Transforming Validated Clinical Research into the new Cerner and EPIC App Stores (SMART FHIR)

Iltifat Husain MD
Co-founder, IMPATHIQ
Assistant Professor of Emergency Medicine
Wake Forest School of Medicine
Overview

- Brief Summary of Our Chest Pain Research
- Our Implementation of CDS into the EHR (Traditional Method)
- Creating an iOS Application
- Learning About FHIR and the Novel EHR App Store Model
- Implementation of CDS with the EHR App Store Model
- Data Extraction Opportunities with the New App Store Model
- Case Study on the Cambridge Health Alliance Implementation
Learning objectives

- Understand differences between traditional EHR builds compared to the new App Store model
- Understand why FHIR alone is not a game changer, but addition of EHR App Stores is the transformative aspect
- Understand the new opportunities the EHR App Store Model presents for Hospital systems to improve clinical practice, reporting, and patient outcomes.
- Understand how to build a FHIR app and where to start
5,000 emergency departments

8,000,000 chest pain visits
>50% admission rate

<10% diagnosed with ACS
$13,000,000,000 in chest pain evaluations

2-4 out of 100 have missed ACS
Grant Funding

Over $2 million in funding supported the development and clinical validation of HEART Pathway

- T-32 Training Grant
- Randomized Clinical trial Study
- Implementation Study
- Multi-site implementation study
- Multi-site Essay Validation Study
- Pre-hospital applications study

Sponsor directives to translate from research to product
The HEART Pathway randomized clinical trial: identifying emergency department patients with acute chest pain for early discharge, Circulation 2015 Link

Cost Analysis of the HEART Pathway Randomized Control Trial, AJEM Link

HEART Pathway accelerated diagnostic protocol implementation: prospective pre-post interrupted time series design and methods, JMIR 2016 Link

A multidisciplinary self-directed learning module improves knowledge of a quality improvement instrument: the HEART Pathway, J Healthcare Quality 2016 Link

Adherence to an accelerated diagnostic protocol for chest pain: secondary analysis of the HEART Pathway randomized trial, AJEM 2016 Link

Chest pain risk stratification: a comparison of the 2-hour accelerated diagnostic protocol (ADAPT) and the HEART Pathway, Critical Pathways in Cardiology 2016 Link

Use of the HEART Pathway with high sensitivity cardiac troponins: A secondary analysis, Clinical Biochemistry 2017 Link
Results

- Enhanced Safety
  Clinically validated in RCT

- Reduced Cost
  Consistency in scores (improved upon the Heart Score)
  Over 90% physician adherence

- Better Outcomes

Results from:
Wake Forest Baptist Medical Center
> $7 million cost reduction in two years throughout the health system

*Extrapolated from cost analysis study*
Dramatic reduction in unnecessary testing

> 12 hr reduction in length of stay

< 0.4% missed acute cardiac events (Heart Score is about 2%)

Transparency in care / discharge plan
Transforming research into practice

- EHR integration of the tool
- iOS App
- FHIR EHR App Store integration
A patient presents to the emergency room with a chief complaint of chest pain.

A contextual alert is triggered in the EHR automatically or manually by the physician.

The physician is presented with the HEART Pathway within the EHR environment.

Based on the patient characteristics, consider running HEART Pathway for clinical decision support. Click here to run HEART Pathway.

The physician enters patient history, symptoms and ECG variables into the HEART Pathway.
In seconds, HEART Pathway displays a risk assessment and clinical guidance to the physician and patient team.

HEART Pathway results are inserted into the EHR documentation.

The physician cares for the patient using best clinical judgment and HEART Pathway guidance.
Lessons learned from hardcoding into EHR

• Building initial iteration took hundreds of hours, but was surprisingly the easiest aspect

• What was difficult:
  – EHR Versioning
  – Updates, optimizations to workflow
  – Updates to actual protocol
  – Accessing data sets
Exporting Data

The most difficult pain point – obtaining clean data sets

Pain Points:
- Data isn’t stored in a clean method
- Clarity database
- SQL
- Significant FTE usage for Data cleaning and validation
Adherence

• In order to achieve adherence best practices reporting is critical
  – Achieved > 90% adherence by performing clinical practice feedback
  – Custom EPIC report writing
    • Dedicated FTE
Transforming research into practice

- EHR integration of the tool
- iOS App
- FHIR EHR App Store integration
"Dammit Jim, I'm a doctor not a software developer"
iPhone App and Metrics

- **Product Page Views**: 7,702
- **App Units**: 10,422
- **Sessions**: 22,891
- **Active Devices (Monthly Average)**: 241

**App Units by Territory**
- United States: 6.05K
- China: 2.47K
- Canada: 350
- United Kingdom: 174
- Australia: 169
Lessons learned from creating an iOS App

• SWIFT
• Analytics tracking
• Great model for testing demand
Transforming research into practice

- EHR integration of the tool
- iOS App
- FHIR EHR App Store integration
**Provider Authentication**
* EHR bridges single sign-on with FHIR token
* Reduces passwords user needs to remember
* Speeds up the launch sequence

**Read Access**
* Query discrete observations (labs, PMH, vitals, demographics, etc)
* Incorporate into run sequence
* Improves runtime and accuracy of inputs

**Write Access**
* Create record in EHR after runtime is complete
* Store results directly in the patient medical record
* Log record of use
Developer ecosystem

Open collaboration

Cerner Open Developer Experience

Connect

Ignite APIs for Millennium

Create application

Create application

Install

Clients

Discover and install

DEVELOPERS

Validated

Publish

app gallery

Publish

Cerner code
App Store Model
[Apple / Google Model]

Epic

App Orchard Store

Physician or Patient Centric App

Cerner

App Store

H H H H

H H H H
FHIR + App Stores = Transformative

= Scalable
FHIR

EHR Read Access

Physician or Patient Centric App

Database Architecture

EHR Write Access
After validation, EPIC APP Orchard Store
HEART PATHWAY
EHR Apps function “Within” the Chart

- Same iFrame
- Native experience
- Within the workflow
There are two ways to launch HEART Pathway:

1. **A BPA** will fire with a link to HEART Pathway, for any patient that meets the following Criteria:
   a. Patient age >21
   b. Chief Complaint of Chest Pain
   c. Provider orders Troponin

2. By clicking the **HEART Pathway Activity** found on the right hand side of the screen, *as seen below*.
   a. This will launch the HEART Pathway, click Confirm.
HEART Pathway

Select risk factors:

- Prior stroke
- Peripheral artery disease
- Smoking in last 90 days
- Currently treated diabetes
- FH of CAD (1st relative < 55)
- Hypertension
- Hypercholesterolemia
- BMI ≥ 30 kg/m²

Next
HEART Pathway

Select ECG findings:

- Repolarization abnormalities
- Nonspecific T-wave changes
- Nonspecific ST changes
- Bundle branch blocks
- Pacemaker rhythms
- Left ventricular hypertrophy
- Early repolarization
- Digoxin effect

Next
HEART Pathway

Results and Recommendations

Hear Score 5
High Risk

Recommendation: Your patient is at risk for ACS! Further cardiac evaluation including serial troponins and stress testing or angiography is recommended.

Clinical Data

The following are present
Click the X to remove it.
- Pinpoint/well-localized
- Sharp
- Peripheral artery disease
- Currently treated diabetes
- BMI ≥ 30 kg/m²
- Nonspecific ST changes
- Over 64

The following are absent
Click the + to add it.
- Middle- or left-sided
- Relieved by nitroglycerin
- Diaphoresis
- FH of CAD (1st relative < 55)
- Repolarization abnormalities
- Pacemaker rhythms
- Digoxin effect
- Heaviness, pressure, or tightness
- Nausea or vomiting
- Smoking in last 90 days
- Hypertension
- Nonspecific T-wave changes
- Left ventricular hypertrophy
- Worse with exertion
- Radiation to arms/jaw/neck
- Prior stroke
- Hypercholesterolemia
- Bundle branch blocks
- Early repolarization

HPI Generator
Save to EHR
From the Flowsheets activity, you can view the data pulled in from your review.

Paste text from the HPI Generator

Use the HPFLOW SmartText to pull in the Flowsheet data for this review

The patient's chest pain is not middle- or left-sided and does not radiate to the arms/jaw/neck. The patient denies diaphoresis. The patient has smoked in the past 90 days. The patient has no history of stroke, has no relevant family history of coronary artery disease (first degree relative at less than age 65) and has no history of hypercholesterolemia.
Select patient’s symptoms:

- Middle- or left-sided
- Pinpoint/well-localized
- Heaviness, pressure, or tightness
- Sharp
- Worse with exertion
- None of the above
HEART Pathway

Results and Recommendations

Hear Score

Low Risk

3

Recommendation: Your patient has a LOW RISK HEAR score. Please obtain serial troponins at 0 and 3 hours. If serial troponins are negative, the HEART Pathway recommends discharge from the ED without stress testing or angiography.

Clinical Data

The following are present

- Pinpoint/well-localized
- BMI ≥ 30 kg/m²
- Over 64
- Sharp

The following are absent

- Middle- or left-sided
- Worse with exertion
- Radiation to arms/jaw/neck
- Diaphoresis
- Peripheral artery disease
- Currently treated diabetes
- Hypertension
- Repolarization abnormalities
- Nonspecific ST changes
- Pacemaker rhythms
- Early repolarization

- Heaviness, pressure, or tightness
- Relieved by nitroglycerin
- Nausea or vomiting
- Prior stroke
- Smoking in last 90 days
- FH of CAD (1st relative < 55)
- Hypercholesterolemia
- Nonspecific T-wave changes
- Bundle branch blocks
- Left ventricular hypertrophy
- Digoxin effect
SMART, FRED RICK (71 yrs.)

HEAR Score: 3

Your patient has a LOW RISK HEAR score. Please obtain serial troponins at 0 and 3 hours. If serial troponins are negative, the HEART Pathway recommends discharge from the ED without stress testing or angiography.

Result type: Depart Summary
Result date: October 31, 2017 9:48 AM CDT
Result status: Auth (Reviewed)
Result title: Heart Pathway Summary Note
Performed by: ImpathQ, PW on October 31, 2017 9:48 AM CDT
Verified by: ImpathQ, PW on October 31, 2017 9:48 AM CDT
Encounter info: 399303487, Baseline East, Inpatient, 9/11/2016 -
Continuously updated and Validated Pathways and Apps

- HEART Pathway™
- Sepsis
- Patient Safety
- Code Stroke
- Checklist #1
- Compliance Reporting
- Custom Protocols

IQ Engine

- Clinical Decision Support
- Optimization, Custom Reports, Research Opportunities, Machine Learning

IQ Engine Provides the “handshake” between EMR and Pathways

Hospital System EMR

- Epic
- Allscripts
- Cerner

Actionable health informatics insights pulled from EMR

Mobile phone connectivity

One click reporting for Auditing and Safety

Accreditation compliance

Auditing and optimizing EMR pathways

Interoperable with multiple EMRs

Plug and Play (FHIR): minimal work required by Hospital’s clinical informatics team
Data Analytics and Insights

Practitioner Compliance

<table>
<thead>
<tr>
<th>Practitioner</th>
<th>All Time</th>
<th>Past week</th>
<th>Past month</th>
<th>Past quarter</th>
<th>Past Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reid, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alicia, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bess, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traci, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carri, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raisa, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosie, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hollie, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domingo, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rigoberto, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delicia, MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score Distribution

<table>
<thead>
<tr>
<th>All Time</th>
<th>Past week</th>
<th>Past month</th>
<th>Past quarter</th>
<th>Past Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

0 10 20 30
Clinical Performance Analytics

ACTIVE DOCTORS
46

TESTED PATIENTS
138

HOURS SAVED
1,656

OVERALL SAVINGS
$96,600
Opportunities
What you can do with FHIR

**Patient Portal**: Patient Feedback / Following up with patients in trials

**Targeting** specific patients for enrollment in trials

**Patient Portal**: Collect survey data or create patient centric tools via the Portal

Launching EHR integrated apps for best practice pathways (e.g. oncology, cardiovascular protocols)

Creating pathology specific data sets (for machine learning, research, AI)

**Multi-Center studies** (One build crosses platforms, and store in a central database)
Benefits of FHIR and App Stores

- **Scalable** (custom builds for each hospital are no longer required)
- Real time clinical metrics and patient data exportation, dramatically reduce time for cleaning data sets
- Crosses over EHRs (EPIC, Cerner, Allscripts): Perfect for Research
- Rapidly change and optimize clinical protocols without going through hospital informatics team
- Compared to traditional EHR builds, much more cost effective
- Perform integrations remotely and access clinical data remotely
Ability to rethink the EHR experience
Sepsis Huddle App

- Team based sepsis approach
- Checklist driven care
- Dedicated EHR sepsis management
- Instant outcomes reporting and Auditing
## Sepsis Huddle App

<table>
<thead>
<tr>
<th>Provider Goals</th>
<th>Nursing Goals</th>
<th>Clinical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactate Ordered</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Blood Cultures Ordered</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Antibiotics Ordered</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>30 mL/kg Ordered</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Repeat Lactate Ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reassessment of Volume Status</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Clinical Data

- Has patient been hypotensive?
  - **YES**
  - **NO**

- Initial lactate:
  - **< 2**
  - **2 - 4**
  - **> 4**

- Did patient respond to fluids?
  - **YES**
  - **NO**
Sepsis Huddle App

- Lactate Drawn
- Blood Cultures Drawn
- Antibiotics Administered
- 30 mL/kg Administered
- Repeat Lactate Drawn
- Discuss Volume Status Reassessment w/ Provider
Sepsis Huddle App
FHIR and Clinical Performance Analytics

- Adherence Tracking
- Clinical throughput tracking
- Rapidly optimize clinical protocols
- Incentive driven care
Building a FHIR App in the EHR App Store

- Figure out your scope
- Patient Facing or Physician Facing
- What are the resources you will need to access from the EHR?
  - Labs, vitals, patient demographics, past medical history, social history, medication lists
- What do you want to write back to the EHR?
  - Calculations, decision support, patient feedback
- Is a backend database required?
  - Tracking behavior, results, creating data sets
Building a FHIR App in the EHR App Store

Basic Skills:
- HTML / CSS / JS
- REST API Experience
- OAUTH Experience

Advanced Skills:
- Server-side language (Golang / Node.js / Python / Rust / PHP / Ruby)
- MS / Linux Server Administration / Architecture Experience
- Database Architecture / Modeling / Security
- "Full Stack" developer
Disadvantages of App Stores

- New technology / unfamiliarity
- Complete FHIR specs are not enabled at this time
- Overpromises in the past hinder the present
- Linking triggers in workflow
- No background fetching
THANK YOU

For a FHIR EHR App Store resource

List: catherine@impathiq.com
Workflow for Hospital Pathways with IQ Engine

EMR Used by Healthcare team

1. Healthcare team Sees Patient
2. EMR Used by Healthcare team
3. IQ Engine triggers Intelligently
4. Data is stored for admin use to provide actionable insights.
5. Data is applied to patient care
6. Data is saved in the EMR

- Launches pathway
- Bidirectional exchange of data with EMR
- Runs algorithms
- Gives clinical suggestions

PATIENT
Custom Pathways and apps can easily be developed for Hospitals by utilizing the iQ Engine
IQ Engine gives leadership new tools

- Usage and Adherence tracking
- Best practices training and compliance
- Populations
- Health Metrics
- Analytics across EHRs
- Analytics across different hospital systems
- Accreditation and reimbursement reporting
# HOW IMPATHIQ EMPOWERS HOSPITAL SYSTEMS

## Clinical Decision Support Pathways
- Evidence Based
- Clinically Validated
- Results Driven

## IQ Engine Informatics
- EMR Interoperable
- Cloud Enabled
- HIPAA Compliant

## Clinical Decision Support Pathways
- Meds/Tests
- Triage
- Admissions
- Length of Stay

## Optimizing Healthcare Administration
- Legal Risk
- Consistency
- Accreditation
- Financials
Costs of App Stores

- Ranging from $5,000 to $15,000 for publishing apps
- Costs associated with data transactions
- 20% revenue from sale of apps
Acknowledgements

ILTIFAT HUSAIN, MD
Emergency Medicine
Founder of iMedicalApps.com
Medical Informatics Expert

SIMON MAHLER, MD
Emergency Medicine
Clinical Research Expert
Principle Investigator of HEART Pathway

SCOTT GILMORE, MD
Emergency Medicine
Software Design
Medical Informatics and Machine Learning Expert