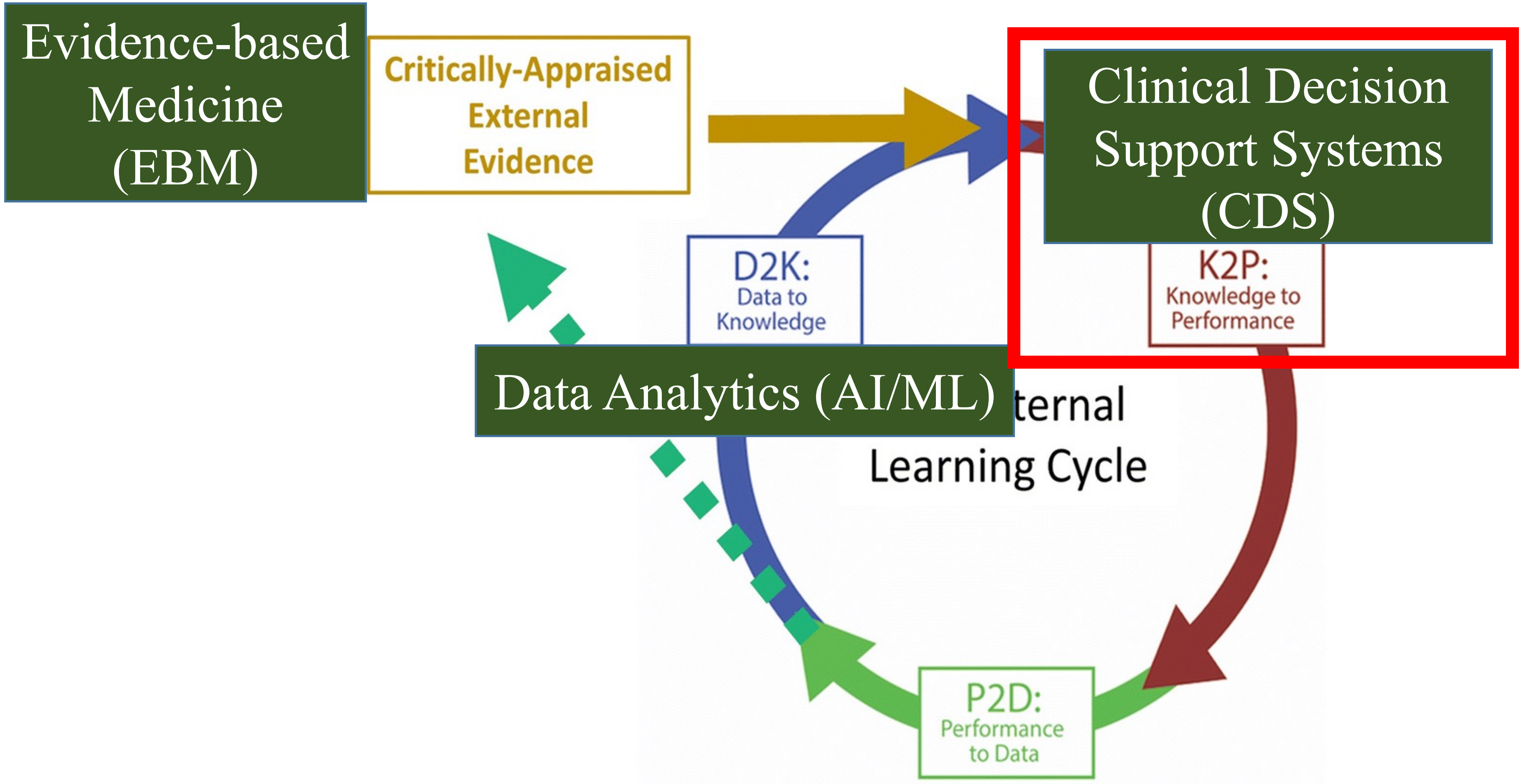
Historic



HL7® FHIR®

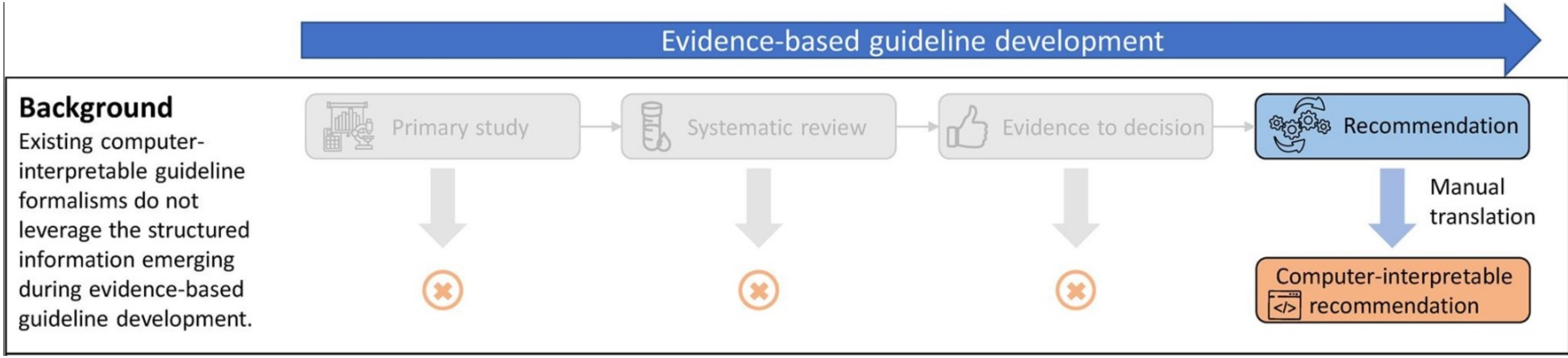


The Learning Health System integrates three disciplines: EBM + AI/ML + CDS



Evidence-based Medicine as a discipline is undergoing major transformation

Historic



- A society or group conducts a systematic review
- A guideline committee generates guidance and an 41 page narrative PDF guideline is written
- Each health system then has their local experts interpret that guideline and create a set of rules/algorithm
- Each health system's IT team then builds that natively into their EHR as decision support
- 5-10 years later that society updates their guideline and the process repeats

DOI: 10.1002/jpen.2267

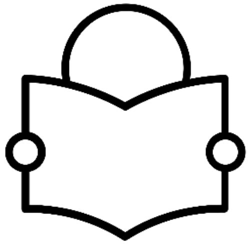
CLINICAL GUIDELINES

aspen

Guidelines for the provision of nutrition support therapy in the adult critically ill patient: The American Society for Parenteral and Enteral Nutrition

Charlene Compher PhD, RD[1] | Angela L. Bingham PharmD[2,3] | Michele McCall MSc, RD[4] | Jayshil Patel MD[5] | Todd W. Rice MD, MSc[6] | Carol Braunschweig PhD[7] | Liam McKeever PhD, RDN[7]

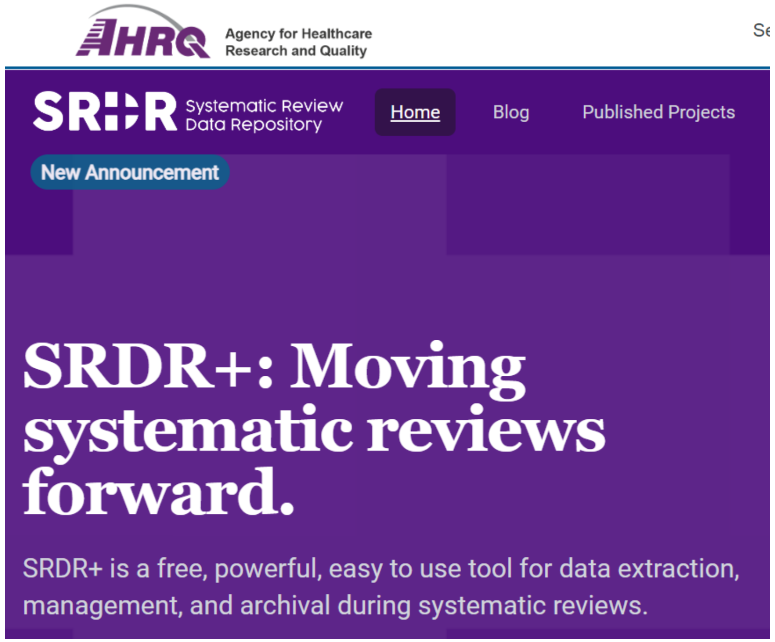
EBMonFHIR developing standards for sharing systematic review data such as citation, study design, outcome definitions, risk of bias, certainty of evidence



EBMonFHIR Risk of Bias: Low

EBMonFHIR Study Design: RCT

EBMonFHIR Study Design: Evidence Certainty Rating

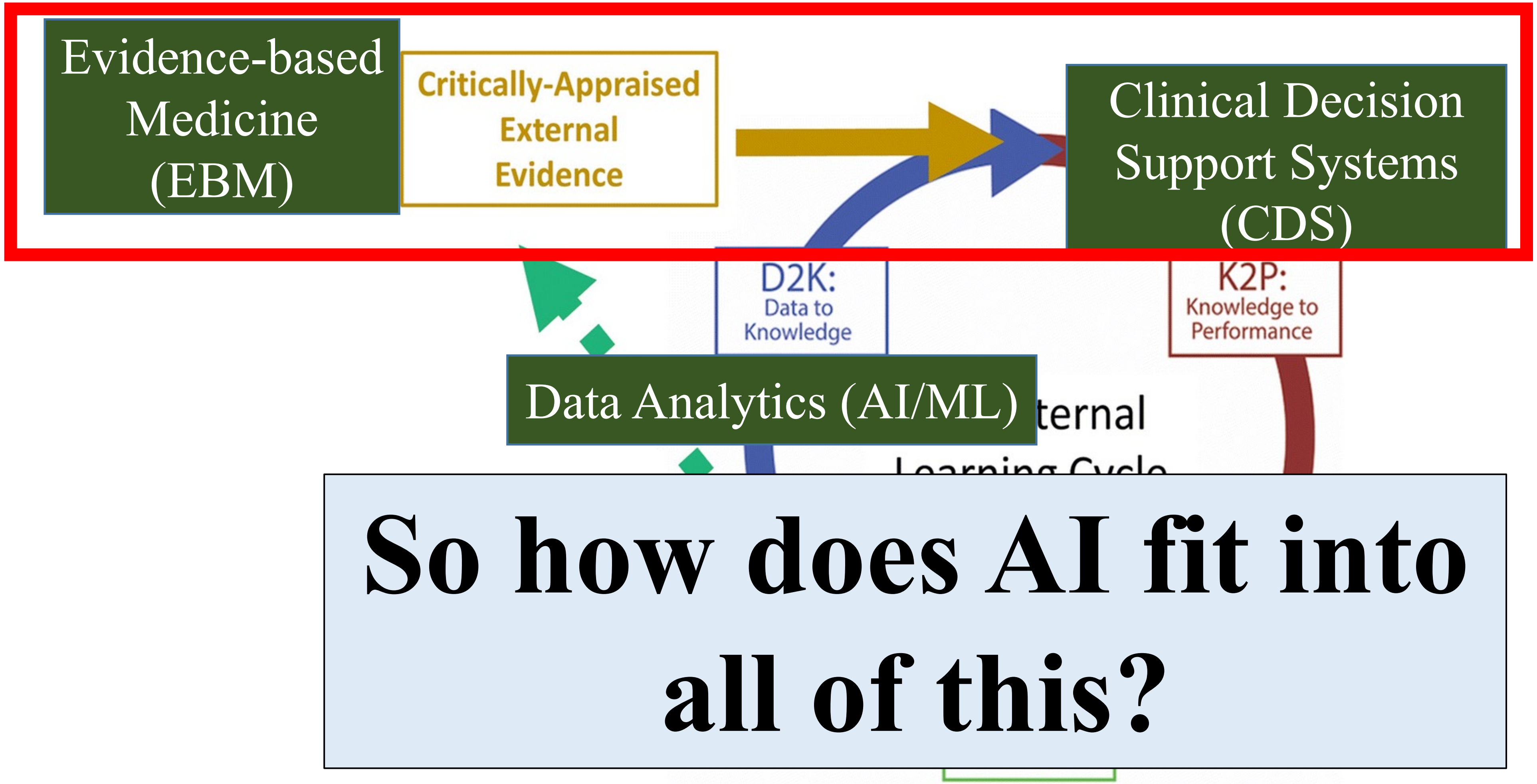


Imagine how easy systematic reviews, meta-analyses, and annual updates to guidelines would be if every published paper had their attributes already stored in SRDR+

Evidence-based Medicine as a discipline is undergoing major transformation

Knowledge Level	Description	Example
L1	Narrative	Guideline for a specific disease that may be written in the format of a peer-reviewed journal article
L2	Semi-structured	Flow diagram, decision tree, or other similar format that EXPLICITLY describes or expresses logic constructs that are interpretable by non-SME 'computable logic developer' for constructing L3, BUT are also expressed in a manner sufficient for domain SME to review and validate
L3	Structured	Standards-compliant Specification for CDS that explicitly encodes computer interpretable logic including data model(s), terminologies (concepts, value sets), logic expressions in a computable language sufficient for implementation- often across a broader set of local implementations
L4	Executable	Manifestation of the logic (typically in a user interface) that is used in a local execution environment (e.g. CDS interventions running live in a local production EHR environment) or available via web services

The Learning Health System integrates three disciplines: EBM + AI/ML + CDS

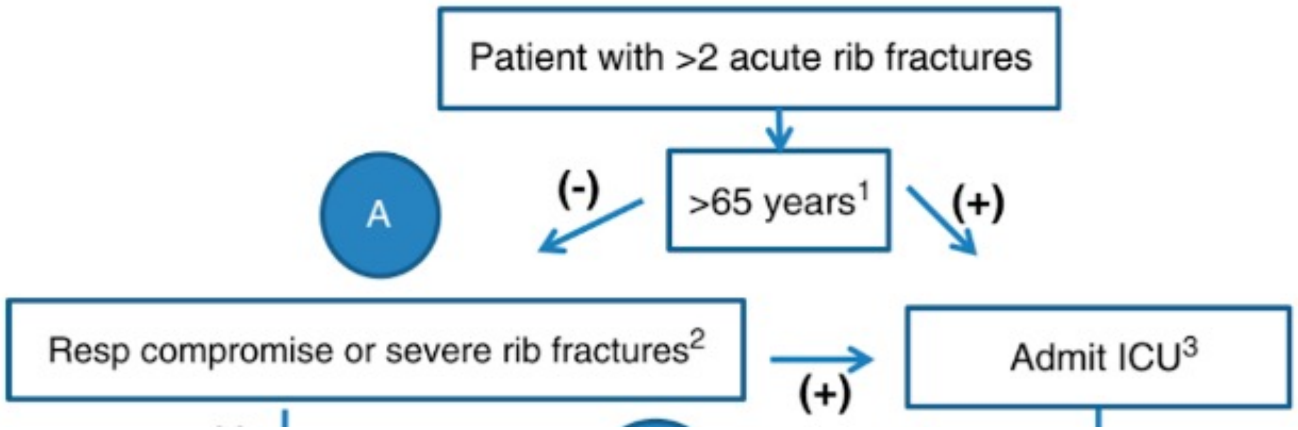


So how does AI fit into all of this?

Lets go back to our rib fracture treatment algorithm

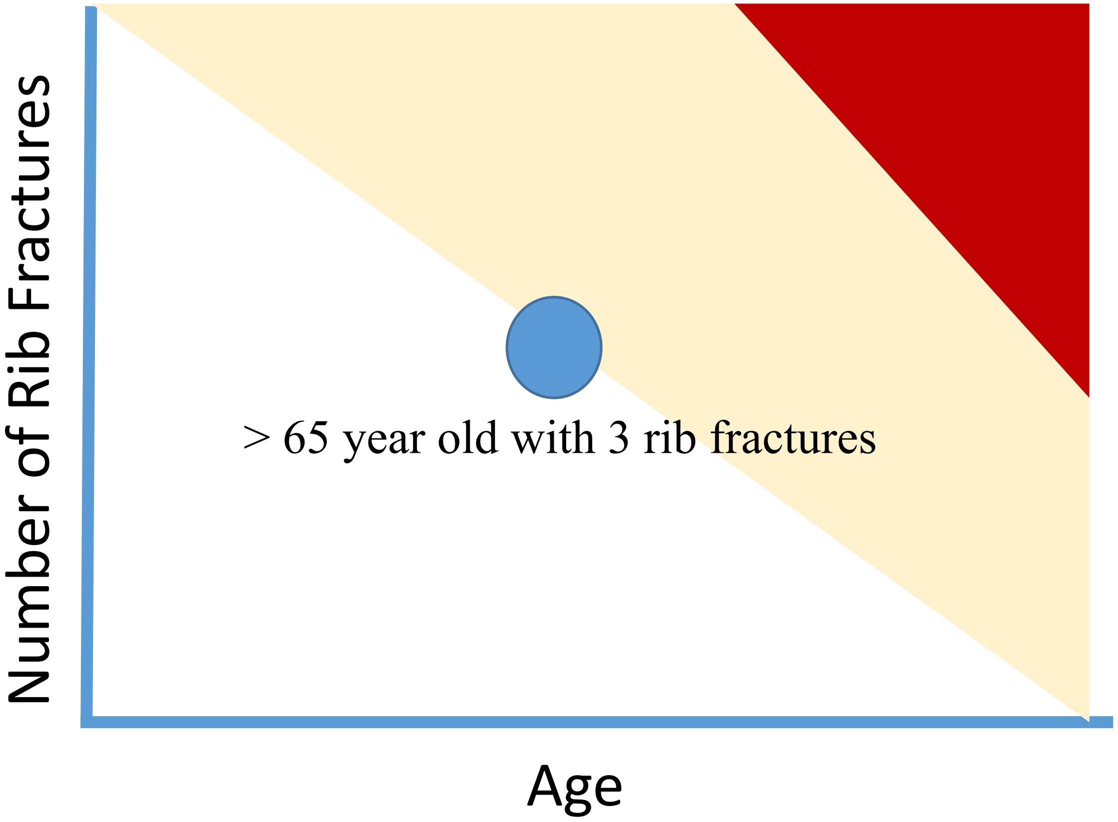
<u>Current State</u>

One size fits all



Best practice for rib fracture patients age 66 and older with 3 or more rib fractures is admission to the ICU

AI/ML allows us to generate a patient specific probability that a treatment is beneficial. RCTs can then investigate if AI (personalized) outperforms current Std of Care



<u>Don’t forget additional dimensions:</u>

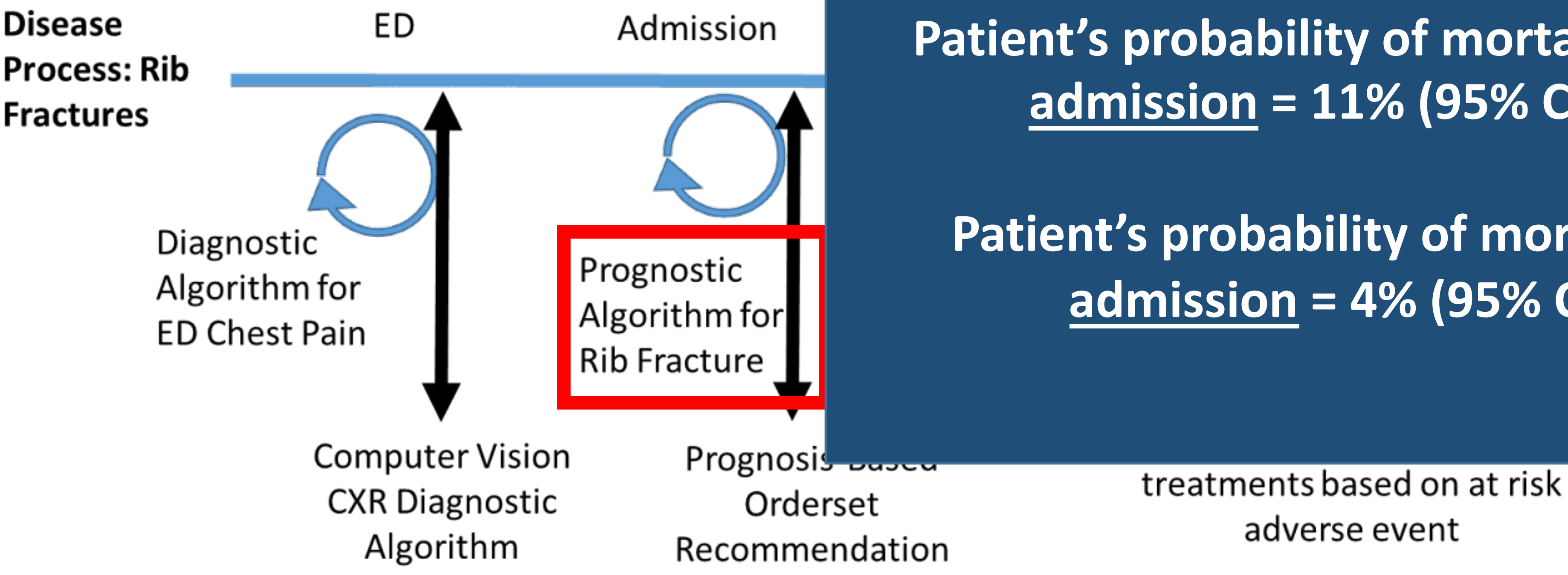
What if they are a smoker with empysema?

What if they are on home oxygen?

What if they have a collapsed lung?

Do X-ray findings/features inform treatment?

Integration of AI tools into the Rib Fracture Care Map

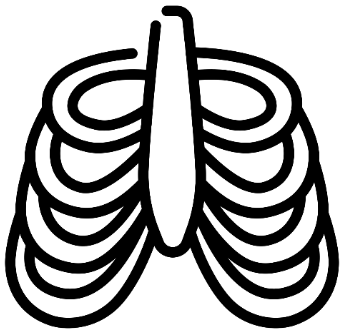


Example Clinical Decision Support BPA

Your patient has a rib fracture

Patient's probability of mortality without ICU admission = 11% (95% CI 9% - 15%)

Patient's probability of mortality with ICU admission = 4% (95% CI 2%-6%)



Multicenter Pragmatic RCT

Current best practice for patients with rib fractures

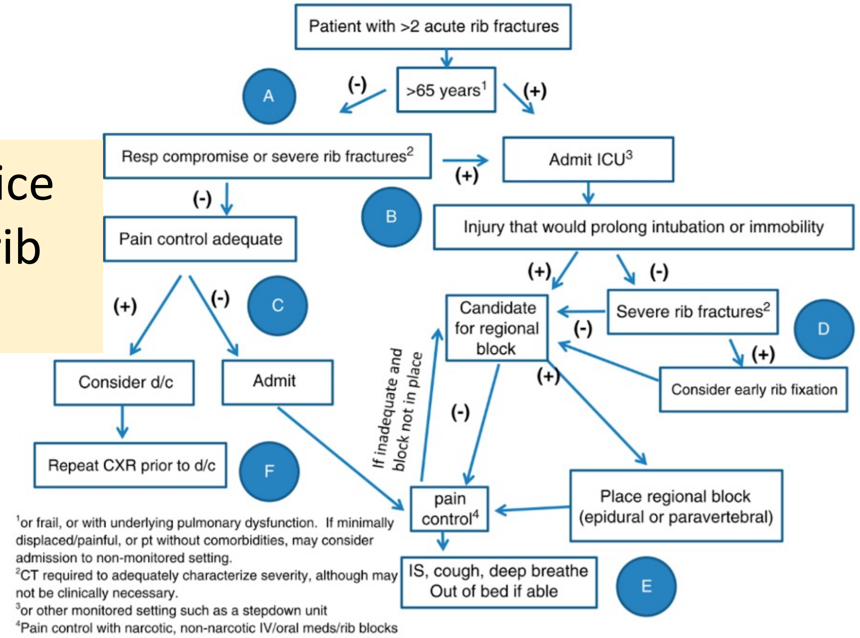
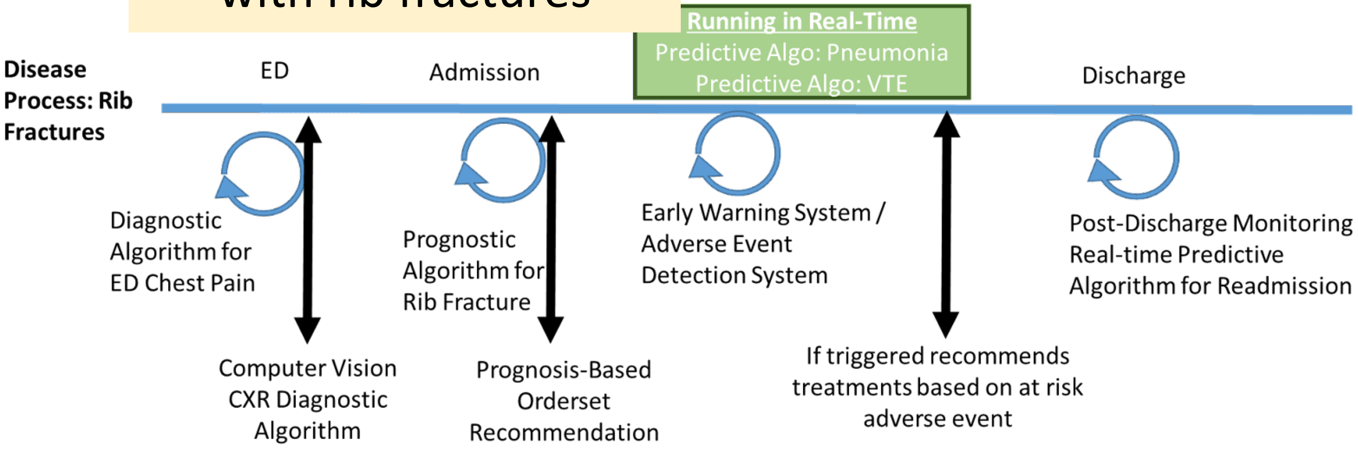


Figure 1. Western Trauma Association rib fracture algorithm. *Circled letters* refer to corresponding areas within the text.

AI generated optimal (individualized) practice for patients with rib fractures



These algorithms can then become integrated into CDS systems

Epic

Cognitive Computing Platform

Embedding machine learning into every Epic application

ED patient

Inpatient with negative COVID-19 status

Input

Images

Processing

AI Algorithm

Output

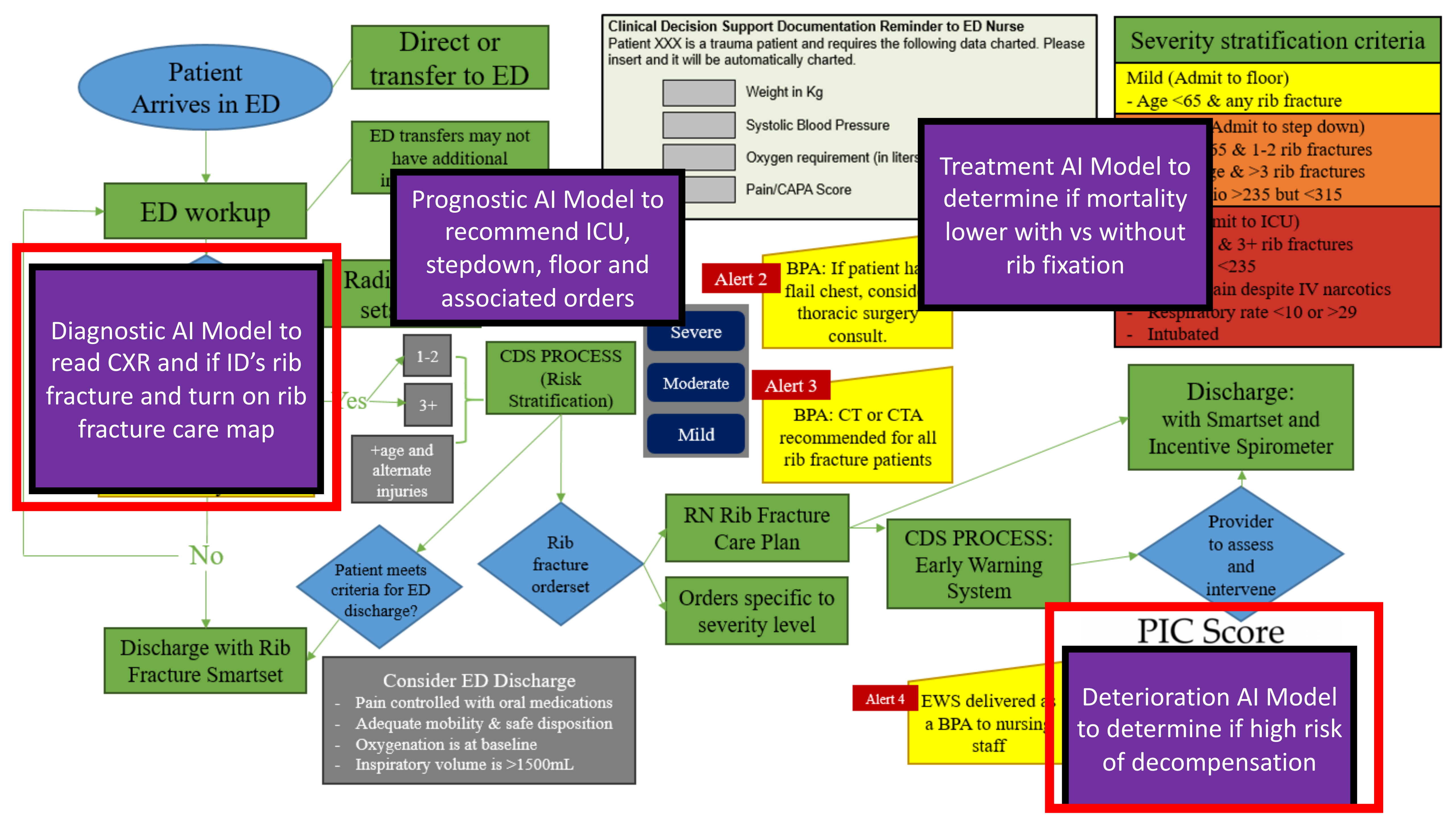
MH FV Electronic Health Record

CDS Services

Information card

- **Covid-19 storyboard update**
- **Add-on to patient list** (optional)
- No BPA (no alert fatigue)

Occurs in REAL-TIME



Patient Arrives in ED
Direct or transfer to ED
ED transfers may not have additional
ED workup
Diagnostic AI Model to read CXR and if ID's rib fracture and turn on rib fracture care map
Prognostic AI Model to recommend ICU, stepdown, floor and associated orders
Clinical Decision Support Documentation Reminder to ED Nurse
Patient XXX is a trauma patient and requires the following data charted. Please insert and it will be automatically charted.
Weight in Kg
Systolic Blood Pressure
Oxygen requirement (in liters
Pain/CAPA Score
Treatment AI Model to determine if mortality lower with vs without rib fixation
Severity stratification criteria
Mild (Admit to floor)
- Age <65 & any rib fracture
Admit to step down)
65 & 1-2 rib fractures
ge & >3 rib fractures
io >235 but <315
mit to ICU)
& 3+ rib fractures
<235
ain despite IV narcotics
Respiratory rate <10 or >29
Intubated
Alert 2
BPA: If patient ha flail chest, consid thoracic surgery consult.
Severe
Moderate
Mild
Alert 3
BPA: CT or CTA recommended for all rib fracture patients
Yes
1-2
3+
+age and alternate injuries
CDS PROCESS (Risk Stratification)
Discharge: with Smartset and Incentive Spirometer
No
Patient meets criteria for ED discharge?
Rib fracture orderset
RN Rib Fracture Care Plan
Orders specific to severity level
CDS PROCESS: Early Warning System
Provider to assess and intervene
Discharge with Rib Fracture Smartset
Consider ED Discharge
- Pain controlled with oral medications
- Adequate mobility & safe disposition
- Oxygenation is at baseline
- Inspiratory volume is >1500mL
PIC Score
Alert 4
EWS delivered a a BPA to nursin staff
Deterioration AI Model to determine if high risk of decompensation

How do we as a trauma community achieve

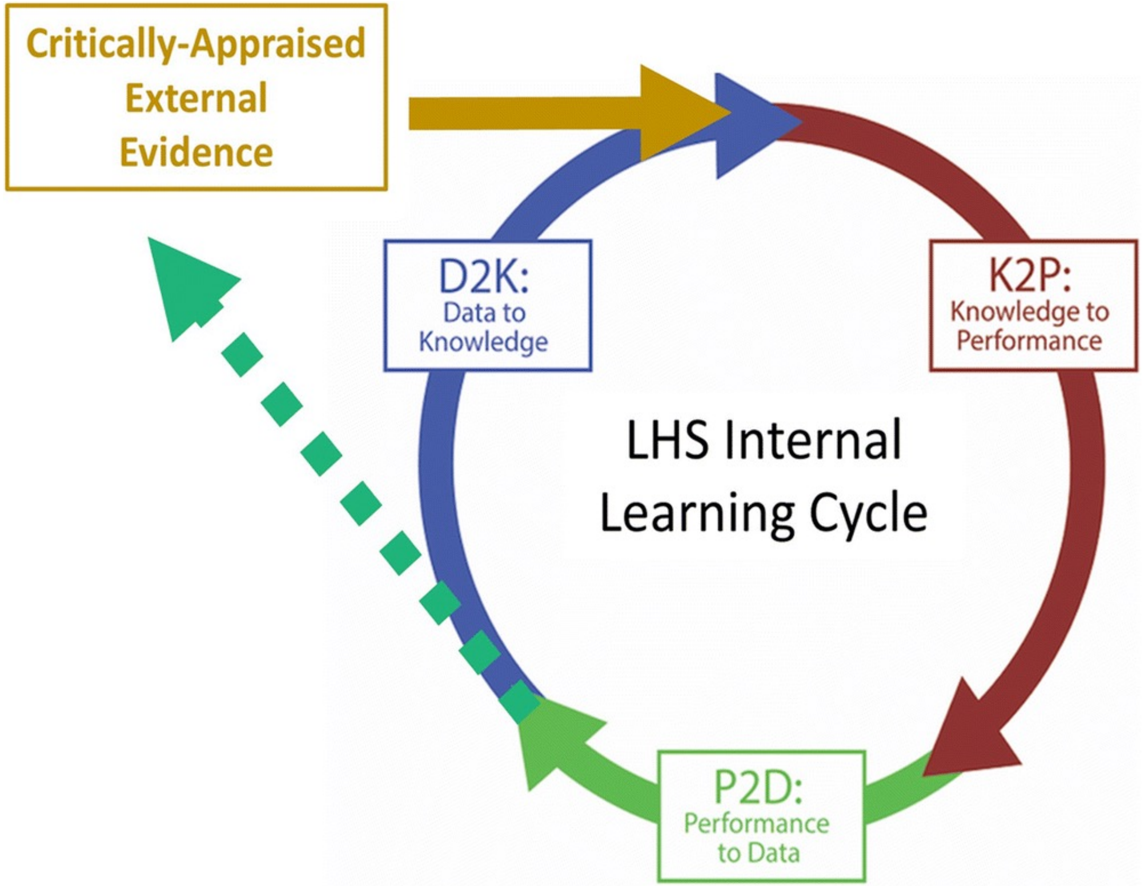
"...a health system in which internal data and experience are systematically integrated with external evidence, and that knowledge is put into practice."

- Agency for Healthcare Research and Quality

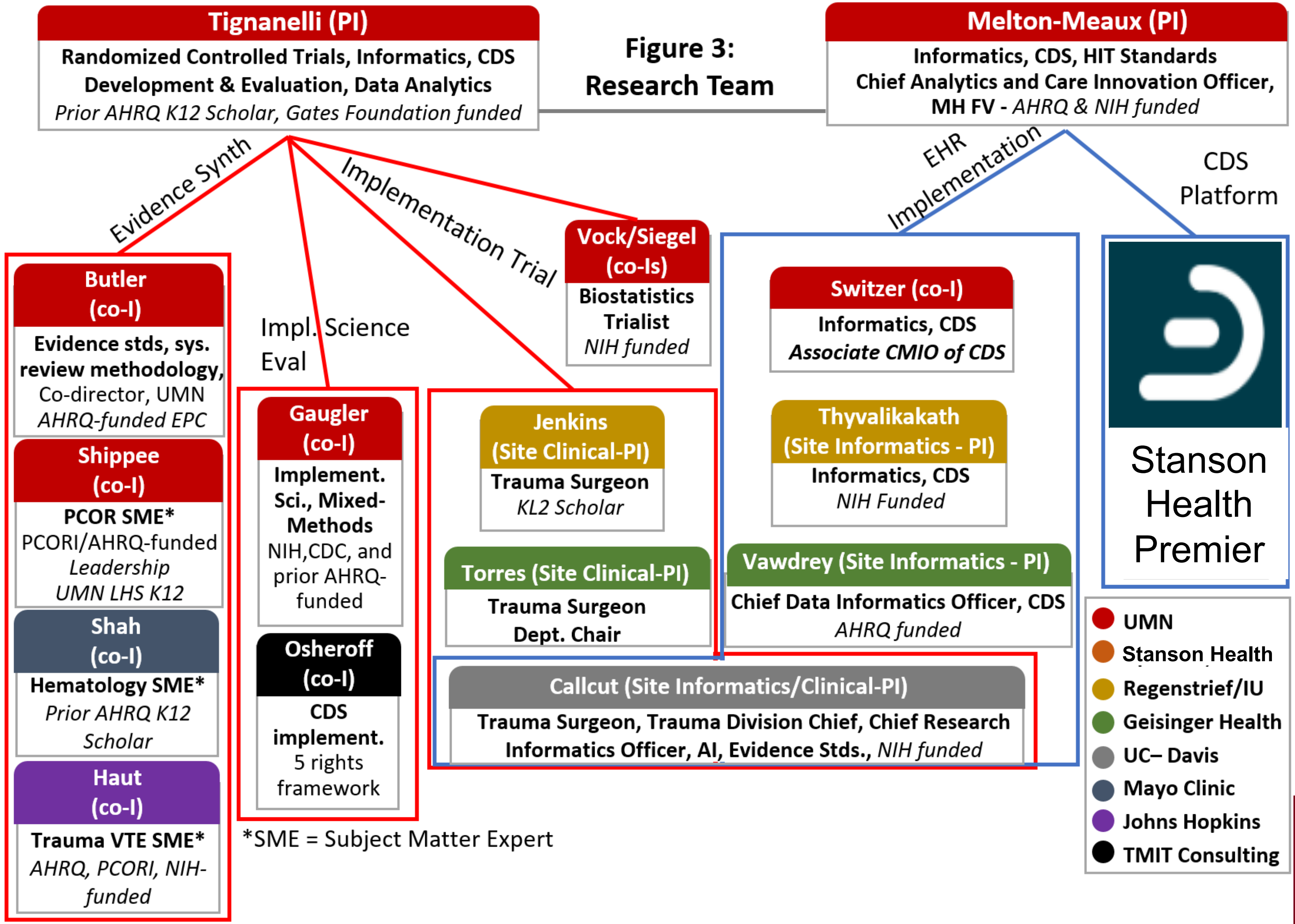
Learning Health NETWORK

- UMN was recently rewarded an AHRQ R18 grant to develop such a Learning Health Network for Trauma (PI: Tignanelli / Melton-Meaux)

- **<u>Need 3 key pieces to make a LHN</u>**
    - 1.) Centrally Maintained Clinical Decision Support Applications
    - 2.) Process for Evidence-Maintenance
    - 3.) Shared Real-time Data Repository to enable AI



The Trauma Learning Health Network Team



*SME = Subject Matter Expert

CNTR COALITION FOR NATIONAL TRAUMA RESEARCH

The American Association for the Surgery of Trauma

ATS American Trauma Society

National Blood Clot Alliance Stop The Clot

NATF North American Thrombosis Forum

east

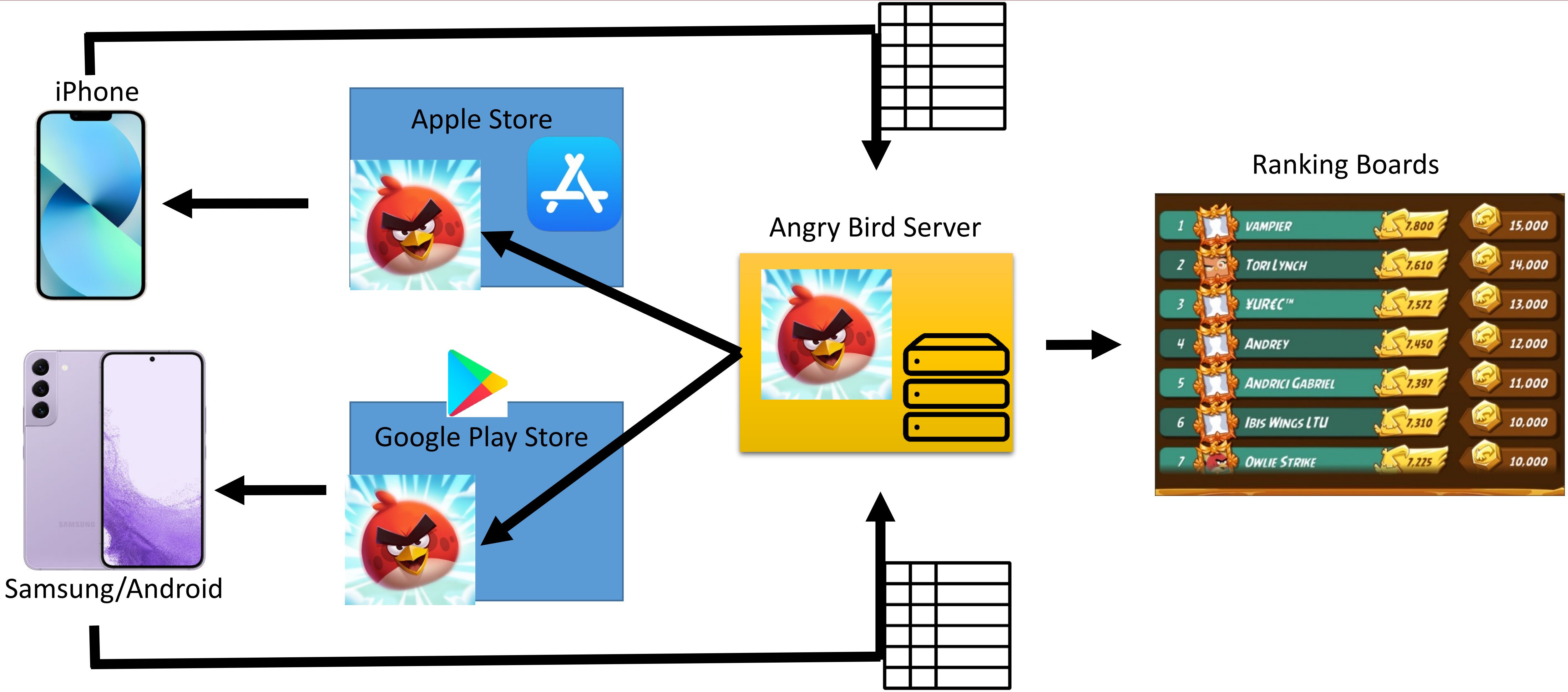
Brain Trauma Foundation

The Committee on Trauma

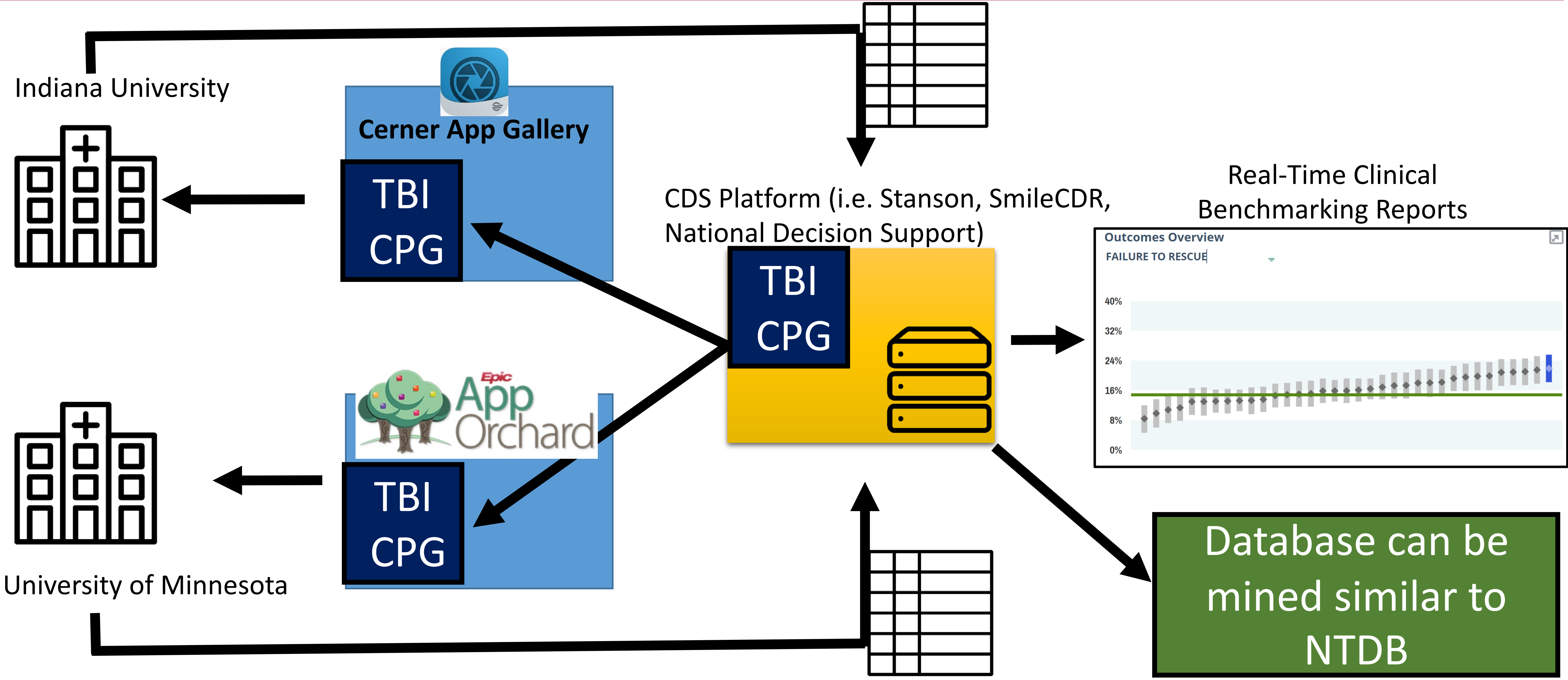
Quality Programs of the American College of Surgeons

University of Minnesota Driven to Discover℠

Centralized Decision Support Application – an example from Angry Birds



Well now imagine if the "Angry Birds" Application was a Clinical Care Map for TBI Management



If the evidence or best practice changes, can update the application once centrally and push out update

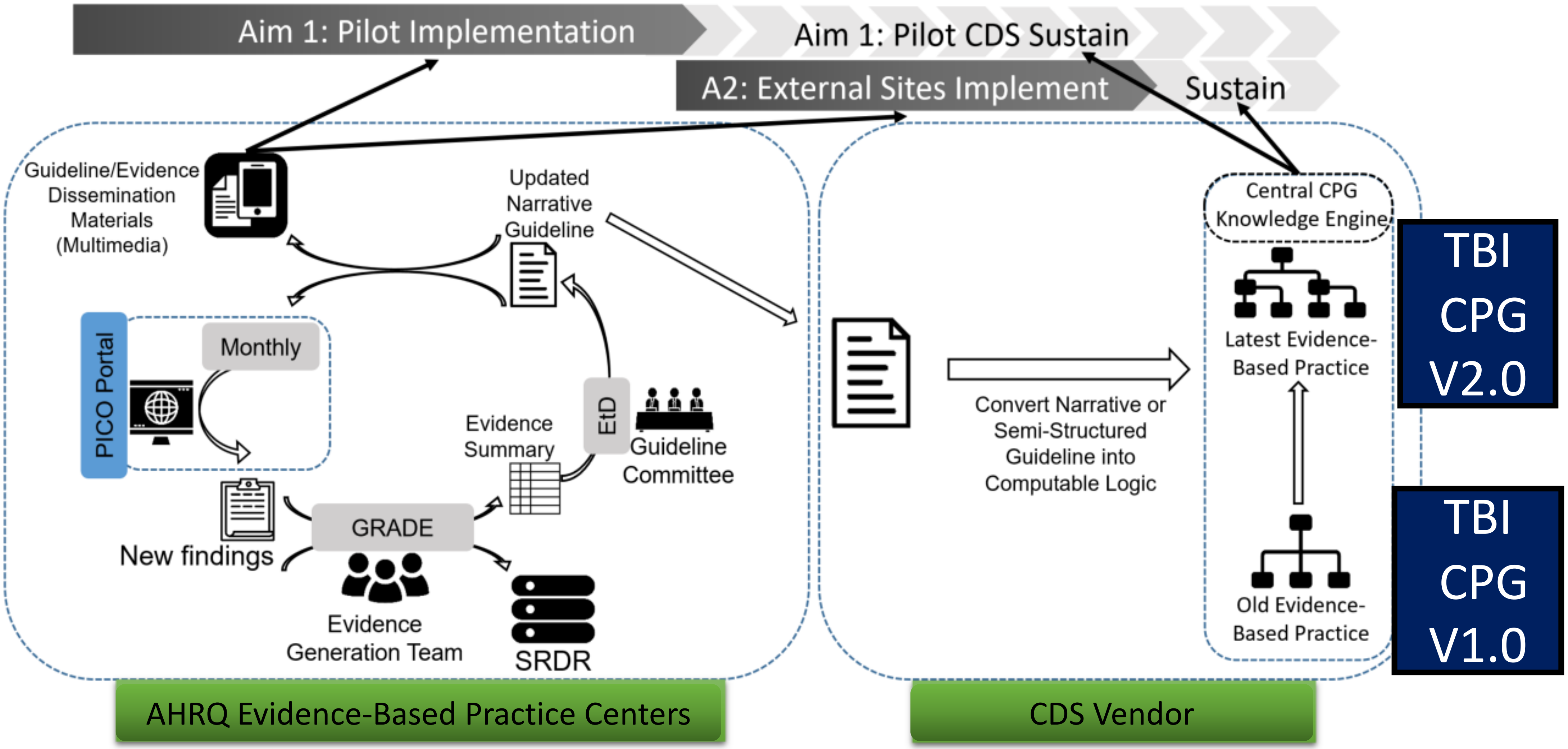


Figure 10: Pilot Process for "Living Guideline"

Developed a data infrastructure since 2020 to support "AI/Analysis-Ready Datamarts"

Health System EHR Data
> 4.6 million M Health Fairview Epic since 2011

Intraoperative and Procedural Videos

Operative Videos!

Device Data
- ❖ Staplers
- ❖ Ventricular Assist Device
- ❖ Robotic
- ❖ Neurosurgical
- ❖ NPWT (i.e. Abthera)

- ❖ 7 PB of images
- ❖ 0.6 billion clinical notes
- ❖ + ECG, EEG, pathology, and other notes
- ❖ ECG images

Manual Disease Registries
NAACR (Cancer)
TQIP (Trauma)
NSQIP (Surgery)
GWTG (Stroke)
Etc…

LHS Data Platform

CQODE Data Core
2 Directors
1 Administrator
2 Project Managers
1 Regulatory Specialist
1.0 FTE Solutions Architect
8.5 FTE Data Analysts
3.0 FTE ETL
2.0 FTE SQL Analysts
Over 20 Clinicians assisting

Omics Data
Proteomic, Transcriptomic, Metabolomic, Cell Surface Markers, Immunologic

EMS EHR
Imagetrend and Zoll

Death Certificate Database
Immunization Database
Well Water Database
Wastewater Database
Radon Database

3rd Party Data

Environmental / Pollution Data:
- ❖ EPA, ERS, CACES Databases

Social Determinants of Health
- ❖ 11 SDoH
- ❖ Gender Identity
- ❖ Sexual Orientation

RPM Devices

Bluetooth Home Scales
Bluetooth Home Spirometers
Patient Mobile Applications

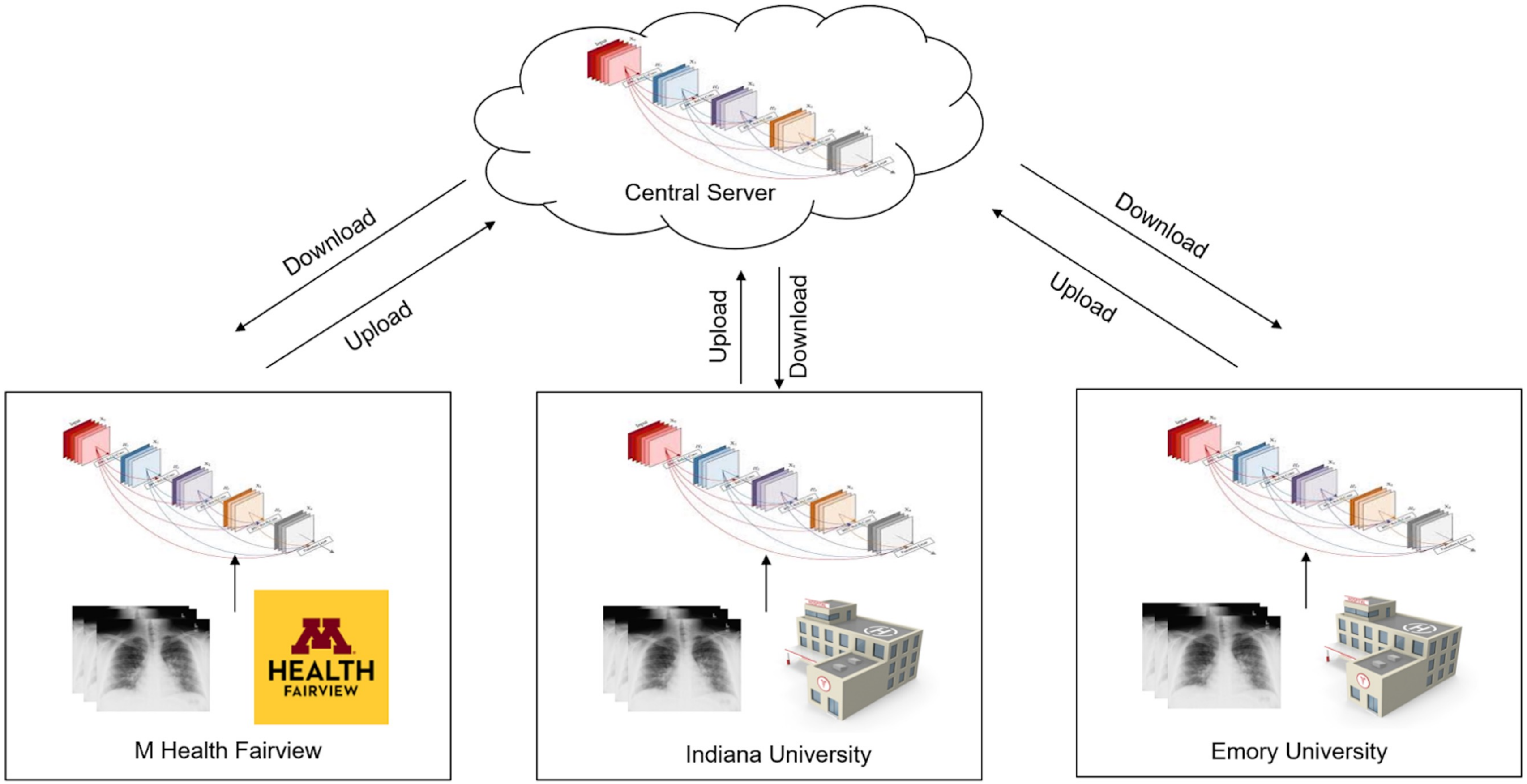
"US Healthcare Federated Learning Collaborative" – Founded in 2020

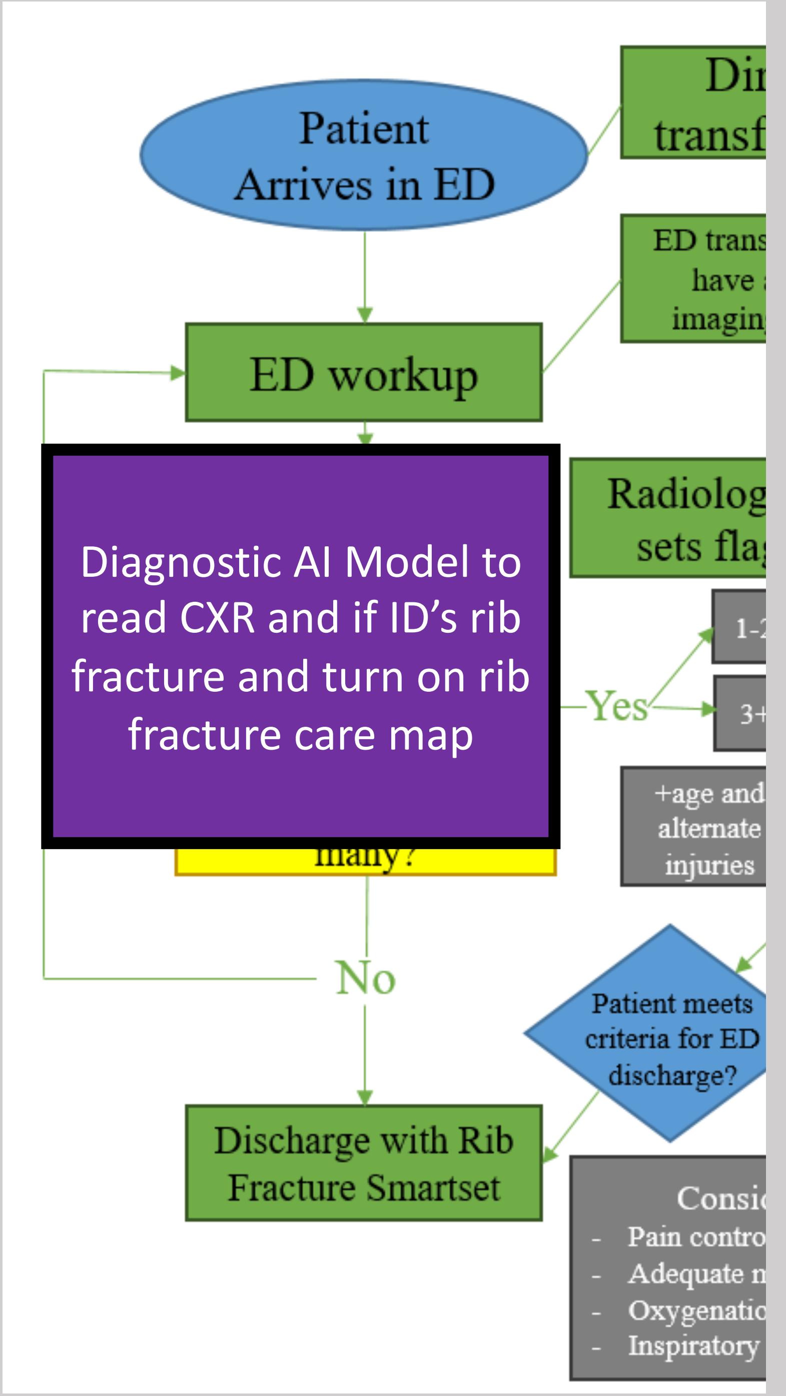
<u>Federated partners</u>

1. M Health Fairview
2. Indiana University
3. Emory University
4. University of Florida Gainesville
5. Medical University of Carolina *(In Progress)*
6. University of North Carolina (UNC) *(In Progress)*

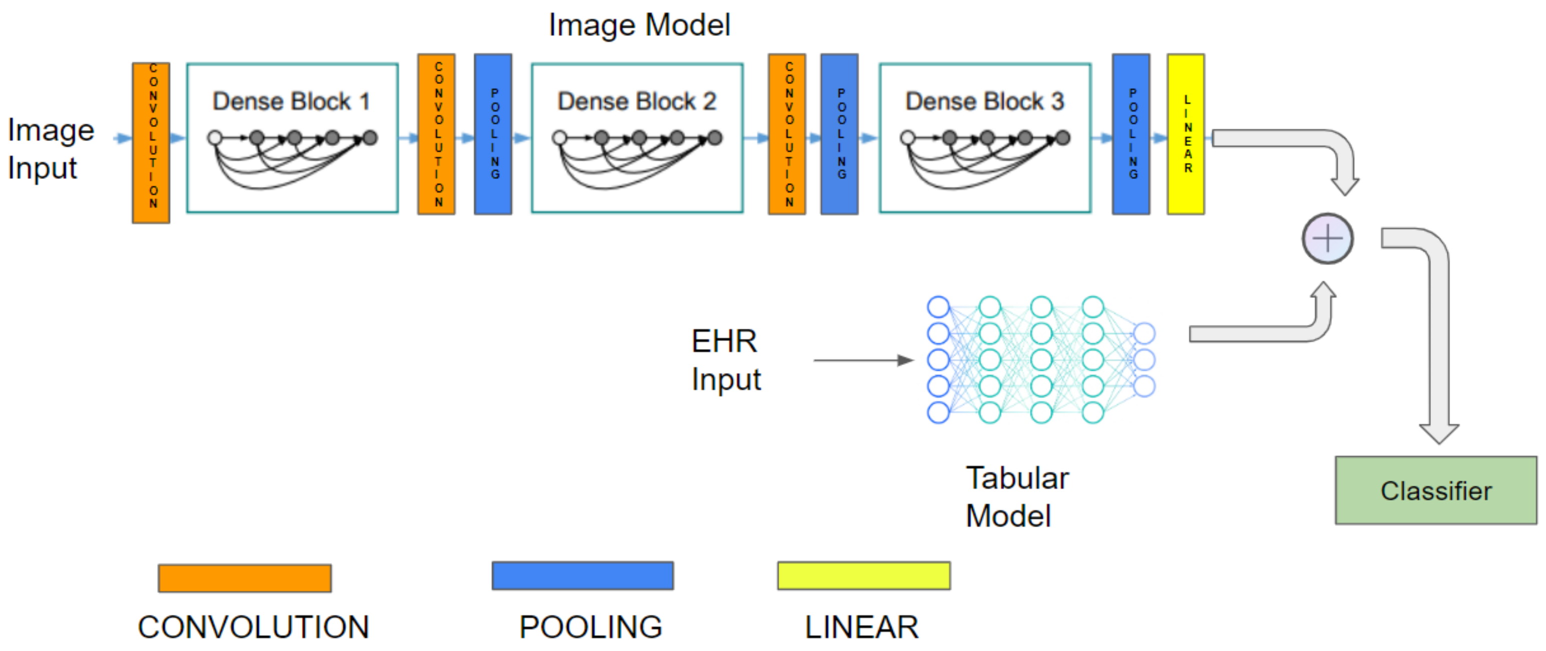
<u>Corporate Partners:</u>

- CISCO
- Nvidia
- Microsoft AI for Health





Rib Fracture AI Diagnostic Model



Institution	N	AUROC	Specificity	Sensitivity
MHFV	3738	0.89	0.83	0.84
UF	343	0.79	0.73	0.74
Indiana	5550	0.75	0.67	0.71

In conclusion, to enable the future digital transformation of trauma evidence-based practice

- Current medical practice routinely fails to delivery evidence-based care
- Technological advances can expedite the evidence to guidance process in a more efficient, computational, and interoperable manner
- AI can enable personalized care and be readily integrated into decision support systems
  - But AI requires new methods for data management

We need to partner together to do this as a medical discipline ideally as a **pilot** across 5-6 trauma systems in conjunction with medical societies, decision support vendors, and the tech industry with financial support from the ACS

We can serve as a model for the entire field of medicine

The Learning Health System integrates three disciplines: EBM + AI/ML + CDS

Advanced in Evidence-based Medicine (EBM)

Evidence to Practice Gap

Clinical Decision Support Systems (CDS)

Physician Cognitive Overload

Data Analytics (AI/ML)

One Size Fits All Approach