BRMS and FHIR Integration

A User Story

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Sr. Manager Enterprise Systems, IT Group
Fresenius Medical Care
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**Fresenius Medical Care around the World**

**America**
- **Waltham, U.S.**
  - Regional headquarters North America
- **01 Ogden, U.S.**
- **02 Concord, U.S.**
- **03 Toledo, U.S.**
- **04 Montreal, CA**
- **05 Knoxville, U.S.**
- **06 Irving, U.S.**
- **07 Reynosa, MX**
- **08 Guadalajara, MX**
- **09 Santafé de Bogotá, CO**
- **10 Jaguarú, BR**
- **11 Pilar, AR**

**Europe**
- **Bad Homburg, GER**
  - Company headquarters and regional headquarters for Europe, Middle East, Africa and Latin America
- **11 Schweinfurt, GER**
- **12 St. Wendel, GER**
- **13 L’Arbresle, FR**
- **14 Palazzo Pignano, IT**
- **15 Krems, AT**
- **16 Vršac, SRB**
- **17 Antalya, TR**

**Asia-Pacific**
- **Hong Kong, CN**
  - Regional headquarters Asia-Pacific
- **18 Inukai, JP**
- **19 Buzen, JP**
- **20 Changshu, CN**
- **21 Ipooh, MY**
- **22 Ensle, MY**
- **23 Smithfield, AU**
- **24 Scoresby, AU**

**Statistics**
- **3,579 Clinics**
- **16,738 Revenue in $ M**
- **108,851 Employees**
- **306,366 Patients**
- **44,596,446 Dialysis treatments**
- **37 Production sites**
How Dialysis Works

In-center hemodialysis is the most common blood-cleansing therapy used by Americans with kidney failure. Patients typically are treated three times a week for three-to-four-hour sessions. Bloodlines can be attached to either a catheter or fistula.

**CONNECTION TYPES**

**A** Catheter
A tube inserted into a vein in the neck, chest or leg

**B** Fistula
A surgically created connection of an artery to a vein

**FLOW DIAGRAM**

1. Blood is pumped out of a patient’s catheter or fistula into the blood line.
2. Heparin, a blood thinner, is added to prevent clotting.
3. Blood flows into the dialyzer, where impurities, salt, and excess fluid are drawn into the dialysis solution.
4. Cleansed blood is returned.

Graphic by Al Granberg
Fresenius Chairside – World’s largest Healthcare Deployment

up to 100k Treatments/day
8 Time zones
Factors driving change at Fresenius

Advances in medicine and technology

All the research in the world is meaningless unless it turns into meaningful results for patients, which is why our research and development efforts are designed to quickly turn new findings into market-ready products. This quick time to market enables us to offer safer and more effective individualized treatment to each and every patient. We focus on technologies to reduce product size and simplify their use, while integrating various treatment elements to create holistic therapy systems.

Sustained growth in patient numbers

It is estimated that by 2020, there will be 3.8 million kidney patients worldwide, fueled by an increase in the number of people who suffer from diseases such as high blood pressure and diabetes. As the number of kidney patients rises, health care systems across the globe will be challenged to find the resources to care for them. Meeting the resulting demand for safe, effective and efficient therapies and associated technologies and products is central to our research and development activities.

Increase in concomitant diseases

Our society is aging overall and the risk of developing end-stage renal disease increases with age. As patients age they also experience a greater likelihood of developing concomitant diseases such as cardiac and vascular conditions. Treating these patients’ comorbidities is increasingly a focal point of our research and development efforts.

Rising cost pressure in health care

An aging population, growth in chronic illnesses, and the desire to offer new and improved technologies in patient care all present major long-term financial challenges to health care systems across the globe. For this reason, we believe successful product innovations must not be not only high quality, but also affordable. Based on our experience operating dialysis clinics, we consider these two priorities to be entirely compatible.
Ours is a typical healthcare enterprise

Oh wait... ours is a typical healthcare enterprise multiplied by 100 😊
Why Application Programming Interfaces Are Key for Healthcare

Application programming interfaces (APIs) are gaining traction in healthcare as developers seek simple, standards-based solutions for their interoperability problems.

WHAT IS AN APPLICATION PROGRAMMING INTERFACE?

An API is an interface that allows unrelated software programs to communicate with one another. They act as bridges between two applications, allowing data to flow regardless of how each application was originally designed.

For applications that function by pulling a constant stream of data from one or more sources, an API is especially important to decrease development time, save storage space on endpoint devices, and overcome any differences in the standards or programming languages used to create the data that lives at either end of the bridge.

For example, third-party travel planning sites like Expedia or Kayak don’t generate data on their own to deliver comparisons of flight prices from ten or twelve different airlines.

They simply use the API provided by each individual airline to plug into the flight scheduling software for each company and pull information into a single view for the end-user.
WHAT is FHIR (nickname FIRE)

• Fast Healthcare Interoperability* Resources
  • Exchanging electronic healthcare information
  • Built on modern web technologies - using REST API.
    • XML or JSON (Javascript Object Notation)
  • Clients to integrate, request and transfer data between different systems.
  • FHIR Resources - recipe used to exchange information and simple to use and easy to extend
  • FHIR Specifications - Defines a way in which resources can be exchanged between different systems.
  • Resource format is defined by the REST call exchanging the data.
  • Goal is to make healthcare information portable and interoperability better.

* noun: interoperability - the ability of computer systems or software to exchange and make use of information.
https://www.hl7.org/fhir/
FHIR Resources

- Resource Categories

**Administration**
- Patients
- Practitioner
- Organization
- Healthcare
- Service

**Clinical**
- Allergies
- Conditions
- Procedure
- Assessment

**Diagnostics**
- Observation
- Diagnostic Report
- BodySite
- Questionnaire
- Response

**Medications**
- Medication
- MedicationOrder
- MedicationAdmin
- Immunization

**Financial**
- Coverage
- Eligibility
- Enrollment
- Claim

**Workflow**
- Task
- Encounter
- Appointment
- Schedule
- Slot

**Security**
- Provenance
- AuditEvent
- Consent
FHIR Resources – API syntax

• Patient resource

<table>
<thead>
<tr>
<th>URL</th>
<th>Resource</th>
<th>ID</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="https://fhir-qa.fmcna.com/STU3/fhirapi/Patient/P5000307186?_format=json">https://fhir-qa.fmcna.com/STU3/fhirapi/Patient/P5000307186?_format=json</a></td>
<td>Patient</td>
<td>P5000307186</td>
<td>_format=json</td>
</tr>
</tbody>
</table>
• Resource identity and metadata

• Human readable

• Extensions

• Standard data contents
Fresenius Clinical Systems approach to APIs

**Fresenius FABRIC** Frezenius Advanced Backbone of Reusable Integrated Components

- SMART Healthcare Application Platform for Patients, Clinicians, Physicians
- SMART concepts Substitutable Medical Applications & Reusable Technologies

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**Fresenius FABRIC is**
- Collaborative app development
- Secure User and backend integration
- Transformative power of technology
- High performance and availability in all data centers

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**Fresenius FABRIC enables to**
- Harness and encourage user engagement
- Transform a system of record into a system of engagement
- Unleash back-end data
- Reduce development time and effort
Fabric concept

FMCNA Lines of Business
- Fresenius Kidney Partners
- Spectra & Shiel
- Fresenius Vascular Care
- National Cardiovascular Partners

Applications
- Enterprise Applications
- Web-based Applications (External & Local)
- Business Intelligence Reporting & Analytics
- Portal Services

FABRIC
- Workflow
- Rules Engine
- Data Transformation
- Services (Restful, FHIR, API...)
- Orchestration
- Development Platform

Applications
- Enterprise Applications
- Web-based Applications (External & Local)
- Business Intelligence Reporting & Analytics
- Portal Services

FMCNA Lines of Business
- Fresenius Health Care
- Fresenius Rx
- Medspring
- Sound Physicians

DATA
- eCF
- eCC
- Rx
- FVC

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Fabric FHIR manifestation – Internal applications and consumers

- SPA
- SWIFT
- Android
- Care Coordination
- Population Care Management
- Admissions
- Patent Portal
- Ordering
- Charting
- Clinician Portal
- Admissions
- Point of Care EHR
- User provision

Business Applications
- Spring Boot Container
- SPA Service
- SPA
- SPA Service
- Jboss EAP Container
- MPA

Business Application Domain Services

INTRANET
- OpenID Connect SSO
- Clinical
- Financial
- Others

FHIR
- OpenID Connect and Oauth2.0
- STU3 FHIR Server
- Enterprise Healthcare Data
- Precision Nephrology
- Workflow Engine
- Data Transformation
- Restful, FHIR, API...
- Orchestration
- Development Platform

DATA

#redhat #rhsummit
# Fabric layers under the hood

## Current Layers

<table>
<thead>
<tr>
<th>SMART OS</th>
<th>RedHat 6.x</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMART PaaS</td>
<td>Platform as a Service (container manager) – FABRIC8</td>
</tr>
<tr>
<td>SMART Containers</td>
<td>OSGI, SPRING BOOT (JVM stacks – Oracle WebLogic, JBoss EAP, Tomcat, Node.js)</td>
</tr>
<tr>
<td>SMART ESB</td>
<td>Web Services Apache CXF, Apache Camel Routes, Persistence (Mongo DB), back ends MS SQL, Oracle DB..</td>
</tr>
<tr>
<td>SMART SOA</td>
<td>FHIR Healthcare API, User Authorization, Caching, Workflow</td>
</tr>
<tr>
<td>SMART DATA</td>
<td>FHIR Resources</td>
</tr>
<tr>
<td>SMART APPS</td>
<td>Angular Apps</td>
</tr>
</tbody>
</table>

## Evolving Layers

<table>
<thead>
<tr>
<th>SMART Paas</th>
<th>OpenShift 3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMART Containers</td>
<td>Docker</td>
</tr>
<tr>
<td>SMART SOA</td>
<td>Data Virtualization</td>
</tr>
</tbody>
</table>
FHIM on FABRIC – The APIs

**Administration**
- Patients
- Practitioner
- Related Person
- Organization
- Healthcare Service
  ...

**Clinical**
- Allergies
- Conditions
- Procedure
- Clinical Impression
- Assessment
  ...

**Diagnostics**
- Observation
- Diagnostic Report
- BodySite
- QuestionnaireResponse
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**Medications**
- Medication
- MedicationOrder
- MedicationAdmin
- Immunization
  ...

**Financial**
- Coverage
- Eligibility
- Enrollment
- Claim
- EOB

**Workflow**
- Task
- Encounter
- Appointment
- Schedule
- Slot
- SupplyRequest
- SupplyDelivery
  ...

**Security**
- Provenance
- AuditEvent
- Consent
  ....

**Document**
- Composition
- DocumentManifest
- DocumentReference
  ....

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**FABRIC Components**

- FHIR
- Security
- Audit
- eCC
- MS SQL
- eCF
- MS SQL
- Pharm Rx
- MS SQL
- BPM
- ESB
- Cache
- Oracle
- onBase
- KCNG
- KC
- EMPI
BPM under the hood

**SMART DATA BPM**

*FHIR* Workflow, Business Process
*Dual Data Center* HA Active-Active

JBPM Suite, KIE Knowledge Is Everything
(Drools, jBPM, OptaPlanner)
BPMN 2.0, BEPL
User, Role and Credential Based
Authoring, Simulation
Data Modeler tied to FHIR Object Model
Deployment Management, Analytics
BPM and FHIR under the hood

**SMART DATA BPM**

**FHIR Workflow, Business Process**

**Dual Data Center HA Active-Active**

| Infrastructure | • Resource: Task  
| • Patterns: Definition, Request, Event  
| • Documentation: Overview, Overview, Communication Patterns, Ad-Hoc Patterns, Management Patterns & Examples  |
| Scheduling | • Appointments: Appointment / AppointmentResponse  
| • Availability: Schedule / Slot  |
| Clinical Process | • Referrals: ReferralRequest, ProcedureRequest  
| • Orders: NutritionOrder, VisionPrescription  
| • Definitions: ActivityDefinition, PlanDefinition  
| • Miscellaneous: ProcessRequest & ProcessResponse, DeviceRequest & DeviceUseStatement, SupplyRequest & SupplyDelivery  |
WHY BRMS
We Hear Yes

- Business automation
- Segregate Rules and application code
- Business user friendly
- UI tools for business
- Developer tool with eclipse
  - Marketplace -> Redhat developer studio
- Decision service -> Rules Engine
- Business Process Module
Use Case

• FEA drugs are expensive.
• Requires extensive approval process.
• Process is / was manual.
  • Clinics submits requests for a patient on a paper form.
  • FEA department reviews each requests – approve or deny.
  • Operational integrity team enters assessments in the EMR for each approved patient.
  • Approval requires the patient to be Financially eligible and Clinically eligible for certain drugs. Clinical Eligibility is required.
P&T (Pharmaceutical and Therapeutics) Project

• Phase I (Sensipar and Parsabiv)

• Phase II (Dialyser and other FEA drugs)
P&T (Pharmaceutical and Therapeutics) Project

• Phase I
  • Nightly Process (Sensipar)
    • Run a query for Financially Eligible (FE) Patients – add them to group in FHIR / FABRIC
    • Run rules for Clinical Eligibility (CE)
      • If clinical eligible (passed thru all rules)
        • Add this patient to CE group.
        • Create an assessments – approved for the drug to be added to their order (treatment)
    • Find patients from FE group that are not CE and run rules to see if the have become CE.
  • P&T UI (Sensipar denials and Parsabiv Approvals and other FEA drugs Approvals)
    • Check if the Patient is FE
      • Run rules for Clinical Eligibility (CE)
      • If clinical eligible (passed thru all rules).
      • Create an assessments – approved for the drug to be added to their order (treatment)
<table>
<thead>
<tr>
<th>Condition</th>
<th>Number</th>
<th>Denial Rules</th>
<th>Message to the user in P&amp;T application</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Patient is not Financially eligible</td>
<td>FKC is not responsible for Sensipar for this patient</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Patient Age is &lt; 18 years</td>
<td>Patient is less than 18</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Patient has allergy to Sensipar</td>
<td>Patient is allergic to Sensipar</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>CDP does not contain active N25.81 diagnosis code</td>
<td>Patient CDP does not contain N25.81 comorbidity</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>More than one PTH results at least 14 to 60 days apart not found in the past 90 days</td>
<td>Patient does not have two qualifying PTH results in the past 90 days</td>
</tr>
<tr>
<td></td>
<td>5A</td>
<td>The two PTH results are not at least 14 to 60 days apart in the past 90 days.</td>
<td>Patient does not have two qualifying PTH results in the past 90 days at least 14 days and no more than 60 days apart</td>
</tr>
<tr>
<td></td>
<td>5B</td>
<td>latest PTH &lt;= 400</td>
<td>Latest PTH results is less than or equal to 400 (show the value)</td>
</tr>
<tr>
<td></td>
<td>5C</td>
<td>latest PTH &gt; 400 &lt;= 600 and is less than second last PTH level which is at least 14 days older than the latest PTH result date</td>
<td>Latest PTH result not consistent with an increasing trend (show the values)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Serum Calcium result not found within past 30 days</td>
<td>Patient does not have a Calcium, Total result in the past 30 days</td>
</tr>
<tr>
<td></td>
<td>6A</td>
<td>latest Serum Calcium result value &lt; 8.5 within past 30 days</td>
<td>Latest Calcium, total result is less than 8.5</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Active order not found for Oral Calcitriol or hectorol(oral or IV) or Zemplar(oral or IV)</td>
<td>Patient has no active order for vitamin D</td>
</tr>
<tr>
<td></td>
<td>7B1</td>
<td>Active Oral Calcitriol order dose is &lt; 1.25 mcg or frequency &lt; 3 x weeks</td>
<td>Inadequate vitamin D dose, Active Oral Calcitriol dose is &lt; less than 1.25 mcg or frequency &lt; 3 x week (show values)</td>
</tr>
<tr>
<td></td>
<td>7B2</td>
<td>Active IV Hectoral order dose is &lt; 3 mcg or frequency is &lt; 3 x weeks</td>
<td>Inadequate vitamin D dose, Active IV Hectoral order dose is less than 3 mcg or frequency &lt; 3 x week (show values)</td>
</tr>
<tr>
<td></td>
<td>7B3</td>
<td>Active oral Hectoral order dose is &lt; 4 mcg or frequency is &lt; 3 x weeks</td>
<td>Inadequate vitamin D dose, Active Oral Hectoral order dose is less than 4 mcg or frequency &lt; 3 x week (show values)</td>
</tr>
<tr>
<td></td>
<td>7B4</td>
<td>Active IV or Oral Zemplar order dose is &lt; 5 mcg or frequency is &lt; 3 x weeks</td>
<td>Inadequate vitamin D dose, Active Zemplar order dose is less than 5 mcg or frequency &lt; 3 x week (show values)</td>
</tr>
</tbody>
</table>
BUSINESS RULES – Acceptance Rules

Auto Approval for Sensipar (Incenter or At Home)

For Incenter/PD/HHD

1. Must have a Sensipar Financial Authorization present and - must have auth, no appeal without auth
2. Is Adult >= 18 and
3. Does not have allergy to requested medication and
4. Has ACTIVE Diagnosis on CDP of Secondary Hyperparathyroidism (N25.81) and
5. Has PTH within the last 12 weeks (> 600 over on two consecutive tests 4 weeks apart. (minimum 2 weeks maximum 8 weeks with average 4 weeks) ) or
6. Has PTH within the last 12 weeks (> 400 on two consecutive tests 4 weeks apart with increasing values between the two dates (minimum 2 weeks maximum 8 weeks with average 4 week) ) and
7. Have to have active order for Oral Calcitriol or
8. Have to have active order for IV Hectorol or
9. Have to have an active order for Oral Hectorol or
10. Have to have active order for IV Zemplar or
11. Have to have active order for Oral Zemplar and
12. Serum Calcium >= 8.5 within the last 4 weeks and
13. If Oral Calcitriol Y then Dose of Oral Calcitrol has to be >= 1.25 mcg or
14. If IV Hectorol Y then Dose of IV Hectorol has to be >= 3 mcg or
15. If Oral Hectorol Y then Dose of Oral Hectorol has to be >=4 mcg or
16. If IV Zemplar Y then Dose of IV Zemplar has to be >= 5 mcg or
17. If Oral Zemplar Y then Dose of Oral Zemplar has to be >= 5 mcg and
18. If Oral Calcitriol Y the frequency must be >= Three times a week (TIW) or
19. If IV or Oral Hectorol Y then frequency of IV or Oral Hectorol must be >= Three times a week (TIW) or
20. If IV or Oral Zemplar Y then frequency of IV or Oral Zemplar must be >= Three times a week (TIW) OR
Data passed to Rules Engine

"valueString": "{\"patientMrn\": \"5000307404\", \"patientVoid\": \"2026253\", \"userLoginId\": \"TPTCommittee\", \"clinicId\": \"1271\", \"formUsage\": \"Exception Medications\", \"formUsageDisplayName\": \"Formulary Exception Medications\", \"formElementName\": \"FE_4%SodCitBox\", \"assessmentData\": [{\"name\": \"SCH_EntityName\", \"value\": \"1271\"}, {\"name\": \"FE_SensiAuth\", \"value\": \"FHIRAUTOMOTIVE\"}, {\"name\": \"FE_SensiStDt\", \"value\": \"20180105\"}], \"medRequestJPAId\": \"MRP1170106328\"}"

#redhat #rhsummit
"coding": [
  {
    "code": "Parsabiv Financial Eligibility"
  },
  {
    "text": "Parsabiv Financial Eligibility"
  }
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"valueBoolean": false
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        }
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      "text": "denial"
    },
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      "coding": [
        {
          "system": "http://hl7.org/fhir/v3/FMCRule",
          "code": "1. Patient IS NOT Financially eligible for Sensipar",
          "display": "FKC is not responsible for Sensipar for this patient. Discuss with the provider placing a prescription for Sensipar adm"
        }
      ],
      "text": "denial"
    }
  }
]
ROI – automated process

Automated
- Denials using UI
- Nightly Process

Manual
- Manual Entry
- Review
- Form Submissions

Times 1000 clinics
ROI – Cost Benefit

• Time spent on one approval
  • 1-2 hours per request
  • 100 requests per day
    • Hours saved per day 100 to 200 person hours
• Projected 500 requests per day with Sensipar
• Manual hours saved
• Cost of project recovered in 2 -3 months
BRMS Challenges – Worth Investing time and money

Time consuming at first
- Initial setup
- Training
- Consultant help – extremely helpful

- Initializing variables
- Understanding of Rules group
- Conversion of FHIR objects

- Learning MVEL dialect
- Attaching rules in the Process
- Execution of Rules
List of resources

https://access.redhat.com/documentation/en-us/red_hat_jboss_bpm_suite/
https://www.drools.org/learn/documentation.html
https://www.drools.org/learn/video.html
https://www.drools.org/learn/slides.html
https://www.drools.org/download/download.html
https://docs.jboss.org/drools/release/6.5.0.Final/drools-docs/html_single/
https://github.com/marianbuenosayres/jBPM6-Developer-Guide
https://www.javacodegeeks.com/minibook/jboss-drools-cookbook
https://github.com/kiegroup/drools
https://github.com/kiegroup/drools/tree/master/drools-examples
https://developers.redhat.com/products/red-hat-decision-manager/download/
https://developers.redhat.com/products/bpmsuite/download/?sc_cid=701f2000000tvRKAAY&gclid=EAIaIQobChMIhMaNjf202gIVDBBpCh2PcAR3EAAYASAAEgJxyPD_BwE
THANK YOU

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