Geisinger inter-APP-ability:
Experience with SMART/FHIR

Alistair Erskine, MD
Chief Clinical Informatics Officer
Geisinger Health System
Multispecialty group
- ~1,220 physician FTEs
- ~750 advanced practitioners
- 113 primary & specialty clinic sites
  - (60 community practice)
- 1 outpatient surgery center
- ~2.8 million outpatient visits
- ~430 resident & fellow FTEs
- ~335 medical students

- 6 hospitals (Pending: AtlantiCare)
- 4 outpatient surgery centers
- 2 Nursing Homes
- Home health & hospice services
- >100K admissions/OBS & SORUs
- 2,045 licensed inpatient beds

- ~500,000 members (including ~100,000 Medicare Advantage members and ~132,000 Medicaid members)
- Diversified products
- ~50,000 contracted providers/facilities
- 43 PA counties
- Offered on public & private exchanges
- Members in 5 states

Moody’s Aa2/Stable
Standard & Poor’s AA/ Stable
The Learning Health System – IOM series

“progress in science, informatics, and care culture align to generate new knowledge as an ongoing, natural byproduct of the care experience, and seamlessly refine and deliver best practices for continuous improvement in health and healthcare.”
Hardwire Learning

Center for Clinical Innovation

Geisinger Center for Healthcare Systems Re-Engineering

Center for Emerging Technology & Informatics

Institute for Advanced Application
Transforming healthcare through continual innovation & reengineering
Applied Research and Clinical Informatics

EHR Optimization and Apps

Care Gaps
72-hr readmission
OpenNotes
EHR Apps

EDW and Data Science

EDW/Big Data
Genomics
i2b2/REDCap

Bluetooth Scales
OpenNotes
eICU
Patient Mobiles
Learning Health System enabled by HIT

- **Analyze**
  - Visualization
  - Data Discovery
  - Action
  - Master Data

- **Innovate**
  - EnrG | Rheum
  - SuperNote
  - Compass

- **Change Behavior**
  - ProvenCare®
  - Care Gaps®

Step 3
Scaling and Generalizing

**GEISINGER**

**CORE OPERATIONS**

*Mission*: Execute Core Business / Innovate

---

**PRODUCT DEVELOPMENT & SERVICE DELIVERY**

*Mission*: Generalize / Disseminate / $ Return

---

**IP Development & Refinement**

**Geisinger Health Plan**

**Quality & Safety**

**Research**

**Geisinger Support Services**

**Clinical Enterprise**

**Innovation & Transformation**

---

**IP Productization**

**xG Health**

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**Transformation Roadmap**

**Leadership & Governance**

**Care Design/Delivery**

**Analytics Services**

**EHR Optimization**

**Multi-Payer Solutions**

---

**Reduced Cost of Care**

**Improved Quality and Coordination of Care**

**Improved Clinical Outcomes**

**Improved Patient & Provider Satisfaction**

---

**Step 4**
Disruptive Innovation & Value Reengineering

- Population Identification
- Bundle Development
- 100% Care Processes and Protocols (Digital)

Patient and condition

Regular Care
Workflow Modification
Delegation and Algorithms
Automation
Patient Activation

Efficiency and Reliability

Low
High
ProvenCare® CHRONIC DISEASE

Portfolio of ProvenCare® Chronic Disease Programs

- Diabetes
- Congestive Heart Failure
- Coronary Artery Disease
- Hypertension
- COPD
- Prevention Bundle
## Improving Diabetic Care for 30,005 patients

<table>
<thead>
<tr>
<th></th>
<th>3/06</th>
<th>1/14</th>
<th>12/14</th>
<th>1/15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Patients</strong></td>
<td>20,178</td>
<td>27,459</td>
<td>29,805</td>
<td>30,005</td>
</tr>
<tr>
<td><strong>Diabetes Bundle Percentage</strong></td>
<td>2.4%</td>
<td>13.7%</td>
<td>19.1%</td>
<td>18.5%</td>
</tr>
<tr>
<td>% Pneumococcal Vaccination</td>
<td>59%</td>
<td>79%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>% Microalbumin Result</td>
<td>58%</td>
<td>80%</td>
<td>76%</td>
<td>76%</td>
</tr>
<tr>
<td>% HgbA1c at Goal</td>
<td>33%</td>
<td>47%</td>
<td>50%</td>
<td>49%</td>
</tr>
<tr>
<td>% LDL at Goal</td>
<td>50%</td>
<td>60%</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td><em>Change to @ Goal on patient list July 2014</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% BP at Goal</td>
<td>39%</td>
<td>79%</td>
<td>76%</td>
<td>76%</td>
</tr>
<tr>
<td><em>Change to @ Goal on patient list July 2014</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Documented Non-Smokers</td>
<td>74%</td>
<td>85%</td>
<td>85%</td>
<td>85%</td>
</tr>
</tbody>
</table>
ProvenCare® Type 2 Diabetes
Value Driven Care Outcome Improvements

Heart Attack
- Less than 3 years
- 305 prevented with estimated savings of $27,111/case = $8.3M

Stroke
- Less than 3 years
- 140 prevented with estimated savings of $2,921/case = $412K

Retinopathy
- Less than 3 years
- 166 cases prevented!
- Quality of life maintained
- Savings…priceless

Primary Care Diabetes Bundle Management: Three-Year Outcomes for Microvascular and Macrovascular Events (FBloom; T.Graf; W.Stewart; G.Steele, et. al., June 2014 (20(6); 175-182)
ProvenCare® Portfolio

ProvenCare®:

- ProvenCare® Autism
- ProvenCare® Bariatric Surgery
- ProvenCare® Cellulitis
- ProvenCare® COPD
- ProvenCare® Coronary Artery Bypass Graft (CABG)
- ProvenCare® CNS Mets
- ProvenCare® Epilepsy
- ProvenCare® Fragility Hip Fracture
- ProvenCare® Heart Failure
- ProvenCare® Hepatitis C
- ProvenCare® Hysterectomy
- ProvenCare® Inflammatory Bowel
- ProvenCare® Lung Cancer (CoC Collaborative)
- ProvenCare® Lumbar Spine
- ProvenCare® Migraine
- ProvenCare® Multiple Sclerosis
- ProvenCare® Percutaneous Coronary Intervention (PCI)
- ProvenCare® Perinatal
- ProvenCare® Psoriasis
- ProvenCare® Rectal Cancer
- ProvenCare® Rheumatoid Arthritis
- ProvenCare® Total Hip
- ProvenCare® Total Knee

ProvenCare® Evidence-Based Guidelines (EBG) (in conjunction with PRIDE):

- Chest Pain – R/O MI (ED)
- Kidney Stone (ED)
- Newborn Protocols
- Pediatric Abdominal Pain (R/O Appendicitis (ED))
- Pediatric Head Injury (ED)
- Pediatric Pulmonary Embolism (ED)
- Sepsis (ED) & Sepsis (Med/Surg)
- Vent Management

Portfolio as of: 01/23/15
ProvenHealth Navigator® Results

- Acute care admissions: 27.5%
- All-cause 30-day readmissions: 34%
- ED visits remain flat

Demonstrated improvement in the risk of heart attack, stroke, and retinopathy in individuals with diabetes:
- 3-year results in 25,000 patients:
  - 305 MIs prevented
  - 140 strokes prevented
  - 166 cases of retinopathy prevented

Patients say quality of care improved when they worked with a case manager:
- 72.7%

Outcomes represent the period 2007—2012 among more than 80,000 Geisinger Health Plan members in Geisinger Health System practices.
Best-of-Breed (1990s)

• Tailored workflows
• Complex architecture
• Difficult to maintain

Ref: NIH Clinical Research Information System available at http://cris.cc.nih.gov/images/Figure_2-lg.png
Monoliths (2000s)
• One database
• Easier to maintain
• Customizations
Tower of Babel

Painting: Pieter Bruegel the Elder c. 1563

**CHIN**: Community Health Information Network
- **1990s**

**RHIO**: Regional Health Information Exchange
- **2000s**

**HIE**: Health Information Exchange
- **2010s**

**Apps**: Use SMART on FHIR resources
- **next**
Inter-APP-able - Geisinger/xG Health Solutions

SuperNote

Rheum App

Compass

Innovation
Invented at Geisinger

Stable framework
Commercially Available

Ordering System
Notes System
Decision Support

there is a better way
Rheum App: Key Improvement Domains

• Empowering the Provider
• Improving Efficiency and Productivity
• Better more Cost Effective Decision Making
• Improving Quality of Care

Key Point: Design to co-exist and augment EHR capabilities; Not design to replace the EHR
Rheum App Achievements

• Grants and Contracts
  • AHRQ, AMGA, and Pharma Grants - $382,000
  • MedMining Opportunities ($1.37 million)

• Patent Pending
  • Submitted 9/12/13 - U.S. Continuation Patent Application No. 14/448,211

• National Presentations (5)
  • ACR Quality Performance Indicators for Rheumatoid Arthritis
  • Rheumatology Dashboard – An Efficient Summary that Alters Physician Treatment
  • Rheumatology Touchscreen Questionnaire - Improve Efficiency/Care
  • Rheumatoid Arthritis Quality Measure Bundle – Development and Implementation
  • Rheum PACER – Design, Implementation, and Adoption

• Manuscripts in Top Peer-reviewed Journal (2)
  • Newman ED, Lerch V, Billet J, Berger A, Kirchner HL. *Improving the Quality of Care of Patients with Patients with Rheumatic Disease Using Patient-Centric Electronic Redesign Software.* Arthritis Care and Research 2014; DOI 10.1002/acr.22479
Improving Quality (2,378 RA patients)

Figure 2. AIM FARTHER quality measure improvement at 22 months

- RA on DMARD: 88% to 90%
- Active RA on DMARD: 52% to 35%
- RA at Low Disease Activity: 53%
- TB testing on biologic: 75%
- Influenza Vaccine: 59%
- Pneumococcal Vaccine: 59%
- LDL Checked: 72%
- All or None Bundle: 22%

*p < 0.001
**p = 0.038
+p = 0.058
Rheum App: Reducing Cost

Biologic De-escalation Analysis CY 2013*

<table>
<thead>
<tr>
<th>Total Number of patient charts for review</th>
<th>940</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients De-escalated</td>
<td>87 (9.3%)</td>
</tr>
<tr>
<td>Number (%) of Successful De-escalations</td>
<td>74 (85.1%)</td>
</tr>
<tr>
<td>Total Savings</td>
<td>$719,702</td>
</tr>
<tr>
<td>1 year Extrapolation for Successful De-escalations</td>
<td>$1,256,886</td>
</tr>
</tbody>
</table>

*Session "Rheumatoid Arthritis - Clinical Aspects II: Remission and De-escalation of Therapy", Presentation #941 on 11/16/14
Conversion to SMART/FHIR: Timelines

- **FIRST WORKING MEETING WITH CERNER – OFFICIAL DEVELOPMENT KICK OFF**
  - Aug 14

- **NEW VERSION OF ENRG™ READY FOR xG DEPLOYMENT**
  - Sept 5

- **xG SERVER READY AND SUCCESSFUL DEPLOYMENT**
  - Sept 16

- **SECOND WORKING MEETING WITH CERNER – ALL CALLS WORKING BY END OF SESSION**
  - Oct 2

- **COMPLETE POC**
  - Oct 9

**40 Business days**
Before FHIR: Epic Application Integration

- External Application in a Side-by-side implementation

Rheum App

Nightly Download Data from Epic up to today

Real-time data Current (today) data only during encounter
After FHIR: Cerner Application Integration

• External Application Embedded In EHR Workflow

Rheum App

Real-time data
Current and historical data
during encounter
<table>
<thead>
<tr>
<th>Function</th>
<th>Pain</th>
<th>Review of Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Joint Pain</td>
<td>Pain (0-10)</td>
</tr>
<tr>
<td>Global</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>Pain</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Stiffness</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Rapid3 (Low dz activity ≤ 6)</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

**Since Last Visit**

<table>
<thead>
<tr>
<th>Event</th>
<th>Y/N</th>
<th>Reason for Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Illness</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Fracture</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Yes</td>
<td>Knee Surgery</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Accident</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>New Symptom</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Med Side Effect</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Marital Change</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

**Family HX**

<table>
<thead>
<tr>
<th>Family History</th>
<th>Event</th>
<th>Y/N</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheum Arthritis</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lupus</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle Disease</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psoriasis</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ank Spondylitis</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroid Disease</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Immune</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Social History**

<table>
<thead>
<tr>
<th>Social History</th>
<th>Event</th>
<th>Work Status</th>
<th>Employed Full Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupation</td>
<td>Teacher</td>
<td>Lives with spouse</td>
<td></td>
</tr>
<tr>
<td>Home Status</td>
<td>3 or more times per week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>Bachelor's Degree</td>
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<td></td>
</tr>
<tr>
<td>Education</td>
<td>Denies Alcohol Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>Never Smoker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls past month</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of Cane</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of Walker</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Nursing

**Events Since Last Visit (or 3 mo if new patient)**

<table>
<thead>
<tr>
<th>Event</th>
<th>Y/N</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Illness</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Fracture</td>
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<td></td>
</tr>
<tr>
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<tr>
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</tr>
<tr>
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<tr>
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</table>

**Social History**

<table>
<thead>
<tr>
<th>Work Status</th>
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</thead>
<tbody>
<tr>
<td>Occupation</td>
<td>Teacher</td>
</tr>
<tr>
<td>Home Status</td>
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</tr>
<tr>
<td>Exercise</td>
<td>3 or more times per week</td>
</tr>
<tr>
<td>Education</td>
<td>Bachelors Degree</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Denies Alcohol Use</td>
</tr>
<tr>
<td>Smoking</td>
<td>Never smoker</td>
</tr>
<tr>
<td>Falls past month</td>
<td>No</td>
</tr>
<tr>
<td>Use of Cane</td>
<td>No</td>
</tr>
<tr>
<td>Use of Walker</td>
<td>Yes</td>
</tr>
</tbody>
</table>

If patient global has not been completed, please ask the patient: Considering all the ways in which your illness may affect you at this time, how are you doing, on a scale of 0-10, 0 being very well and 10 being very poorly.

Patient Global (0-10): 8
Real-time results
Trend over time
<table>
<thead>
<tr>
<th>Measure</th>
<th>Today's Value (Date)</th>
<th>Previous Value (Date)</th>
<th>First Value (Date)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patient Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDHAQ (0-10)</td>
<td>9 (4/6/2015)</td>
<td>8 (1/14/2015)</td>
<td>2 (1/11/2012)</td>
</tr>
<tr>
<td>Pain VAS (0-10)</td>
<td>9 (4/6/2015)</td>
<td>8 (1/14/2015)</td>
<td>1 (1/11/2012)</td>
</tr>
<tr>
<td>Fatigue VAS (0-10)</td>
<td>8 (4/6/2015)</td>
<td>9 (1/14/2015)</td>
<td>2 (1/11/2012)</td>
</tr>
<tr>
<td>AM Stiff (0-10)</td>
<td>8 (4/6/2015)</td>
<td>7 (1/14/2015)</td>
<td>2 (1/11/2012)</td>
</tr>
<tr>
<td>Patient Global (0-10)</td>
<td>8 (4/6/2015)</td>
<td>9 (1/14/2015)</td>
<td>2 (1/11/2012)</td>
</tr>
<tr>
<td><strong>Physician Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tender joint count (0-28)</td>
<td>24 (4/6/2015)</td>
<td>22 (1/14/2015)</td>
<td>2 (1/11/2012)</td>
</tr>
<tr>
<td>Swollen joint count (0-28)</td>
<td>21 (4/6/2015)</td>
<td>19 (1/14/2015)</td>
<td>3 (1/11/2012)</td>
</tr>
<tr>
<td>Physician Global (0-10)</td>
<td>8 (4/6/2015)</td>
<td>8 (1/14/2015)</td>
<td>1 (1/11/2012)</td>
</tr>
<tr>
<td><strong>Lab/Composite</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDAI (0-76) - low activity ≤ 10</td>
<td>61 (4/6/2015)</td>
<td>58 (1/14/2015)</td>
<td>8 (1/11/2012)</td>
</tr>
<tr>
<td>Rapid3 (0-30) - low activity ≤ 6</td>
<td>26 (4/6/2015)</td>
<td>25 (1/14/2015)</td>
<td>5 (1/11/2012)</td>
</tr>
<tr>
<td><strong>Goals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDHAQ (0-10)</td>
<td>9 (4/6/2015)</td>
<td>8 (1/14/2015)</td>
<td>worse</td>
</tr>
<tr>
<td>Pain (0-10)</td>
<td>9 (04/06/2015)</td>
<td>8 (01/14/2015)</td>
<td>about the same</td>
</tr>
</tbody>
</table>
“SMART/FHIR” Rheum App: Accomplishments

- The Rheum App allowed us to transition data integration points quickly and efficiently via a data virtualization layer.
- No prior knowledge working with SMART on FHIR – team gained knowledge in the 40 day POC timeframe.
- Most FHIR resources utilized with the Rheum App at Proof of Concept completion.
- Real time data for current and historical data.
- Additional functionality coded at the time of SMART/FHIR conversion:
  - Problem list Diagnoses Insert via FHIR Services
  - Progress note Insert via FHIR Services
The Four ICSM Principles

• Stakeholder value-based guidance.
• Incremental commitment and accountability.
• Concurrent multidiscipline engineering
• Evidence and risk-based decisions.

SMART/FHIR Rheum App: Learning

Not all HIT developers are FHIR-ready:

- More negotiation about the expected attributed exchange between App and EHR is likely
- Significant amount of “code conversion” as HIT developers adapt their proprietary APIs to SMART/FHIR
- Each FHIR resource needs agreement between App and EHR on which profile to use to transmit data
- Nevertheless, most of the App code was re-usable across multiple HIT developers

Several types of Apps are emerging from exercise:

- EHR-agnostic Apps: functions purely through data exchange
- EHR-dependent Apps: combine App with ordersets/templates
- EHR embedded Apps: App entirely dependent on EHR functionality
SMART/FHIR Rheum App: Learning

Testing and Validation

– Used SMART Platform for testing*
– Created a particular dataset for validation of App-specific needs
– Only used 11 of the 49 FHIR resources for Rheum App
– Found it better to use FHIR calls in real-time rather than store in local database

Consortium/Alliances Support

– HSPC (http://healthcaresoa.org/Introduction.html)
– Project Argonaut (https://hl7-fhir.github.io/argonauts.html)
– Commonwell (http://www.commonwellalliance.org)

Questions remain:

– External Apps writing back to EHR database
– Vendor neutral “App-Store”, currently only HIT developer stores

* SMART Platform at http://www.smartplatforms.org
## SMART/FHIR Project Resources/Cost

<table>
<thead>
<tr>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 40 Business days from kickoff to completion of POC</td>
</tr>
<tr>
<td>• 31 Business days of development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programming Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 3 Web App Developers</td>
</tr>
<tr>
<td>• 1 Lead Web App Developer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programming Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 736</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programming Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>• $17,859</td>
</tr>
</tbody>
</table>