UW Medicine
Enterprising FHIR

UW FHIR Workshop
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Kevin L. Swank
klswank@uw.edu

UW Medicine Lead Enterprise Interfaces and Data Integration Architect
AGENDA

Introduction and UW Medicine

Service Oriented Architecture – putting FHIR in the bigger picture

Mayo Clinic Clinical Innovation Accelerator Pilot

Lessons learned applied to UW Medicine

Mayo Clinic Clinical Innovation Informatics Environment

OneOme, LLC MDS Use Case Example

Questions/Discussion
• Seattle, Washington area – Olympia to Bellingham
• 65,000 admissions annually
• 4 hospitals, 188 clinics, 1,544 beds, 86 operating rooms
• 1.6 million outpatient and 205,000 ED visits
• 2,483 employed faculty and 4,649 clinical faculty across the WWAMI (Washington, Wyoming, Alaska, Montana & Idaho) medical education program
• 26,000+ employees
• EpicCare for Ambulatory Cerner Millennium for Inpatient
  Valley instance of Epic NWH instance of Soarian
• New CIO – Joy Grosser
• New CHSO – Lisa Brandenburg
<table>
<thead>
<tr>
<th>Organization Unit</th>
<th>EMR</th>
<th>Integration</th>
<th>Lab</th>
<th>Path</th>
<th>Rad</th>
<th>Pharm</th>
<th>Enterprise</th>
<th>Cardiovascular</th>
<th>Periop</th>
<th>Auxiliary Systems</th>
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</thead>
<tbody>
<tr>
<td>NWH</td>
<td>Soarian</td>
<td>OpenLink</td>
<td>Sunquest LIS, Sunquest Instrument Manager, Iguana</td>
<td>Sunquest PowerPath, Tissue Tracking, Mirth</td>
<td>GE PACS*, GE RIS, Powerscribe*, TeleRad,</td>
<td>Cerner PharmNet (in), Eterby (ambul.), Pyxis, PIMS</td>
<td>3M(coding), WhiteBoards, EDW, ADFS, Mindscape, PUMA</td>
<td>MCG BreezeSuite, eMix, GE Mars and Muse, LifeImage, PaceArt, Qlab, Syngo Dynamics, TeraRecon, CareFusion VMx, and Xcelera</td>
<td>Alaris Pumps, Allscripts, Audibase, CADD-Solis Infusion pumps, Endoworks, Forum PACS, Heidelberg Eye Explorer PACS, Merge Eye Care PACS, HOPS, Maestro, Nox, N-Centaurus, OPEl, ThenDoc</td>
<td>Support Group</td>
</tr>
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<td>HMC</td>
<td>Epic Ambulatory Cerner (ORCA) – In-patient</td>
<td>Infor Cloverleaf, Go Anywhere MFT, Epic Bridges &amp; Interconnect, Cerner OpenLink, Cerner iBus</td>
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</tbody>
</table>

Support Group:
- ITS
- Laboratory
- Pathology
- Radiology
- Pharmacy
Journey of Clinical Transformation supports and enables our UW mission to Improve the Health of the Public.

One Patient, One View, One Story across the health system.

Not an IT project.

The journey will be led by our clinical and business leaders and enabled by technology.
Business and Operating Efficiencies:
• Revenue Cycle Management Improvements.
• Simplification and standardization across operations and IT.
• Optimized resource utilization.
• Platform development for future opportunities for centralized clinical and administrative services.
“The future of the EHR is going to look a lot like your [cell] phone,” predicts Stanley Crane, Chief Information Officer at Allscripts.1

“We’re really looking at this as Cerner is a platform versus a product solution,” says Zane Burke, president of Cerner. “We’ll know we’re there when you see a lot of apps on our platform.”2

Geisinger's Journey to Inter-APP-ability
https://www.youtube.com/watch?v=Z87iAYVQ2gA&feature=youtu.be&t=1414

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A service-oriented architecture (SOA) is a style of **software design** where **services are provided** to the other components by application components, **through a communication protocol** over a network. The basic principles of service-oriented architecture are independent of vendors, products and technologies.
Myth: APIs Are New; Service-Oriented Architectures Are Old

1Gartner, Basic API Management Will Grow Into Application Services Governance, G00271064, 28 October 2014
REMOVING THE CONFUSION

SOA has become confused with heavy-weight (some would say over-engineered) interfaces using SOAP/WS*.

API has become confused with lightweight, mobile-focused ReSTful interfaces.

SOA is an architectural approach

- defines, at its core, architectural best practices for building de-coupled applications and fostering service reuse

API’s are programming interfaces using SOAP/WS*, ReST, and other technical approaches

\(^2\)SOA Software, SOA and API Convergence, pg. 3, 2014
SOA AT MAYO CLINIC

- Architectural Pattern they are using to create the Mayo Clinic Enterprise API

Business Strategy and Operating Model

Elaborates and Translates

Register Patient

SOA

- Business Architecture
- Data Architecture
- Application Architecture
- Technology Architecture

Mayo Clinic Enterprise APIs

Register Patient API(s)
2016 project at Mayo Clinic to deploy a SMART on FHIR “platform” using out-of-box Epic FHIR and project developed FHIR services. Deploy a SMART on FHIR application from Smart Health IT’s App Store and build one as part of project.

Initiated on 18MAR2016 and completed NOV2016
Focus on innovation by leveraging standardized data on best software engineering standards and not on where does data exist, what format, how do I get access, what libraries to use to deliver it to my customers.
MCCIA KEY DELIVERABLES

Shared Services Components

- ALM Tools (Build, Package, Deploy of Visualizations, Templates, Libraries)
- Open Developer Network (TFSVC / GIT Repository)
- IT Education – Best Practices, API 101, HTML5
- Developers Guide and IT Hub for documentation, Standards etc.,

Platform components

- Configuration of API Platform
- Refactor CDANS to FHIR Resources
- Catalog for Internal Store
- SMART Environment (Dev, Int)
Key takeaways:

Need enterprise management of the FHIR spec
- It is very unwieldy and is still emerging
- Can quickly become a non-standard standard
- Need to identify reference and code set data that will be used in the UW Medicine implementation of FHIR
- Recommend a FHIR Steering group

Need Data Governance
- terminology, data standards, cross-references
- What are the rules of the road for data access

Identity Management and Access
- needs to be federated and support OpenID Connect (our ADFS instance does)
- how else can different systems seamlessly access each others data and functions unless they share a common source for authentication – whether internal or federated
Implement an API Management Platform

- Enables interoperability across differently sourced services by standardizing and providing API discovery, security, and other non-functional requirements
- Single “place to go” for all the UW Medicine APIs whether from an internal or external source
- Allows management and visibility into the UW Medicine services environment
- Abstracts backend complexity from consumers
- API flexibility through policies and configuration rather than coding
- Keeps API proliferation from spiraling out of control and becoming unusable

Enterprise API Team

- Direct evolution of APIs and API Platform (Incl. DevOps)
- Build Enterprise APIs as Directed
- Consult with other teams
<entry>
  <resource>
    <Patient>
      <id value="555-44-4444"/>
      <extension url="http://ihe.net/ITI-78/Profile/pdqm#mothersMaidenName">
        <valueHumanName>
          <family value="Jones"/>
        </valueHumanName>
      </extension>
      <identifier>
        <use value="official"/>
        <system value="http://ghh.org/patient"/>
        <value value="555-44-4444"/>
      </identifier>
      <identifier>
        <use value="official"/>
        <system value="http://www.ohio.gov/dmv/driverslicence"/>
        <value value="67-A4335"/>
        <period>
          <end value="2003-05-20"/>
        </period>
      </identifier>
      <name>
        <use value="official"/>
        <family value="Everywoman"/>
        <given value="Eve E."/>
      </name>
      <telecom>
        <system value="phone"/>
        <value value="(206)3345232"/>
        <use value="home"/>
      </telecom>
      <telecom>
        <system value="phone"/>
        <value value="(206)752-121"/>
        <use value="work"/>
      </telecom>
      <gender value="female"/>
      <birthDate value="1962-03-20"/>
    </Patient>
  </resource>
</entry>
<entry>
  <resource>
    <DiagnosticReport>
      <id value="1045813"/>
      <!-- Filler Order Number -->
      <contained>
        <Observation>
          <id value="observation-1"/>
          <code>
            <coding>
              <system value="http://loinc.org"/>
              <code value="1554-5"/>
              <display value="GLUCOSE^POST 12H CFST:MCNC:PT:SER/PLAS:QN"/>
            </coding>
          </code>
          <valueQuantity>
            <value value="182"/>
            <units value="mg/dL"/>
            <system value="http://unitsofmeasure.org"/>
            <code value="mg/dL"/>
          </valueQuantity>
          <interpretation>
            <coding>
              <system value="http://hl7.org/fhir/v2/0078"/>
              <code value="N"/>
              <display value="normal"/>
            </coding>
          </interpretation>
          <issued value="2002-02-15T07:30:00-04:00"/>
          <status value="final"/>
          <reliability value="ok"/>
          <subject>
            <reference value="Patient/555-44-4444"/>
            <display value="Eve E. Everywoman"/>
          </subject>
          <performer>
            <reference value="Practitioner/444-44-4444"/>
            <display value="Harold H. Hippocrates"/>
          </performer>
        </Observation>
      </contained>
    </DiagnosticReport>
  </resource>
</entry>
The following snippet shows how we’ve restricted the datatype of ‘asNeeded’ in the MedicationPrescription resource to Boolean, and also made it required, by setting both min and max to 1.

```
<structure>
  <type value="MedicationPrescription"/>
  <name value="asNeededConstraint"/>
  <element>
    <path value="MedicationPrescription.dosageInstruction.asNeeded"/>
    <definition>
      <short value="Only support boolean in the 'asNeeded' property"/>
      <formal value="Only support boolean in the 'asNeeded' property"/>
      <min value="1"/>
      <max value="1"/>
      <type>
        <code value="boolean"></code>
      </type>
      <isModifier value="true"/>
    </definition>
  </element>
</structure>
```
The following snippet shows how we've restricted the code values that can be used for medications to those defined in a ValueSet of ULM (Universal List of Medicines) codes that a GP (Ambulatory care) clinician can prescribe. We could also have used a direct reference rather than the ValueSet, but the ValueSet allows us to filter the list.

```xml
<structure>
  <type value="Medication"/>
  <name value="medicationCodeConstraint"/>
  <element>
    <path value="Medication.code"/>
    <definition>
      <short value="GP ULM Codes only"/>
      <formal value="Specify that the medication code must come from the NZ ULM codeset"/>
      <min value="0"/>
      <max value="1"/>
      <isModifier value="false"/>
      <binding>
        <name value="List of medications GP's can prescribe"/>
        <isExtensible value="false"/>
        <referenceResource>
          <reference value="http://www.nzgovt/fhir/ValueSet/ulm-gp"/>
        </referenceResource>
      </binding>
    </definition>
  </element>
</structure>
```
Master Data:
1. Patient, Customer
2. Employee, Partner
3. Location, Organization
4. Diagnosis, Service, Product
IDENTITY MANAGEMENT PLATFORM (IDMP) FRAMEWORK

Mayo Clinic IDMP Conceptual Architecture
UW Medicine Service Oriented Architecture Reference Model

Development Services
- Service Lifecycle Management
- Developer Portal
- ALM/TFS

Interaction Services
- Human Interifiable Workflow
- Portlets/Viewers
- GUI-based Applications

Process Services
- Service Orchestration
- Process Orchestration
- State Machines

Information Services
- Master Data Services
- Terminology Services
- Metadata Services

IT Service Management
- Service Management
- Security Enforcement
- Policy Enforcement
- <ITIL Processes>

Integration Layer
- Enterprise Integration Platform
  - Event Notification
  - Intelligent Routing
  - Publish/Subscribe
  - Managed File Transfer
  - Transformation Services
  - Data Caching
  - API Management
  - Adapters
  - Reliable Messaging

Partner Services
- Cloud Gateway
- API Gateway
- Device Gateway

Business App Services
- Business Services
- Composite Services

Access Services
- Data as a Service
- Knowledge as a Service

Operational Governance
- Service Registry
- Service Repository
- Policy Manager

Information Architecture
- Master Data Management
- Metadata Management
- Information Governance and Management
- Data Repositories

Quality of Service
- Security Management
- Monitoring and Management
- Policy Monitoring and Alerting

Infrastructure
(Network, Storage, Compute, Devices, ...)

Governance

UW Medicine
REQUIRED INTEGRATION CAPABILITIES

UW Medicine Enterprise Integration Platform

Application Service Management
- API Management
- API Virtualization
- API Orchestration
- Service Hosting
- Data Caching
- Cloud Gateway
- IoT Gateway
- BPM Engine
- Throttling
- External/Internal Gateway
- API Economy Support

Enterprise Service Bus
- Transformation
- Managed File Transfer
- Intelligent Routing
- Scheduling
- Queuing
- Protocol Mediation
- Message Flows
- Transportation
- Message Persistence
- Adapters
- Logging

Operational Governance
- Service Registry
- Service Repository
- Policy Manager

Quality of Service
- Security and ID Man.
- Monitoring/Alerting
- Auditing/Logging
- Configuration Management

Development Services
- ESB/API Tools
- API Lifecycle Man.
- Service Lifecycle Man.
- Developer Portal

Infrastructure
- Servers, Networks, OS, Storage, ...

Capability Provided
Capability Partially Provided
Capability Not Provided
I have to go through multiple manual steps that must be repeated for each new application...

- Almost nothing is reusable
- Resource intensive
- No single point for security, access control, auditing, monitoring, governance, ...

Delivering new functionality can take months
If I want to build a new app that is similar and uses the same data, I can just reuse the same APIs that were previously built.

- Almost everything is reusable
- Resource can move to higher value activities instead of support activities
- Still no single point for security, access control, auditing, monitoring, governance, ...
- Proliferation of APIs, who’s using them and what data are they seeing quickly becomes a management headache

Delivering new functionality can take weeks
ADDING IN THE MANAGEMENT LAYER

UW Medicine Enterprise API Management Platform

- Access Control
- Security – OAuth, SAML, ...
- Service Level Agreements - Throttling
- Auditing
- Composite API’s
- API Orchestration
- Transformation, Protocol Mediation (SOAP to REST, ...)

RESTful APIs
- WASHINGTON STATE IMMUNIZATION INFORMATION SYSTEM
- APIs by Millennium Objects
- Cerner
- Epic

ADFS 3
- Shibboleth

My APIs
- New APIs

Alerting and Analytics
- Management

UW Medicine
KEY TAKEAWAYS

- API and API Management are mature technologies that have been around for 10+ years
  - Supports the ability to access data across multiple systems (and organizations) to get data where it’s needed, when it’s needed.
  - APIs drive the internet and mobile apps today and are keys of success behind companies like Amazon and JPMorgan Chase.
  - APIs without API Management = Chaos and Missed Opportunities
- FHIR and SMART on FHIR leverage APIs – being used today by many healthcare organizations to transform healthcare delivery, support rapid innovation, and improve the experience of healthcare professionals and patients. Healthcare organizations that have led in this space have implemented API Management Platforms
- Supports dual-mode IT: Systems of Record (e.g. Epic) evolve methodically and relatively slowly, but the APIs they provide can be used to rapidly innovate and provide solutions for providers and patients
- Supports internal and external collaborations by allowing partners to share information and provide services through APIs quickly with low overhead

**Consider this:** with Meaningful Use 3, application vendors will be engaging our patients with innovative, sophisticated apps using the data from our (and other health system’s) EHRs with little to no input from us! This is likely to change patient opinions and expectations of their healthcare providers rather quickly... Are we ready?
Security
- One federated security model across all the data and business services in the enterprise – setup once and reused across all APIs; partners/collaborators use their own ID/Passwords
- Ability to audit all access to UW Medicine data and service APIs in one place
- Ability to stop a person or organization’s access to all our APIs at once

Governance
- Maintain a single point of oversight and governance of the data and resources available through APIs – it's our data and services and we should know who’s using it, how they are using it, and be able to give or remove access immediately
- Enforce policies and documentation requirements as part of API deployment workflow – do what’s required with as little overhead to users as possible
- Enforce policies uniformly across all APIs – hide the complexities of the heterogeneous UW Medicine applications and data environment behind standardized, homogeneous access points (APIs)

Speed Delivery of Applications
- Discoverability – directory of all APIs available on platform allows for fast, easy search and discovery
- API Platforms use configuration and policies instead of coding (“flipping switches”)
- Write-once, reuse over-and-over again APIs to get to the business value quickly – 1 API can be exposed in various ways to different consumers by configuration rather than re-programming
- Simple versioning of APIs – provides flexibility/agility to users by giving them additional time to change in response to new or updated applications
Collaboration

- Discover, request access, test, and provide communication channel between API owners and users (vendors, patients, providers, researchers) – crucial if users are external (e.g. patients)
- Creates a “sticky relationship” between owners and users – repeat business, increased interest in collaborations from potential partners

Reduce Costs

- Single point for security/governance instead of potentially thousands
- Directory of all APIs means they can be found – reduce redundant development
- Standards-based means more developers/vendors/tools to choose from – increased competition and lowered costs
- API reuse means less has to be developed by IT
- Plug-n-play applications provide agility as we can quickly swap and add/remove applications with limited negative impacts to other systems
The video link above shows how Mount Sinai Health System is leveraging an API Management Platform to transform healthcare, engage partners and patients, and reach people in need across the continuum of care. The vendor used by Mount Sinai is just one of several providing API Management Platforms. What API Management Platforms can enable in Healthcare is the important point, not the vendor used.
Mayo Clinic

- Clinical Innovation Informatics Environment
- Provided by Thomas Johnson, Mayo Clinic API Platform Owner

OneOme, LLC

- Molecular Decision Support
- Provided by Jason Ross, OneOme Chief Technology Officer
Clinical Innovation Informatics Environment
"That’s fine, but that’s not the criteria we would use for a defining a pilot…"

"Some parts seem like research. How much of this is Discovery?"

"Can’t you find a way to do the work in Epic?"

"You need (different) funding. We can support this, but not that."

"The software is hosted in the cloud. I don’t need IT."

"Which oversight groups need to approve?"

What does CC think?

Clinical Proponent
What is Clinical Informatics Innovation Environment?
  - An incubator for Clinical Informatics Discovery and Innovation
  - Enables informaticians discover and innovate in the field of medicine and clinical practice
  - Provides rapid development, testing, piloting and productization capabilities by leveraging and orchestration of services provided by the Enterprise

Discover -> Translate -> Apply (DTA)
  - Clinical Informatics Innovation Ecosystem supports DTA framework through tailored services, tools, and governance; collectively enabling rapid discovery and innovation

**Discover**: build insight, propose changes to standard of care, validate tools, and approach

**Translate**: demonstrate a technical and clinical pathway to adoption of what was discovered into the standard of care

**Apply**: operationalize the new insights, standard of care or tools into the enterprise-wide practice
Mayo Architecture for Digital Medicine

- Mayo Providers
- Patients
- Affiliates and Partners
- Consumers

- Mayo Innovation Sandbox & Epic Hyperspace
- Knowledge + Data Apps
- Products

- Mayo Clinic API Platform (SMART - FHIR)

- Non-Epic Applications
  - Epic APIs
  - Epic Core
  - Epic Data

- UDP
- KMDP

- Business Partner Platforms / Services

Discovery Tools (Analytics)
Technical Concept for Innovation Sandbox

- Dev Guide
- Open Developers Network
- R
- Python

Platforms
- UDP
- API
- IDMP

Infrastructure
- Networks, DCIS, Cloud

Provisioning Service Layer

ALM
- Build / Deploy
- Automated Test

Represent capabilities that can be “provisioned” to meet specific needs of sandbox environment requestors
FHIR Support – Innovation Sandbox
Reference Model

Clinical Informatics Innovation Ecosystem

Innovation and Discovery Workflow

Data Discovery
- Predictive: Tell me something that the data about this patient predicts will happen, often contingent
- Synthetic: Construct a higher level view of the patient by synthesizing new data from existing data
- Extractive: Construct a view into the patient record using advanced techniques (NLP, e.g., to regularize data only found in notes)

Construction
- Decision Models
  - Decision Model API
  - Calculators
  - Rules

Innovation Applications
- Interactive Web applications (SMART on FHIR apps)
- Clinical Workflows
- Enrichment

Clinical Pilot
- Pilot and assess if suitable for clinical adoption

Productization
- Internal product placement
- Commercial product placement

Components & Services
- Platform Portal
  - Education and awareness
  - Gallery
  - Access to Services
  - Help
- Platform Services
  - Project Service Line
  - IT Service Hooks
  - Platform Governance

Enterprise IT Assets
- Platforms
- Data Platform
- Integration Platform
- Infrastructure Platform
- ALM Platform
- IDM Platform
- EHR
- Knowledge Platform

Discovery Sandbox
- Analytics toolkits
- Discovery VMs
- Discovery Containers

Innovation Sandbox
- Developer toolkits
- Reusable components
- Web Containers

Subject Matter Experts

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Innovation SL Model

Advisory Group Review

Key Roles
- Service Line Owner
- Project Manager
- Informatics Specialists
- IT Solution Architect

Kern Center Services (as required)
- Quantitative/Qualitative Analysis
- Systems Engineering / Study design
- Knowledge Synthesis
- Human Factors / UX
- Study Coordination
- Knowledge Creation
- Knowledge Management

IT Development Shared Services
- Dedicated Mode 2 Team
- Leverages Best Software Development Practices
- Improves Innovation Sandbox Capabilities

IT Data Analysis
- IT Service Line
- Provides services to acquire and obtain data

IT Data Enrichment Service Line
- IT Service Line
- Provides services to derive and enrich data

Data Discovery
- IT Service Line
- Provides compute and analytic environments for data mining and discovery

Epic Services
- Epic Config
- Epic Products
- Provides services to use Epic capability

AHI (Augmented Human Intelligence)
Enterprise FHIR Resources in Production

- Patient
- Encounter
- Procedure
- Practitioner
- Location
- Organization
- Diagnostic Report
- Communication
- Document Reference
- Condition

- Medication
- Medication Statement
- Medication Administration
- Observation (Labs, Vitals, Assessments, IO, Smoking status)
- Allergy Intolerance
• Three main areas of focus
  • Ability to order and receive discrete results within EMR
  • Disruptive/active medication alerts
  • Passive decision support
• Which areas to implement depends on your envisioned workflow and needs
  • Each can be implemented separately
  • Each can support different requirements
EMR ORDER AND RESULTS

We provide the capability to receive orders electronically through your Epic system and return discrete results and the RightMed comprehensive test report (PDF)

- Leverages Epic’s existing HL7 reference laboratory interface
BENEFITS OF ELECTRONIC INTERFACING

- Allows all providers to find and order RightMed test within EMR
  - Defined in EMR laboratory catalog
  - Provides collection instructions
- Enables integration into providers’ ordering workflows and order sets
  - Integration into downstream collection and shipping processes
- Stores RightMed results in standard laboratory EMR views
  - Instantaneous return of results
  - Accessible to all providers (enables collaboration/sharing)
- Enables use of active alerting through EMR rules engine
  - Enables the implementation and adoption of PGx CDS rules
- Reduces the risk of transcription errors
• Provides real-time decision support within the EMR at the time of medication ordering
  • Active alerting - stops provider
  • Based on the patient’s RightMed results
  • Ability to determine when to trigger (red or yellow)
• Provides detailed information about the medication classification, genes involved, and clinical guidance
• Ability to link to RightMed Advisor
• Requires configuration/set-up on customer side
  • E.g. BPA rules that trigger when to check for OneOme results
Alerts provider of possible reduced metabolism

- Provides general guidance on dosing

Provides the genotype and phenotype derived recommendations

Allows for removal of drug order and links to RightMed Advisor
• Providers should only be interrupted for critical issues. However, they need the ability to access additional information when needed and within different workflows (e.g. review patient history, flow sheets, lab results).

• Providers often need the ability to view aggregate, disparate information within the EMR to get a holistic view of the patient.
  • Pharmacogenomic recommendations
  • Medications
  • Diagnosis
  • Medication and treatment guidelines

• To meet this need we are actively developing an EMR-embedded application
• Ability to implement within the EMR in certain applications/workflows
  • Application launches with a patient context
  • Ability to access patient information such as medications
• Provides quick view of patient’s current PGx risks
• Allows users to dig deeper into the information
• Provides instant access to all RightMed reports
  • Specialty reports
  • RightMed Advisor custom reports

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