Regenstrief Institute’s New Medical Gopher: A Next-Generation Open-Source Physician Order Entry System

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MedInfo 2013
THE MEDICAL GOPHER -- A MICROCOMPUTER BASED PHYSICIAN WORK STATION

Clement J. McDonald, M.D.
Reprinted from Proceedings of 1984 SYMPOSIUM ON COMPUTER APPLICATIONS IN MEDICAL CARE
November 4-7, 1984 Washington, D.C.
<table>
<thead>
<tr>
<th>Patient</th>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Bed #</th>
<th>Provider</th>
<th>Note Label</th>
<th>Consult Note - Gopher</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>999999-6</td>
<td>26 FEB 1984</td>
<td>01:42PM</td>
<td>EXAM01</td>
<td></td>
<td>TEST, RESIDE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Consultants Recommended Orders**

1. **REVISE** Sorbitol 70% Solution 30 ml
2. SUGGEST D/C Docusate Na 100 mg PO
3. Morphine Sulfate SR 15 mg PO Q12H

**Consultants Recommended Orders choices**

1) Comprehensive Metabolic
2) Hepatic Function Panel
3) Docusate Na
4) Sorbitol 70% Solution
5) Regular Diet
6) Up Ad Lib
Gopher

• Gopher grew from a single clinic to over 1000 workstations, inpatient, outpatient, ED
• 25+ years of iterations has resulted in robust functionality and efficiency
• Served as the research platform for many of the seminal studies in healthcare computing
1984

Consultant's Recommended Orders
1. REVISE Sorbitol 70% Solution 30 ml
2. SUGGEST D/C Docusate Na 100 mg PO
3. Morphine Sulfate SR 15 mg PO Q12H

Consultant's Recommended Orders choices
1) Comprehensive Metabolic
2) Hepatic Function Panel
3) Docusate Na
4) Sorbitol 70% Solution
5) Regular Diet
6) Up Ad Lib

2010

Consultant's Recommended Orders
1. REVISE Sorbitol 70% Solution 30 ml
2. SUGGEST D/C Docusate Na 100 mg PO
3. Morphine Sulfate SR 15 mg PO Q12H

Consultant's Recommended Orders choices
1) Comprehensive Metabolic
2) Hepatic Function Panel
3) Docusate Na
4) Sorbitol 70% Solution
5) Regular Diet
6) Up Ad Lib
Developing the new Gopher

• In 2009 Regenstrief Institute began rebuilding its core clinical information system platform.
• In 2010, we began work on a new web-based version of the venerable Gopher.
• This system was designed using the knowledge gained from the past 25 years of Gopher as well as from the evolving literature on CPOE system design.
Started with a Blank Slate
Guiding Principles

Support Patient Safety
Improve Quality of Care
Improve User Satisfaction
Promote Provider Efficiency
Design Strategies

Leverage Metaphors

Constrain Then Innovate

Set Gravity in the Right Direction
Leverage Metaphors
Leveraging Metaphors
Leveraging Metaphors
Leveraging Metaphors
## E-Commerce

### Medications

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>Refills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citalopram 10 mg Tab</td>
<td>10 MG By Mouth Hourly</td>
<td>#60 Tab(s) with 3 refills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lisinopril 10 mg Tab</td>
<td>1 Tab(s) By Mouth Daily</td>
<td>#90 Tab(s) with 1 refill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LORazepam 0.5 mg Tab</td>
<td>1 Tab(s) By Mouth Every 12 hours as needed for Anxiety</td>
<td>#56 Tab(s) with no refills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>metFORMIN HCI 500 mg Tab</td>
<td>1 Tab(s) By Mouth 2 times daily</td>
<td>#60 Tab(s) with 1 refill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naproxen 250 mg Tab</td>
<td>250 MG By Mouth Every 8 hours as needed for pain</td>
<td>#30 Tab(s) with no refills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sertraline 100 mg Tab</td>
<td>200 MG By Mouth Daily</td>
<td>#120 Tab(s) with 2 refills</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tests

- **Lipid Profile**: TODAY, (Billing Indication: diabetes mel insulin cefp) [250.01]

### Consults

- **Ophthalmology Consult/App**: Nurse/staff to schedule an appointment to see Dr. Jones next available for management suggestions for Glaucoma. Referred on 10 Jun 2013.
Workflow Wizards
Constrain
Then Innovate
140 characters

hashtags
retweets
url shorteners
brevity

Instagram
Vine
Yammer
Waze
Screen Real Estate

• At outset of development process, set aside an untouchable area of screen real estate
• That area— the InfoPanel— was not utilized for >1 year into development but has become a critical asset
06:22 PM DEV MD, DR STAFF ONE D said Sure, I'll meet you at the caf in 20 mins
06:22 PM SIMPSON, HOMER D said Will do. Want to grab a bite afterwards?
06:21 PM DEV MD, DR STAFF ONE D said I'm going to head up stairs to see Ms. Test, let me know if you need anything
06:20 PM SIMPSON, HOMER D said I just checked and they would like to keep her full code
06:20 PM DEV MD, DR STAFF ONE D said Homer, don't forget to check with her family re: Code Status
Set Gravity in the Right Direction
### Formulary Recognition

#### Medications

<table>
<thead>
<tr>
<th>Order</th>
<th>Medications</th>
<th>Imi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IMITREX (Sumatriptan Inj)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMITREX (Sumatriptan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMITREX NASAL SP (Sumatriptan Nasal Spray)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imipenem Inj</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imipramine Hydrochloride</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imipramine Inj</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imipramine Pamoate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imiquimod 5% Cr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imiquimod 3.75% Cr</td>
<td></td>
</tr>
</tbody>
</table>

#### Medications

<table>
<thead>
<tr>
<th>Order</th>
<th>Medications</th>
<th>hydrocort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydrocortisone 1% Cream</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 1% Ointment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 2.5% Cream</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 2.5% Ointment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACETIC ACID/HYDROCORTISONE (Vosol HC Otic Equiv)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLINDAMYCIN/HYDROCORTISONE CR (Clindamycin/HC Cream)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CLINDAMYCIN/SULFUR/HYDROCORT 1% (Clindamycin/Sulfur Pot/HC Cream)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COLISTIN/NEOMYCIN/HYDROCORT OTIC (Colymycin S Otic Sol)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HYDROCORTISONE FOAM (Epifoam)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 0.5% Shampoo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 0.5% Sp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 1% Lotion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone 2.5% Lotion</td>
<td></td>
</tr>
</tbody>
</table>
Allergy Entry

Aminoglycosides
- Tobramycin 0.3% Ophth Ont
- Tobramycin 0.3% Ophth Sol
- Tobramycin Inj
- Tobramycin Nebulizer Solution

Are you sure?
Allergies usually apply to a class rather than a specific drug

Switch to Aminoglycosides
Leave as Tobramycin 0.3% Ophth Ont
Fitt’s Law

Warfarin interacts with Naproxen

Effect: In some patients, NSAIDs have been associated with an increase in the hypoprothrombinemic effect to anticoagulants. Mode of Action: The exact mechanism is unknown. Some NSAIDs may displace anticoagulants from plasma protein binding sites. NSAIDs also have the potential to produce gastrointestinal ulceration and bleeding. Some NSAIDs may impair platelet function and prolong bleeding times.

Patient on Naproxen 250.0MG Every 8 hours

Cancel Warfarin Order  Continue Order
### Medicaions

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Frequency</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen 300 MG / Codeine Phosphate 30 MG Oral Tablet</td>
<td>2 Tab(s)</td>
<td>By Mouth Every 6 hours, #40 Tab(s) with 2 refills, for Poliomyelitis (ICD: 045.90)</td>
<td>10-23-2012</td>
</tr>
<tr>
<td>Acetaminophen 325 MG Oral Tablet</td>
<td>1 Tab(s)</td>
<td>By Mouth Every 4 hours as needed for pain or fever, No more than 6 tablets each day, #60 Tab(s) with 1 refill</td>
<td>10-16-2012</td>
</tr>
<tr>
<td>Amoxicillin 0.25 MG/ML</td>
<td>1 mg</td>
<td>Intravenous 3 times daily, #7.2 ML with 1 refill</td>
<td>11-23-2011</td>
</tr>
<tr>
<td>Ampicillin 500 MG Oral Capsule</td>
<td>500 MG By Mouth 3 times daily, #30 Cap(s) with 3 refills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin 500 MG Enteric Coated Tablet</td>
<td>500 MG By Mouth Daily, #60 Tab(s) with 2 refills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erythromycin 500 MG Enteric Coated Tablet</td>
<td>500 MG By Mouth Bedtime, #99 Tab(s) with no refills, for foot ulcer(s) (ICD: 970.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esomeprazole 20 MG Enteric Coated Capsule</td>
<td>1 Cap(s)</td>
<td>By Mouth Daily, #90 Cap(s) with 1 refill</td>
<td>10-23-2012</td>
</tr>
<tr>
<td>Furosemide 80 MG Oral Tablet</td>
<td>80 MG By Mouth 4 times daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glimepiride 1 MG Oral Tablet</td>
<td>1 MG By Mouth 2 times weekly, #60 Tab(s) with 1 refill</td>
<td>12-19-2011</td>
<td></td>
</tr>
<tr>
<td>Hydrocodone 5/Methadone 500</td>
<td>Take one tablet daily after dinner, #55 Tab(s) with 2 refills</td>
<td>06-26-2012</td>
<td></td>
</tr>
<tr>
<td>Midodrine Bitartrate 7.5 MG</td>
<td>1 Tab PO q4h pm (Do not take any more than 5 tablets per day), #50 Tab(s) with 4 refills, Comments to pharmacy: This is a controlled substance. Printed prescription is available.</td>
<td>06-25-2012</td>
<td></td>
</tr>
<tr>
<td>NPTh Regular Insulin, Human 70U/ml (50 IU/mL)</td>
<td>Test, #5 Vial(s) with 1 refill</td>
<td>08-09-2012</td>
<td></td>
</tr>
<tr>
<td>Mg-AI Hydroxides Suspension 200-225 MG/ML</td>
<td>15 ML By Mouth Every 4 hours as needed for stomach upset, #1 Bottle(s) with 1 refill</td>
<td>10-23-2012</td>
<td></td>
</tr>
<tr>
<td>Sertraline 100 MG Oral Tablet</td>
<td>Safety and efficacy not established for children under 12 yrs of age, #4 Tab(s) with 1 refill</td>
<td>10-21-2012</td>
<td></td>
</tr>
</tbody>
</table>

### Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Last Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus (250.11)</td>
<td>06-21-2012</td>
</tr>
<tr>
<td>Foot Ulcer(s)</td>
<td>09-25-2012</td>
</tr>
<tr>
<td>Headache</td>
<td>10-17-2012</td>
</tr>
<tr>
<td>Mild Cognitive Impairment (MC) (331.83)</td>
<td>09-26-2012</td>
</tr>
<tr>
<td>Moderate Persistent Asthma (493.92)</td>
<td>02-20-2012</td>
</tr>
<tr>
<td>Nausea (789.02)</td>
<td>06-25-2012</td>
</tr>
<tr>
<td>Poliomyelitis (045.90)</td>
<td>12-19-2011</td>
</tr>
<tr>
<td>Pregnant (V23.9)</td>
<td>10-18-2012</td>
</tr>
<tr>
<td>Weight Loss</td>
<td>10-23-2012</td>
</tr>
</tbody>
</table>

### Allergies

<table>
<thead>
<tr>
<th>Allergy</th>
<th>Onset Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOXICILLINS</td>
<td>10-17-2012</td>
</tr>
</tbody>
</table>
What’s inside the new Gopher?

• **Data capture**
  – Order entry
  – Note Writing
  – Observations
  – Patient Letters
  – Document uploader
  – Electronic signature
  – Problem list management
  – Allergy Management
  – Order Sets
  – Natural Language Processing

• **Results display**
  – Recent results
  – Flowsheet
  – Clinical abstract
  – Clinical documents
  – Encounter display
  – Order summary
  – Appointment history
  – Patient dashboard
  – Medication summary
  – Chart search

• **Clinical Decision support**
  – Alert display
  – InfoPanel
  – Rule Authoring
  – Relevance Adjustment Module
  – FDB Integration

• **Setting-specific functionality**
  – Outpatient
  – Inpatient
  – Emergency Department
  – Touch interface

• **Administrative Tools**
  – User management
  – Remote troubleshooting
  – Property management
  – Concept mapping
  – Disaster aid support

• **System integration**
  – McKesson portal
  – Relay Health portal
  – Docs4Docs integration

• **Research**
  – Randomization
  – Medication adherence
  – Medication reconciliation
  – Med profile visualization
  – ResNet Recruitment
  – SMART plug-ins

• **Certifications**
  – Meaningful Use Inpt / Outpt
  – NCPDP e-Prescribing

• **Reporting**
  – Population search
Major Functions

• Order entry
• Documentation / note writing
• Medication / problem / allergy management
• Results viewing
• Research
• Clinical decision support
Advancements in New Gopher

• Context-Driven Dynamic Alerts
• Adaptive Learning
• Real-time Natural Language Processing
• Multimedia Alerts
• Advanced Rule Authoring
Advancement #1: Dynamic Alerts

• Gopher has embedded mechanics to dynamically change alert display based on context
  – Patient
  – Physician
  – Institutional
Alerting Zones
Relevance Adjustment Module

- Every alert has a baseline relevance level which determines its display location
- For example, for DDI alerts, about 40% are interruptive and 60% non-interruptive
- The RAM can adjust this default level
TRIAMTERENE Interacts with LISINOPRIL
Risk of **Hyperkalemia**
Severity: Moderate
Relevance: 5 (Average)

**Lisinopril** Order

**Original Alert**

**Final Alert**

TRIAMTERENE Interacts with LISINOPRIL
Risk of **Hyperkalemia**
K 5.3*, Cr 1.3, GFR 55
Relevance: 7 (High)

**DDI Alert Service**

**Relevance Adjustment Module**

**Related Concepts**

Hyperkalemia Has Relevant Labs:
K, Cr, GFR

**Data Repository**

Patient has lab values:
K 5.3*, Cr 1.3, GFR 55
Risk of Hyperkalemia
Triamterene-75/HCTZ-50 interacts with Lisinopril
Patient on Lisinopril

Management Recommendations
- Cancel Triamterene-75/HCTZ-50 Order
- D/C Lisinopril

No thanks, continue with this order
Lisinopril Order

Original Alert
TRIAMTERENE Interacts with LISINOPRIL
Risk of Hyperkalemia
Severity: Moderate
Relevance: 5 (Average)

DDI Alert Service
TRIAMTERENE Interacts with LISINOPRIL
Risk of Hyperkalemia
K 3.3, Cr 0.8, GFR 114
Relevance: 3 (Low)

Final Alert

Relevance Adjustment Module
Related Concepts
Hyperkalemia Has Relevant Labs:
K, Cr, GFR

Data Repository
Patient has lab values:
K 3.3, Cr 0.8, GFR 55
Relevance Adjustment Module

• RAM can also make changes based on provider characteristics
• For example, can make particular alerts non-interruptive for certain specialties
• Conversely, for medical students all alerts can be made interruptive
Advancement #2:
Gopher is a Learning System
Advancement #2: Gopher is a Learning System

• Gopher can track user actions and activity such as
  – Number of logins
  – Frequently selected orders
  – Responses to previous alerts

• Can customize system behavior based on individual user history
Alerts That Learn

Risk of Hemorrhage and Increased anticoagulant effect

Warfarin interacts with Diazepam

Details >

Patient on Diazepam 5 MG

Details >

Cancel Warfarin Order  Continue Order
Alerts That Learn

Risk of Hemorrhage and Increased anticoagulant effect

Warfarin interacts with Diazepam

Patient on Diazepam 5 MG
Advancement #3: Natural Language Processing

- Gopher can analyze notes in **real-time**
- Can determine section (e.g., FHx, PMH) to give context to the concepts retrieved
- Multiple services may be run simultaneously (e.g., CDS, quality metrics, study recruitment)
- Results may be displayed as alert or used for background data capture

Section header detection thanks to SecTag from Vanderbilt University:
http://knowledgemap.mc.vanderbilt.edu/research/content/sectag-tagging-clinical-note-section-headers
A/P:

1) DM - due for A1c, ophtho consult, lytes.
2) HTN increase lisinopril, get EKG, consider ECHO
3) Hyperlipidemia - overdue for lipids, get today
4) Screening- need colonoscopy, PSA
Study Reminders

FHx: Breast CA, HTN

Study Reminder
Dr. Smith is recruiting for a study on patients with a family history of breast cancer. If appropriate, may we contact this patient for this study?

- Yes
- No
- No Family History of breast CA

Submit
Natural Language Processing

• Can be used as a CDS trigger
• Can be used to enhance structured documentation for ‘meaningful use’
• Can be used for clinical research
• Integrated with our Advanced Rule Authoring environments
Advancement #4: Multimedia Alerts

Propafenone may interact with the patient's allergy to Propafenone (rash)

You ordered Propafenone and patient had Propafenone allergy documented by TEST CNA, MEDICAL ASST THREE D
Warfarin interacts with Amiodarone

Details >

Patient on Amiodarone 300.0MG

Details >
Adherence Information

Outpatient Orders and Documentation

Problems
- arthritis other (716.90)
- diabetes mellitus insulin dep (250.01)
- headache (784.0)
- Mild Cognitive Impairment (331.83)
- moderate persistent asthma (493.92)
- nausea (787.02)
- Poliomyelitis (045.90)

Medications
- Acetamin/Codeine
- Amoxicillin 0.25 MG/ML
- Ampicillin 500 MG
- Aspirin 500 MG
- Erythromycin 500 MG
- Esomeprazole 20 MG
- Furosemide 80 MG
- Glimepiride 1 MG
- HYDROCODONE 5/ACETAMINOPHEN 500

Recent Orders
- 14-Aug-2012 Amlodipine/Atorvastatin DC
- 13-Aug-2012 Esomeprazole
- 13-Aug-2012 Amlodipine/Atorvastatin
- 09-Aug-2012 Insulin Hurn 70/30

Prevention/Recommendations

Alerts

Diabetes Drug Adherence

ACTOS 92% (GOOD)

Congratulations the patient on their good adherence to the above medication(s).

AMARYL 20% (POOR)

HUMALOG MIX 75:25 12% (POOR)

Please discuss with patient and medical issues such as:
- Medication concerns
- Perceived need
- Perceived affordability
- Forgetting to take or pick up
- Transportation problems

Other issues
Research Study Eligibility

This patient may be eligible for a study on the Effect of Januvia (Sitagliptin) on Oxidative Stress in Obese Type 2 Diabetics.

- **Age**: 46
- **Gender**: F
- **Height (in.)**: 61
- **Weight (lbs.)**: 196
- **BMI**: 35
- **HbA1c**: 8.2%

- Is patient on Statin, ACE Inhibitor, Thiazolidenedione, or Antioxidant?
- Is patient a stable dose?
- Is patient on Exenatide, incretin, or insulin therapy?
Advancement #5: Advanced Rule Authoring

• The Rule Authoring and Validation Environment (RAVE) is a rule authoring tool within Gopher

• The RAVE is designed to empower stakeholders to create complex, rule-based actions using a simple graphical interface
Rule Authoring

• Rules are necessary to drive decision support logic as well as other system actions
• Rule authoring is generally a complex task requiring code-like syntax
BLOCK_GERCLCR_LISINO

(CARE_VARIABLE) Rule Type : REMINDER

Author/Respn : ABERNATHY, GREGORY, Last Changed by ABERNATHY, GREGORY
(Changed : 10/22/07 11:00:25) - (Compiled : 10/22/07 11:00:25)

1) If {PREGNANT_POSSIBLE/L}
suggest: !:ACE inhibitors increase the risk of MAJOR CONGENITAL MALFORMATIONS. If this pt is pregnant, ACE inhibitors are CONTRAINDIQUED;!
message:
msg ID : n/a Guideline ID : n/a
2) If {AGE}>=17 AND {AGE}<=50 AND {SEX}="F"
suggest: !:Female of child-bearing age. ACE inhibitors increase the risk of MAJOR CONGENITAL MALFORMATIONS (including likely in first trimester - NEJM 2006). Avoid if currently pregnant. Consider pros/cons of using an ACE inhibitor if might become pregnant.!
message:
msg ID : n/a Guideline ID : n/a
3) If ({AGE}>17 AND {CREATININE_LAST/N} AND {GERSTUDY_CLCR/L} AND NOT({BLOCK_GERCLCR_EXCLUSIONS})) AND {USER_STUDY} CONTAINS "u"
suggest: message: Usual Care Provider, no reminder shown. Estimated creatinine clearance {GERSTUDY_CLCR} ml/min. Creatinine {CREATININE_LAST/N} on {CREATININE_LAST/D}. Weight {GERSTUDY_WGHT_LBS/N} lbs on {GERSTUDY_WGHT_LBS/D}
msg ID : n/a Guideline ID : n/a
4) If ({AGE}>17 AND {CREATININE_LAST/N} AND {GERSTUDY_CLCR/L} AND NOT({BLOCK_GERCLCR_EXCLUSIONS})) AND {GERSTUDY_CLCR} >= 10 AND {GERSTUDY_CLCR} < 30
suggest: !:For initiating antihypertensive therapy or adding lisinopril to an existing blood pressure regimen and creatinine clearance > 10 ml/min and < 30 ml/min;!! The suggested dose is lisinopril 5 mg per day
message: Lisinopril should be ADJUSTED for RENAL INSUFFICIENCY. This patients estimated creatinine clearance of {GERSTUDY_CLCR} ml/min is based on a creatinine of {CREATININE_LAST/N} on {CREATININE_LAST/D} and a weight of {GERSTUDY_WGHT_LBS/N} lbs on {GERSTUDY_WGHT_LBS/D}. For patients not on dialysis, the following dosing schedule is recommended.
msg ID : n/a Guideline ID : n/a
5) If ({AGE}>17 AND {CREATININE_LAST/N} AND {GERSTUDY_CLCR/L} AND NOT({BLOCK_GERCLCR_EXCLUSIONS})) AND {GERSTUDY_CLCR} < 10 AND {GERSTUDY_CLCR} > 0
suggest: !:For initiating antihypertensive therapy and creatinine clearance < 10 ml/min;!! The suggested dose is lisinopril 2.5 mg per day
message: Lisinopril should be ADJUSTED for RENAL INSUFFICIENCY. This patients estimated creatinine clearance of {GERSTUDY_CLCR} ml/min is based on a creatinine of {CREATININE_LAST/N} on {CREATININE_LAST/D} and a weight of {GERSTUDY_WGHT_LBS/N} lbs on {GERSTUDY_WGHT_LBS/D}. For patients not on dialysis, the following dosing schedule is recommended.
msg ID : n/a Guideline ID : n/a
6) If DEFAULT
suggest:
message: CRCL above cutoff. No reminder shown. Estimated creatinine clearance {GERSTUDY_CLCR} ml/min. Creatinine {CREATININE_LAST/N} on {CREATININE_LAST/D}. Weight {GERSTUDY_WGHT_LBS/N} lbs on {GERSTUDY_WGHT_LBS/D}
msg ID : n/a Guideline ID : n/a
Duration : 1 HOUR Null Rule :
Daughter Rules:
1) AGE 3) CREATININE_LAST 5) GERSTUDY_WGHT_LBS 7) SEX
2) BLOCK_GERCLCR_EXCLUSIONS 4) GERSTUDY_CLCR 6) PREGNANT_POSSIBLE 8) USER_STUDY
Good artists copy. Great artists steal.

- Pablo Picasso
Put the internet to work for you.

Join IFTTT
Channels

You have 17 of 63 Channels activated
New status message = Post a tweet
by parifftt on May 24, 2013
used 16 times

Send attachments to my backup Gmail account
by kev on Jun 13, 2013
used 12 times

favorite a youtube video = email is sent with embedded video & url
by magic7602 on Jun 7, 2013
used 6 times

Text me today's forecast each morning
by jwolff76 on Jun 13, 2013
used 46 times

Save all Gmail attachments to Drive
by phoenix710 on Jun 10, 2010
used 166 times

send weather forecast to Twitter
by rferia on May 31, 2013
used 13 times
**Trigger**

Tomorrow's forecast calls for
This Trigger monitors changes in tomorrow's forecasted weather condition.

**Condition**

Rain

**Action**

Send me an SMS
This Action will send an SMS to your mobile phone.

**Message**

`Tomorrow's Condition` tomorrow!

**Weather Ingredients**
Data from the Trigger

Select an Ingredient

Use Recipe
RAVE = IFTTTT for EMRs

• Built a variety of channels for EMR activities
• Channels may server as
  – Triggers (If)
  – Actions (Then)
  – Both
• Additionally, we added a ‘For’ component to specify when the rule should be run
Rule Authoring and Validation Environment

CHF Renal Failure Rule edit

For... If... Then...

Patient
User

Enable this Rule

Save Rule Cancel
Rule Authoring and Validation Environment

CHF Renal Failure Rule  edit

Order
Problem
Note NLP
Allergy
Chart Actions

For...  If...  Then...

Enable this Rule
Save Rule  Cancel

Preview
Rule Authoring and Validation Environment

CHF Renal Failure Rule  edit

For...  If...  Then...

Alert
Email/Page
Logging

☐ Enable this Rule
Save Rule  Cancel

Preview
<table>
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<tr>
<th>RAVE Channels</th>
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<th>Then Channels</th>
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</tr>
<tr>
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<td></td>
<td>• HL7</td>
<td></td>
</tr>
</tbody>
</table>
FOR: Patient Channel

Patient Channel

1. Patient Age: $\geq 18$
2. Labs/Radiology: Creatinine Serum Qn $\leq 1.4$ within last 365 days
3. Patient Medication: Furosemide

Add another

Rule Logic:

$1+2+3$

Legend: "*" = and  "\|" = or  "\!" = not
Sample: $1 + 2 \; \| \; (3 + 4) \; \!$
IF: Diagnosis Channel

Rule Authoring and Validation Environment

CHF Renal Failure Rule edit

Problem Trigger Channel

- CHF  is added
- edema peripheral  is added

Add another

Save Channel Cancel

Preview
THEN: Alert Channel
CHF Renal Failure Rule

For

Patient Channel:
1. Patient Age: >= 18
2. Labs/Radiology: Creatinine SerPi Qn Any >= 1.4 within last 365 days
3. Patient Medications: Furosemide
Patient Channel Logic: 1+2+3

If

Diagnosis Trigger Channel:
CHF is added,

Note NLP
CHFCPOE:NTER.NLP.RESSUS,

Then

Alert Then Channel:
Alert Title: Caution with Lasix in Renal Failure
Alert Type: Sidebar Display
Alert Message: The patient's last Creatinine was ${CREATININE_LAST} and they are taking furosemide for CHF. Be sure to check the potassium and creatinine today!
Group Header: Suggested Labs
Group Suggested Orders:
Potassium SerPi Qn, Creatinine SerPi Qn,
RAVE Output

2 Labs/Radiology: Creatinine SerPl Qn
   Any > 1.4
   within last 365 days

3 Patient Medications: Furosemide
   Patient Channel Logic: 1+2+3

If

   Diagnosis Trigger Channel:
   CHF is added,

   Note NLP
   CHFCPOE.NOTE.NLP.RESULTS,

Then

   Alert Then Channel:
   Alert Title: Caution with Lasix in Renal Failure
   Alert Type: Sidebar Display
   Alert Message: The patient's last Creatinine was \${CREATININE_LAST} and they are taking furosemide for CHF. Be sure to check the potato
   Group Header: Suggested Labs
   Group Suggested Orders:
   Potassium SerPl Qn, Creatinine SerPl Qn,

Show Advanced Rule Syntax

Confirm Save  Cancel
RAVE DROOLS Syntax

```
rule "CHF Renal Failure Rule"
dialect "mvel"
enabled false
when
  $patient : Patient()
  $user : User()

  ( ( TargetEventConcept(name == "CPOE NOTE.NLP.RESULTS")
  and TargetConcept(code == "365", sysld == 1 )
  )
  or ( TargetEventConcept(name == "CPOE PROBLEM.ADDED")
  and TargetConcept(code == "365", sysld == 1 )
  )
)

Patient(numAgeInYears >= 18 )
and List(size > 0) from collect(ClinicalResult numericValue > 1.4) from getClinicalVariablesFromDate(patientRegistration, 1, "255", "Creatinine SerPl Qn", "BEFORE", 365, "DAY:"
and ActiveMedication(give.code == "133")
then
FormatterOptions options = new FormatterOptions();
options.setUnitized(true);
options.setTabular(false);

DroolsRuleResponse resp1 = new DroolsRuleResponse("The patient's last Creatinine was " + expandText(patientRegistration, "$\{CREATININE\_LAST\}")) + " and they are taking fun
resp1.addListValue("suggestedActions", new SuggestedAction("Suggested Labs"))
resp1.addListValue("suggestedActions", new SuggestedAction(1, "45"))
resp1.addListValue("suggestedActions", new SuggestedAction(1, "45"))
```
Rule Authoring and Validation Environment

Bibliographic citation of the intervention
Tierney et al. JAMA Oct 20 2004

Developer of the intervention

Funding source

Release funding source

Release date

Continue  Cancel
RAVE = Customizability

• Can mix and match channels to create a remarkable array of functionality without need for programmer intervention
• Can write rules just for yourself or (with permission) your clinic, specialty, or all users
• Rule syntax is generated automatically in a standard rules syntax (Drools)
Gopher Demo
Gopher and Open Source

• Regenstrief is philosophically and contractually committed to release of the new Gopher platform as open source software
• We are looking for partners to take part in both software development and community building around this effort
• Please let us know if this is something you would be willing to commit time and energy to pursuing
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- Chen Wen
Questions?

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